Ecological Site Descriptions: A Tool to Support Adaptive Management

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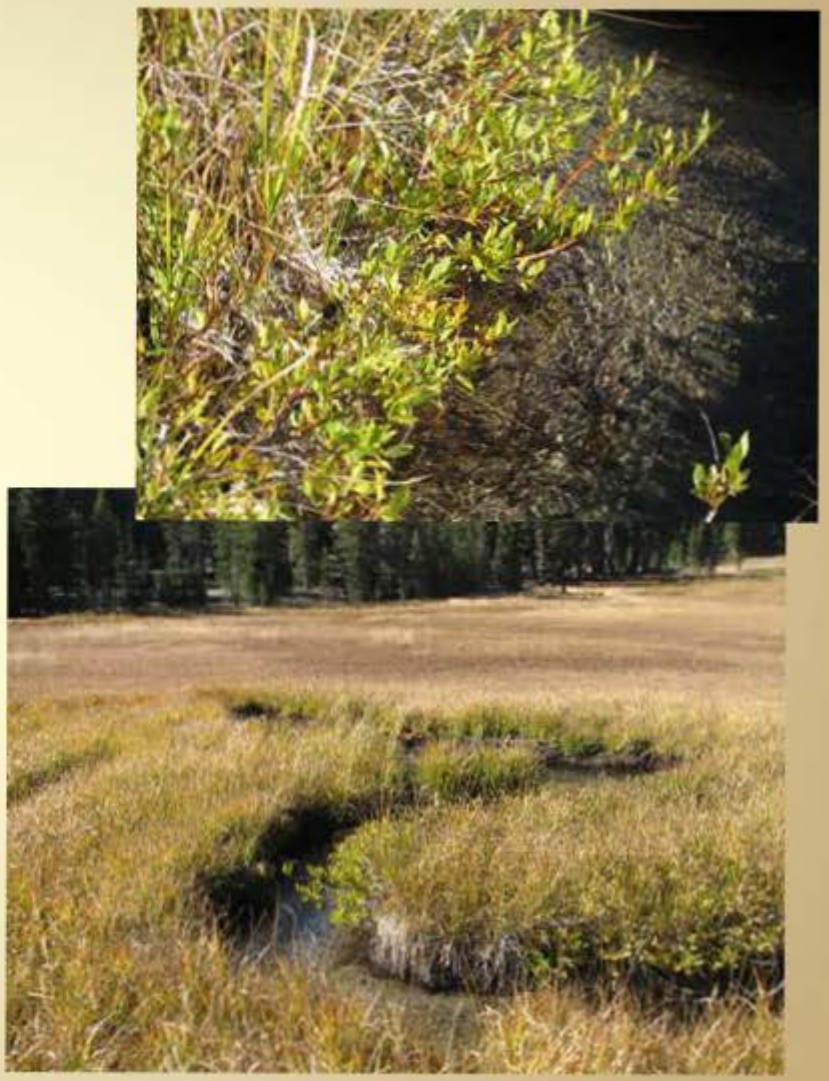
Outline

- What is an Ecological Site
- Ecological Site Process
- What is included in an Ecological Site Description
- Ways an ESD can be used for management

Ecological Site

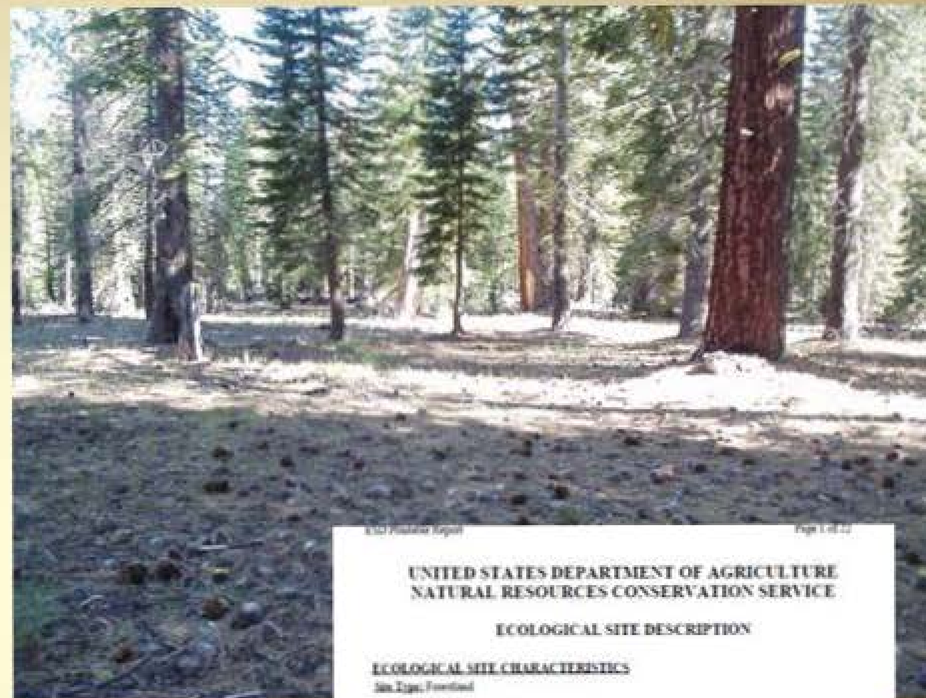
A distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation and in its ability to respond similarly to management actions and natural disturbances.

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

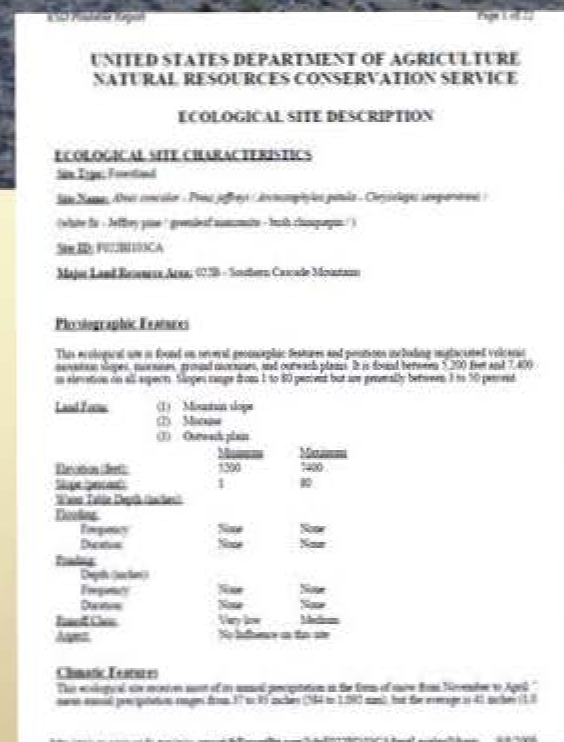


Ecological Sites

It is important to remember that ***ecological sites*** are a <u>conceptual</u> grouping of characteristic soils, vegetation, and hydrology based on similar climate, landform and disturbance regimes.



And ***ecological site descriptions*** are a <u>document</u> that describes and defines the relationships between these ecological characteristics, in order to provide land managers and land users a baseline or guideline for management on the ecological sites they work with.



UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

ECOLOGICAL SITE DESCRIPTION

ECOLOGICAL SITE CHARACTERISTICS

Site Type: Forestland

Major Land Resource Area: 022B - Southern Cascade Mountains

Physiographic Features

Land Form: (1) Mountain slope (2) Moraine (3) Outwash plain

	Minimum	Maximum
Elevation (feet):	5200	7400
Slope (percent):	1	80
Water Table Depth (inches):		
Flooding:		
Frequency	None	None
Duration	None	None
Ponding:		
Depth (inches)		
Frequency	None	None
Duration	None	None
Runoff Class:	Very low	Medium
Aspect:	No Influence on this site	

Climatic Features

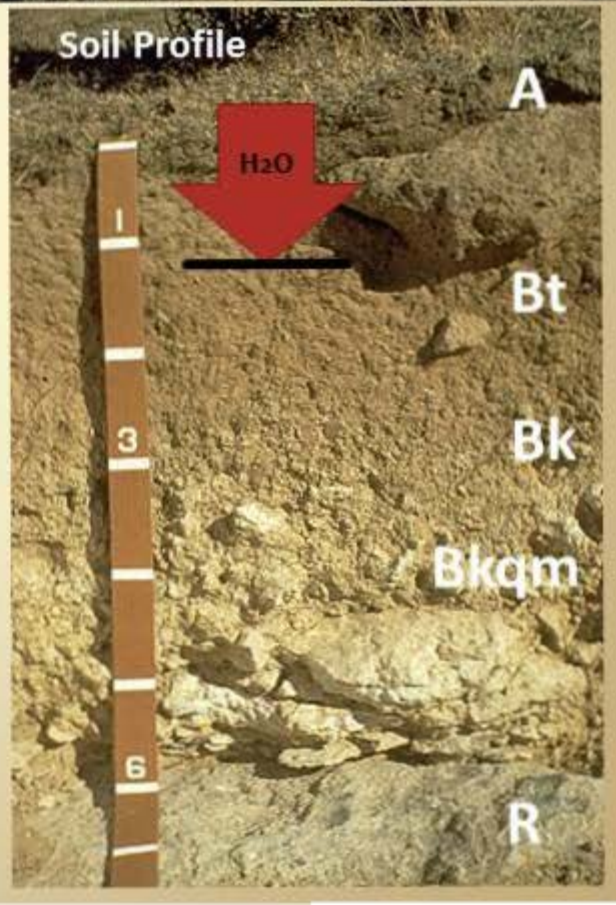
Ecological sites are a product of all the environmental factors responsible for its development.

This includes:

- Soils
- Topography
- Climate
- Hydrology
- Vegetation
- Disturbance Regime
  - Fire
  - Herbivory
  - Flooding
  - Erosion
  - Drought

Ecological Sites have characteristic soils, vegetation and hydrology

Water flow through the soil on this ecological site is severely limited by these three horizons; all can be water- and root-restricting. This ecological site will likely have distinct vegetation assemblages and lower annual production than another similar ecological site without these restrictive soil horizons.



The Core of the ES Concept: State-and-Transition Models

- A diagram and description of the ecological site community dynamics
  - Discrete community states
  - Transitions indicating change from one community or state to another community or state
  - Thresholds which indicate the difference between states

State

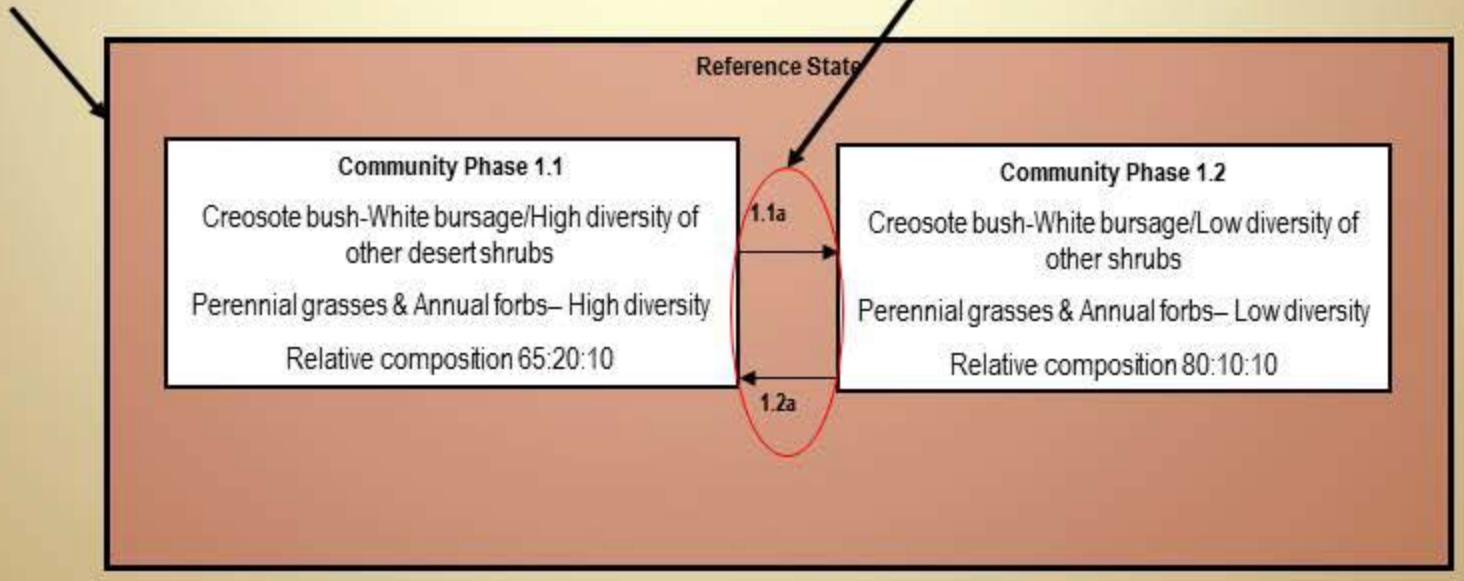
A recognizable, resistant and resilient complex of two ecosystem components, the soil base and the vegetation structure.

Several community phases may occur within the same state –if they are relatively discrete and identifiable.

Community pathways represent the natural dynamics that occur in the ecological site. They represents gradients of change in community phases, describing the negative feedbacks that maintain the state.

Redish box is the "State"

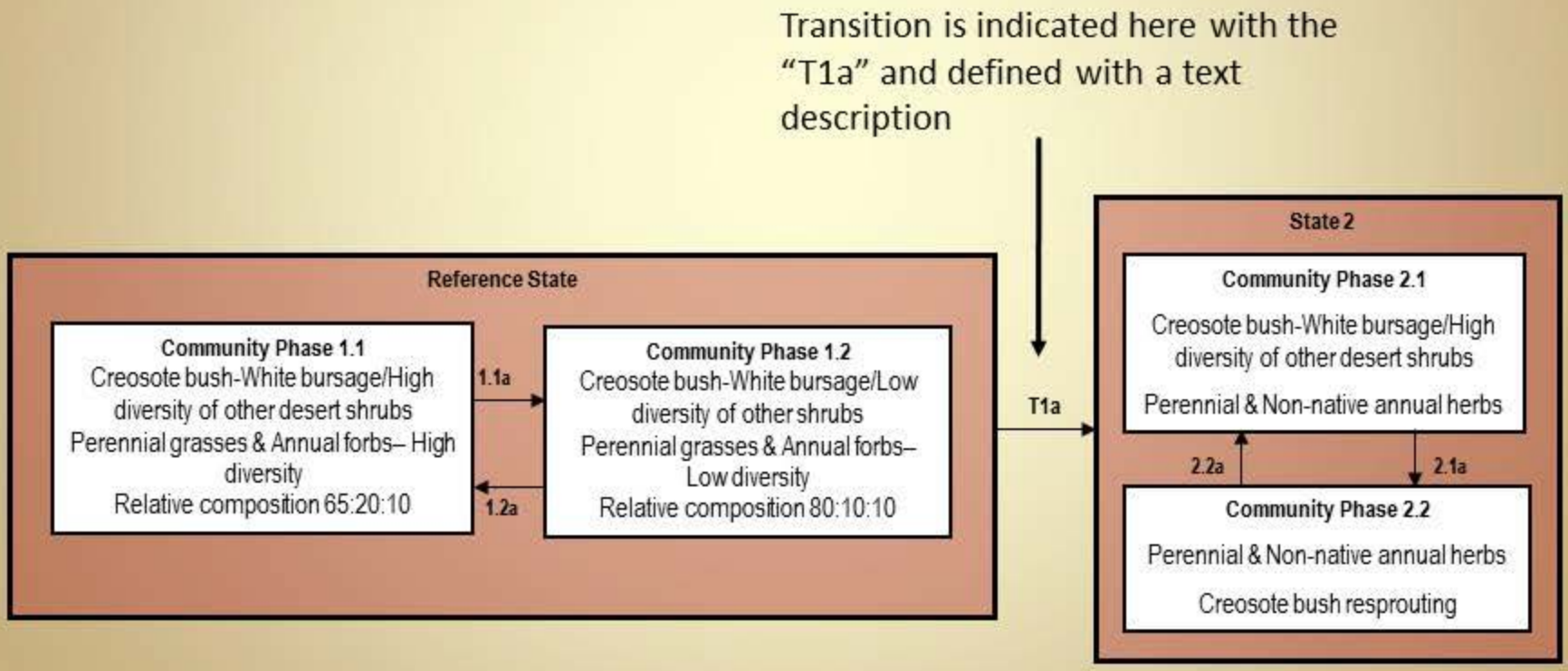
Community Pathways shown as 1.1a and 1.2a



Transition

A transition indicates that a change has occurred to move from one state to another.

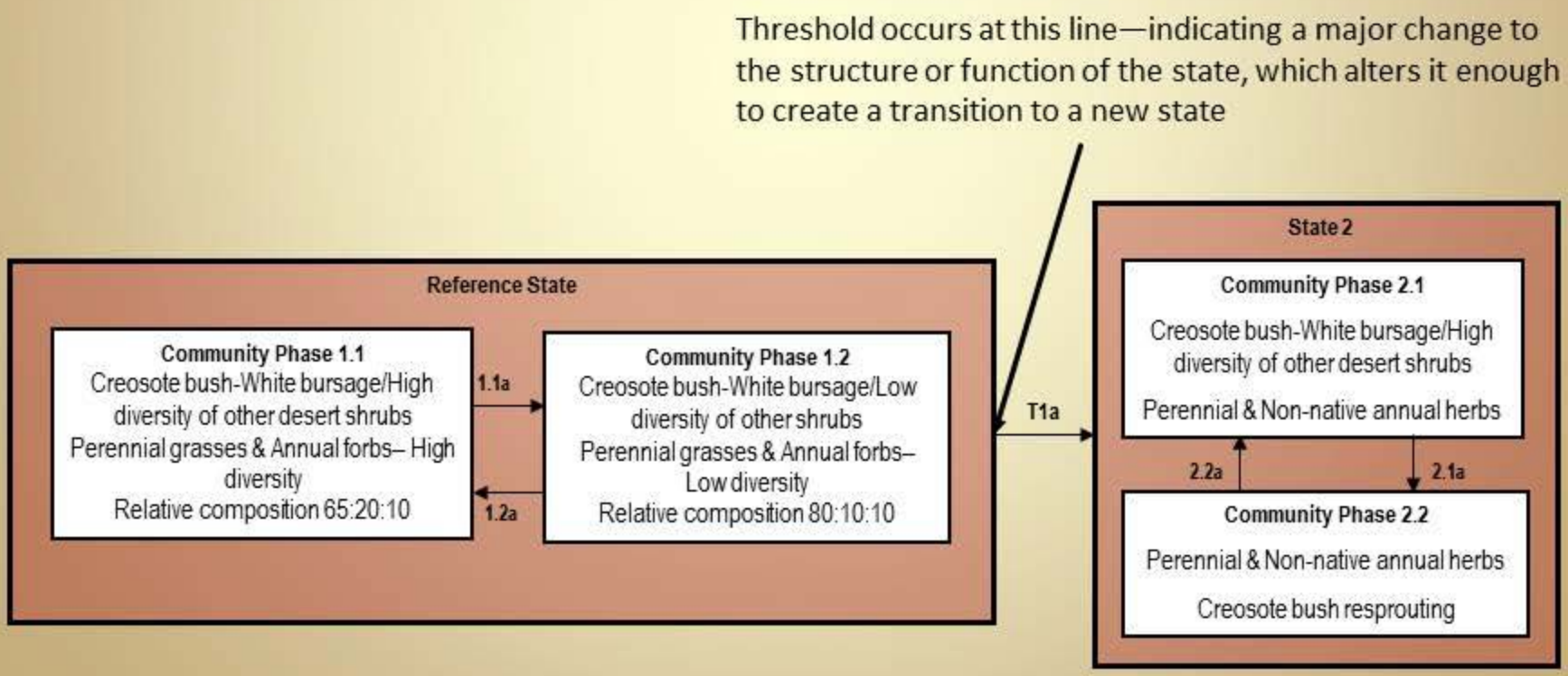
Transitions are the events and drivers that initiate changes to a new state.



Threshold

A threshold is the condition defined by the vegetation and soils and related processes that separate states and preclude recovery of the former state.

Once a threshold is crossed, it is difficult to go back without lots of investments in time and money to recover the lost structure or function in the ecological site.



Upland Loam Ecological Site

Reference State

Time without fire

Time without fire

Threshold here is being represented by the time without fire going long enough that Juniper is too fire-resistant to be removed by the natural fires that occur on this ecological site.

No fire

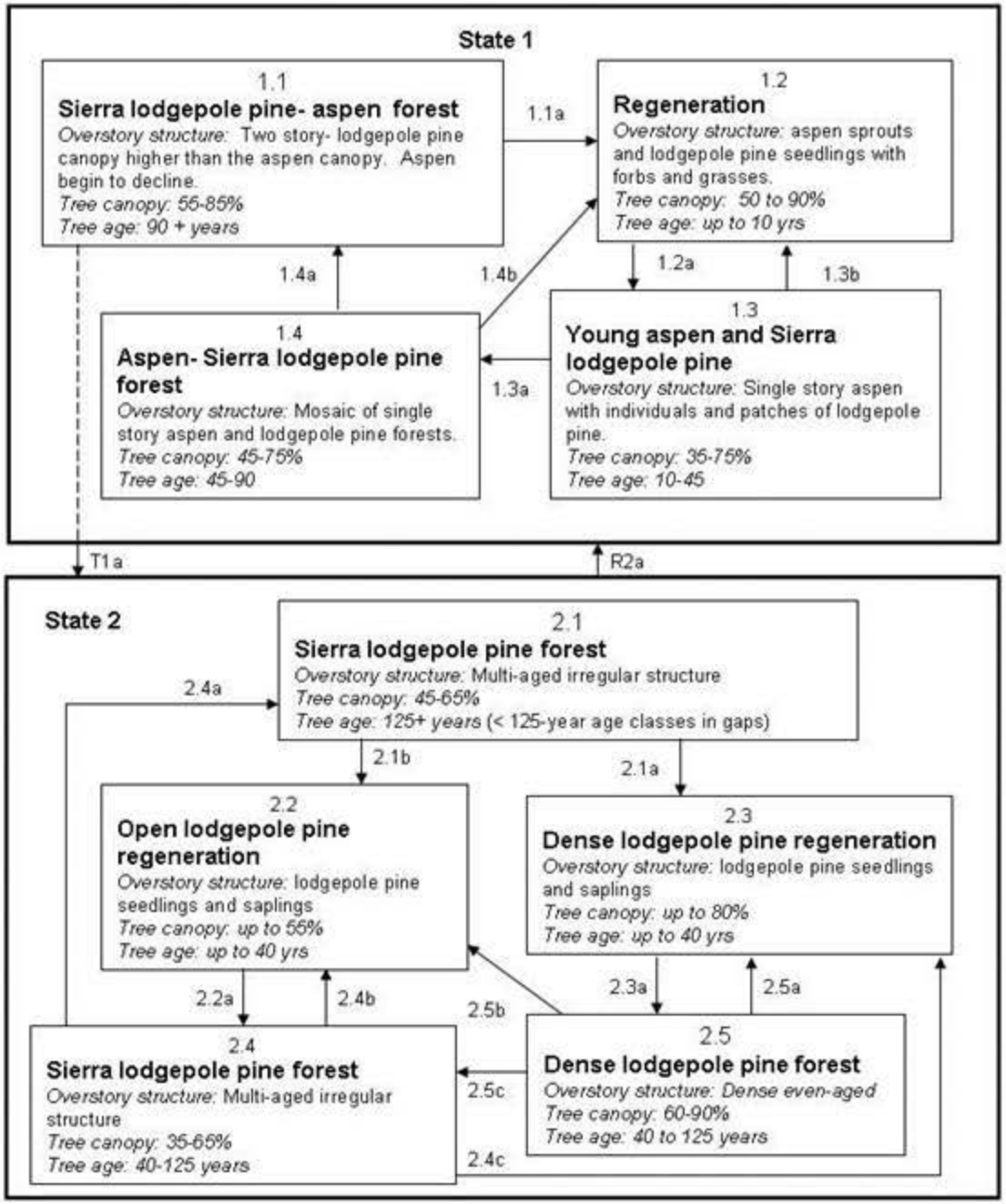
Transitions

State 2

Cheatgrass Invasion

State 3

Ecological Site F022BI105CA: Sierra Lodgepole Pine-Quaking aspen Forest

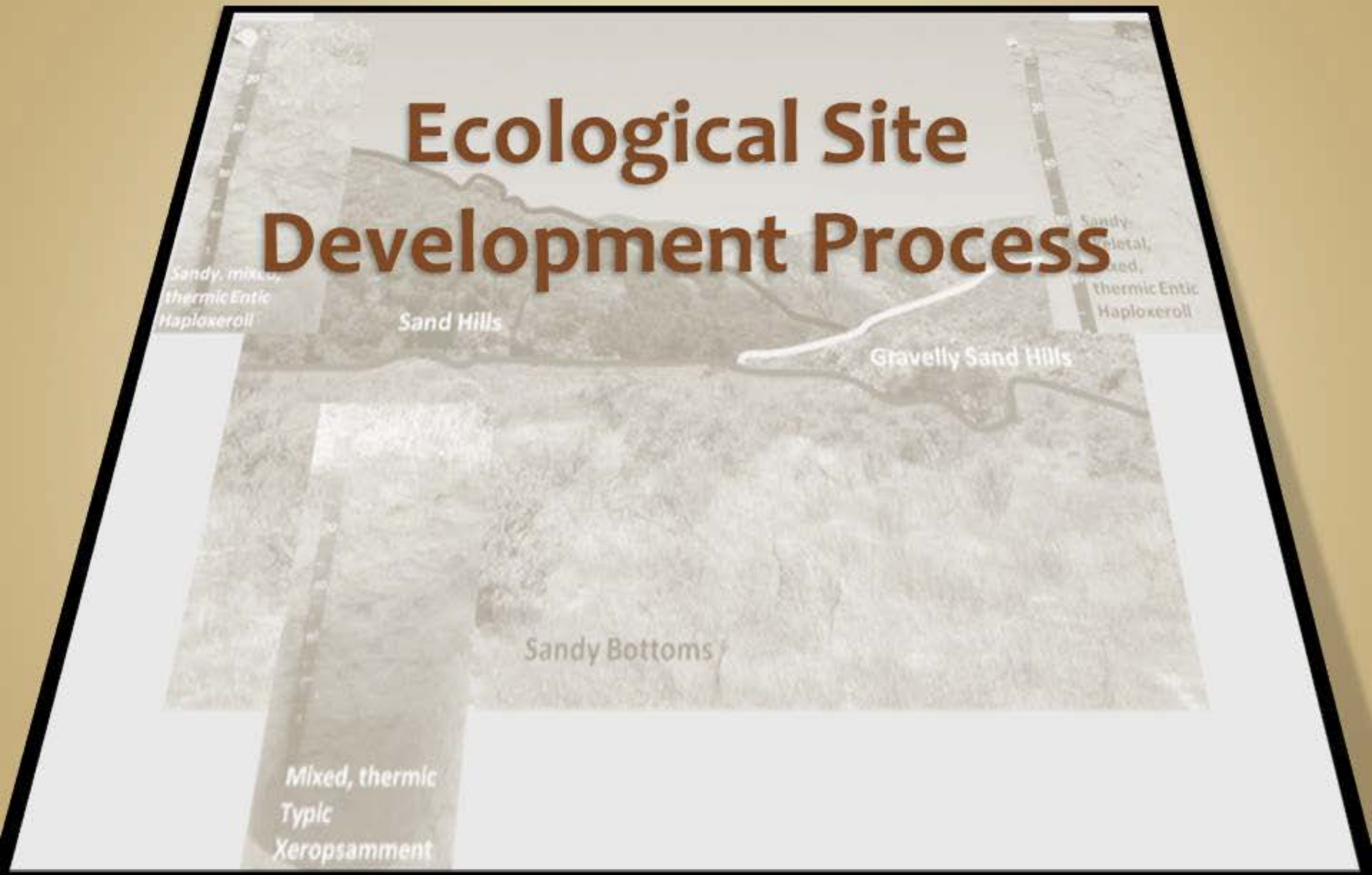


State & Transition Model Narratives

****This STM was developed using Limy 5-7, R030XA20CA –****

- Reference STATE – This site is dominated by creosotebush-white bursage with a site potential from 200-350-500 lbs/ac of annual production, which includes a high diversity of other desirable shrubs – winterfat, horsebrush, spiny hopsage, ephedras, and shadscale. Also a significant grass component, including ACHY, ACDE, ELEL5, and POSE.
- TRANSITION - 1.1-1.2 – During drought years some of the shrub diversity may be reduced and a lot of the grasses will also be reduced.
- TRANSITION - 1.2-1.1 – Following years of above average rainfall, the shrub diversity and grass diversity would return….also would see increased annual production of dominant shrubs.
- THRESHOLD - State 2 – Following years of chronic severe defoliation and invasion of non-native species, LATR and AMDU would persist, but the other shrubs and desirable grasses would be grazed out of the system. After these species are removed, non-native species will invade the site and become the dominant herbaceous component. *THRESHOLD that is crossed, is the introduction of non-native annuals that cannot be removed from the system and will alter disturbance regimes significantly from their natural or historic range of disturbances.*
- 2.1-2.2 – Following either light fires that burn the herbaceous layer and some of the LATR and AMDU or chronic severe defoliation of mostly AMDU, the site will be more heavily dominated by non-native annuals and LATR.
- 2.2-2.1 – AMDU will come back to this site over time.
- Ref State to State 3 – Following repeated use by OHVs, LATR will become most dominant and possibly only species that still exists given enough time. LATR will not likely be run over, but run around, destroying all other lower growing shrubs and grasses. There will be increased open spaces b/w shrubs, gravels will be pushed below the soil surface, in turn pushing up finer sediments that are more easily erodable, which will increase the chance of wind and water erosion. This will also be a pc that is susceptible to the invasion of exotics.
- State 2 to State 3 – With OHV use, this community will be pushed to State 3 and will not be able be restored.
- 3.1-3.2 – Poor vigor LATR will be all that's left, with active erosion and evidence of water gullies. No other plants will likely be found on this site….this is after multiple years of repeated OHV use.
- State 2 to State 4 – This shift occurs after severe fires that happen following a couple years of good precip that increased annuals herbaceous layer. This would remove all LATR and AMDU and be replaced by a suite of fire-tolerant shrubs that would likely include Ericameria, Buckwheats, and Hymenoclea. With an annual herbaceous layer.
- State 4 to State 2 – Restoration pathway for LATR and AMDU
- 4.1-4.2 – pushed by OHV use to mostly bareground, active erosion and scattered fire/disturbance tolerant shrubs.
- 4.2-4.1 – Can go back to 4.1 if given enough time for shrubs to recover.

Ecological Site Development Process



Ecological Site Concept

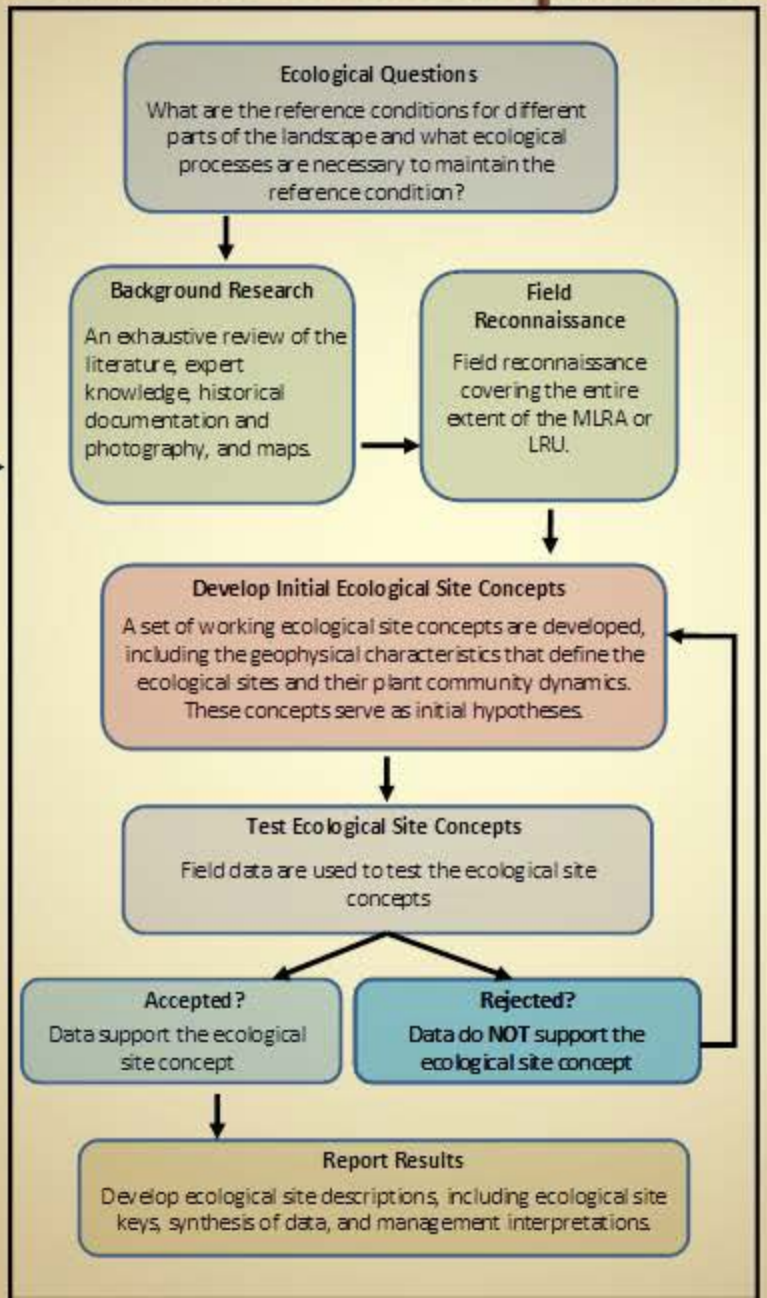
- Like a 'species concept'

- Defines the distinguishing geophysical properties of a site and its STM

- Ecological site and STM development occur together

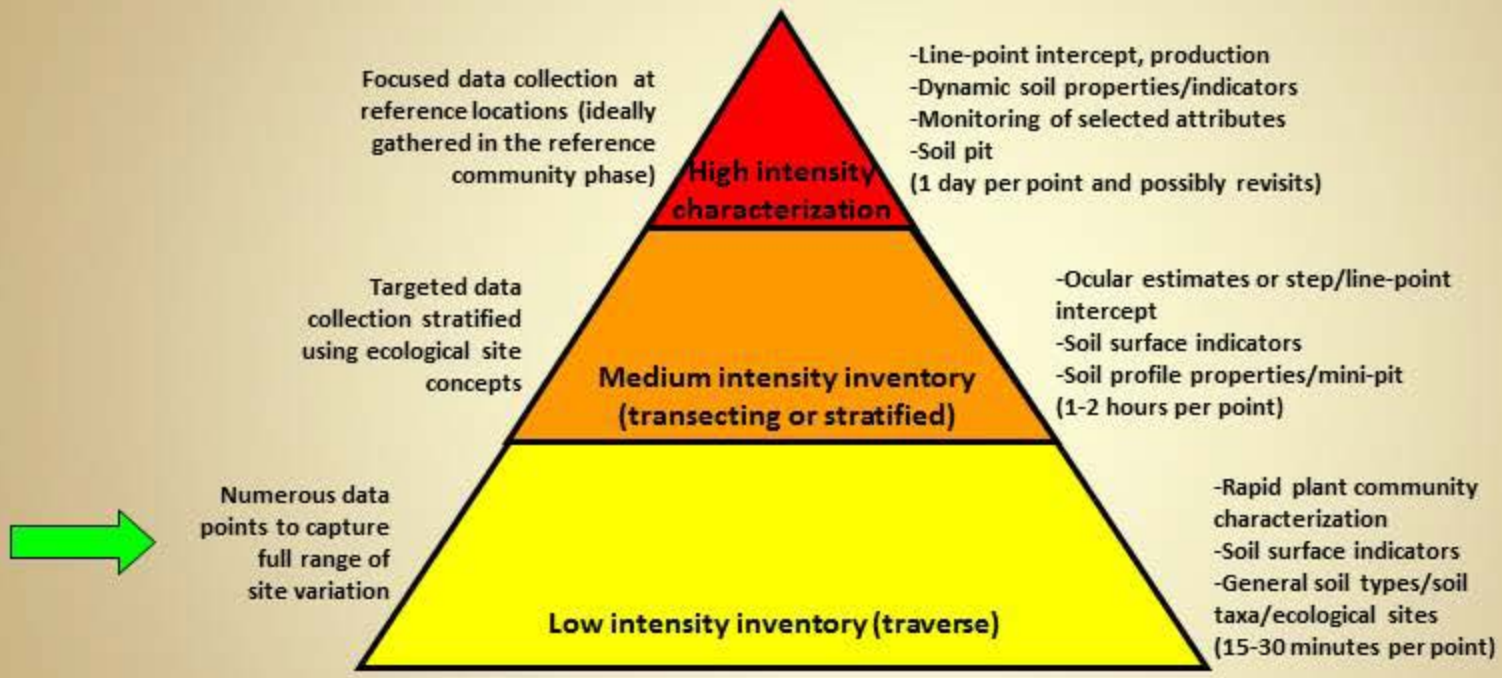
Ecological Site Development-Approach

MLRA or LRU



Moseley et al., 2010

Ecological Site Development-Data support



Moseley et al., 2010

Developing Concepts

- Background research
  - How should ecological potential vary across the landscape?
  - Existing mapping of soils, geology, weather & climate, vegetation, hydrology etc.
  - Interview with "local knowledge" experts
  - Historical documentation (survey records, journals and diaries, photos, etc)
  - Science literature, published studies in the area

Developing Concepts

Background research should result in rudimentary groupings of climate zones/elevation zones, parent materials, soil properties, and vegetation and wildlife communities, and provide information on common land uses and management concerns.

Developing Concepts

- Reconnaissance (refining initial concepts)
  - Correlations among soil properties and vegetation
  - Variability in plant community-soil relationships
  - Local knowledge: historical events, vegetation-soil relationships, and the origins of landscape patterns
  - Reference sites (exclosures, airports)
  - Observations across MLRA or LRU
  - Systematic, low intensity records

Developing Concepts

- After research and reconnaissance, develop initial sites concepts
- Initial site concepts represent a hypothesis that can be tested
- Clearly specify the climatic, topographic, and soil properties that distinguish the site from others

Developing Concepts

- Climate
  - Precipitation amounts (averages and extremes)
  - Precipitation timing
  - Temperature (averages and extremes)
  - Growing season (length and relationship to precipitation)
  - Wind speeds

Developing Concepts

- Topographic properties
  - Elevation
  - Aspect
  - Slope
  - Landscape Position
  - Contributing or accepting resources

Developing Concepts

- Soil Properties
  - Surface texture (importance for water infiltration, retention, soil erodibility)
  - Surface modifiers (gravels, stones, boulders, hummocks, etc)
  - Subsoil horizons (texture, type)
  - Depth to root restrictive horizons, water table, or bedrock (type)
  - Chemistry (Sodium, Calcium, Gypsum, etc)

Developing Concepts

- Specify a range in characteristics that vary at different spatial scales
  - Relatively fine scales of soil properties
  - Broader scale elevation and climatic variations

Developing Concepts

- Existing vegetation can not be a primary ecological site criterion because it is easily manipulated therefore highly variable.
- Nonetheless, certain species can be used to assist in ecological site definition and identification because they provide clues to soil and climatic conditions.
- The ecological site concept should be developed, using geophysical attributes that enable identification of the ecological site without vegetation on the site.

Developing Concepts

- Where changes in soils, aspect, topography, or moisture conditions are abrupt, boundaries of the ecological site will be obvious
- Where these factors change gradually along broad environmental gradients, ecological site distinctions are more difficult identify and may require data collection before solid ecological site concepts can be developed

Developing Concepts

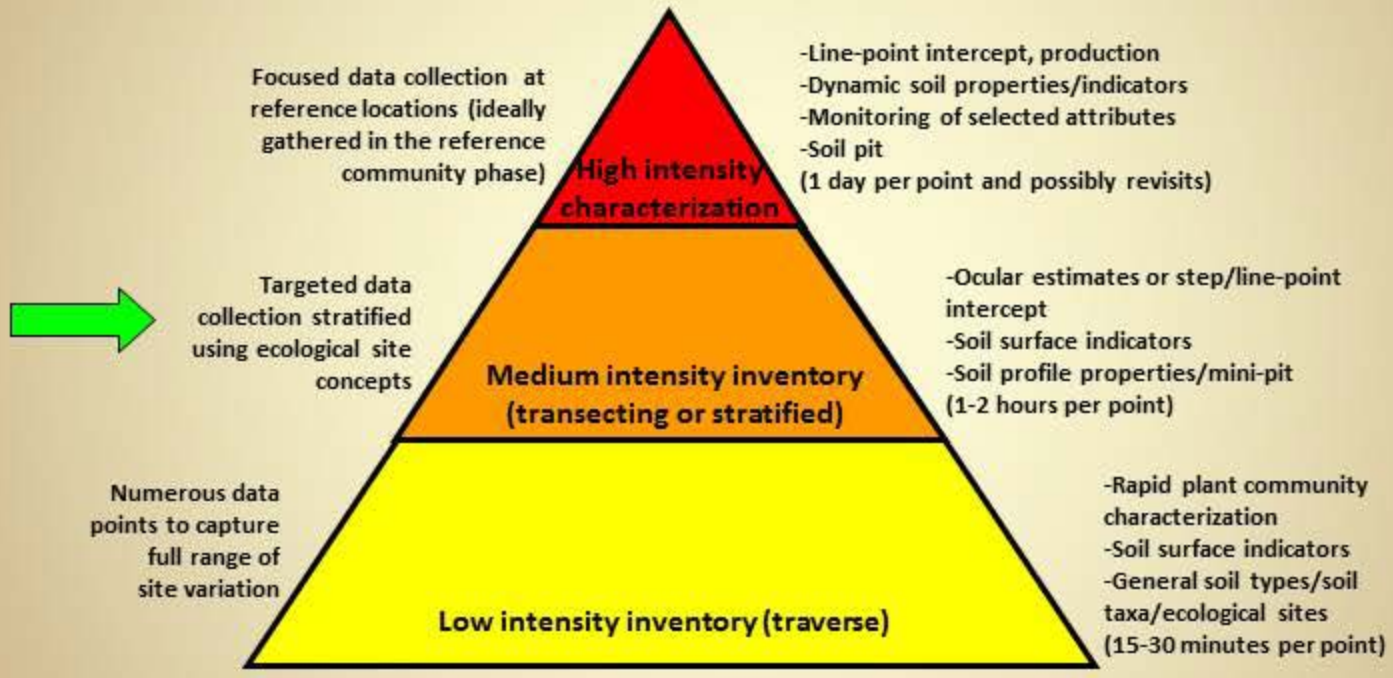
Developing Concepts

- Ecological site concepts are multivariate constructs. They are built from the relationships of several, interacting attributes that collectively produce similar environments for plant communities, similar ecological dynamics, and similar response to disturbances.

Example ecological site concepts

Preliminary Ecological Site	Elevation (ft)	Landform	Geology	Aspects	Slopes	Soil Texture	Soil Depth	Dominant Reference Vegetation	Data Collection Needs?
1	1500 – 3500	Mountains	Granite	South West	Steep	Sandy	Deep	Chamise-Buckbrush	High variation – extensive data needs
2	1200 – 3800	Mountains	Granite	North East	Steep	Loamy Sand	Moderately Deep	Bigberry manzanita-Scrub oak	High variation – extensive data needs
3	500 – 1000	Upper Stream Terraces	Rhyolite	Neutral	Flat	Sandy Clay Loam	Deep	Valley oak-Sedge	Low variation – minimum data needs
4	1500 – 3500	Footslopes	Volcanic Breccia	North East	Steep	Sandy Loam	Shallow to bedrock	Hollyleaf cherry-Toyon	High variation – extensive data needs

Testing ecological site concepts



How do we decide the ecological sites to be recognized?

Ability to **produce** kinds, amounts and proportions and in **response** to disturbance:

- Abiotic factors that influence plant production, composition, ecological processes.
- Significant differences in presence of species or species groups.
- Significant differences in relative proportion of species or species groups.
- Significant differences in total annual production.
- Significant differences in responses to management actions or disturbance processes.

USDA-NRCS NRPH (2007); IESHR (Draft)

Testing ecological site concepts

- Systematic inventories of two types:
  - Stratified random based on repeated samples of different ecological site delineations, especially those for which data are needed
  - Areas deliberately selected due to information contained in them (e.g., reference areas, degraded areas, areas with known management histories connected to local knowledge)

Testing ecological site concepts

- Stratified random inventory:
  - GIS layers (DEM, geology, soils, imagery) used to estimate locations of ecological sites and random points are selected
  - Google Earth and NASA WorldWind
  - Replication sufficient to build statistical models
  - Samples can be clustered (transecting or groups)
  - Samples can be stratified by landscapes

Testing ecological site concepts

Modified Domin-Krajina cover estimate in 20x20 m plot

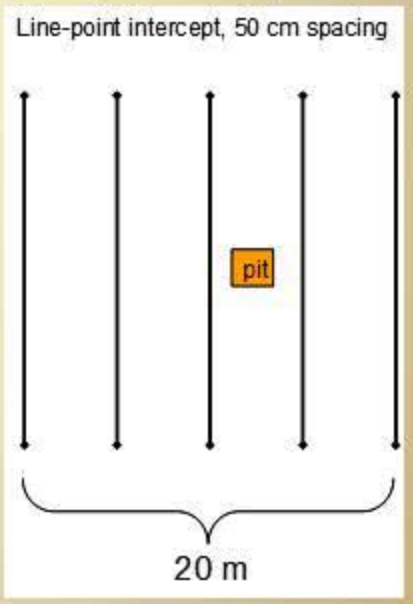
+--few	1--<0.1%	2--<1%	3--1-4%	4--5-10%	5--10-25%	6--25-33%	7--33-50%	8--50-75%	9--> 75%
+--<0.2m2	1--0.2-0.5m2	2--0.5-4m2	3--4-20m2	4--20-40m2	5--40-100 m2	6--100-132 m2	7--132-200	8-200-300	9--300-380

Woody	Class	**Grass**	Class	**Forb**	Class	**Other**	Class		
						Litter			Percent
						Cryptogram			Scale

20 m

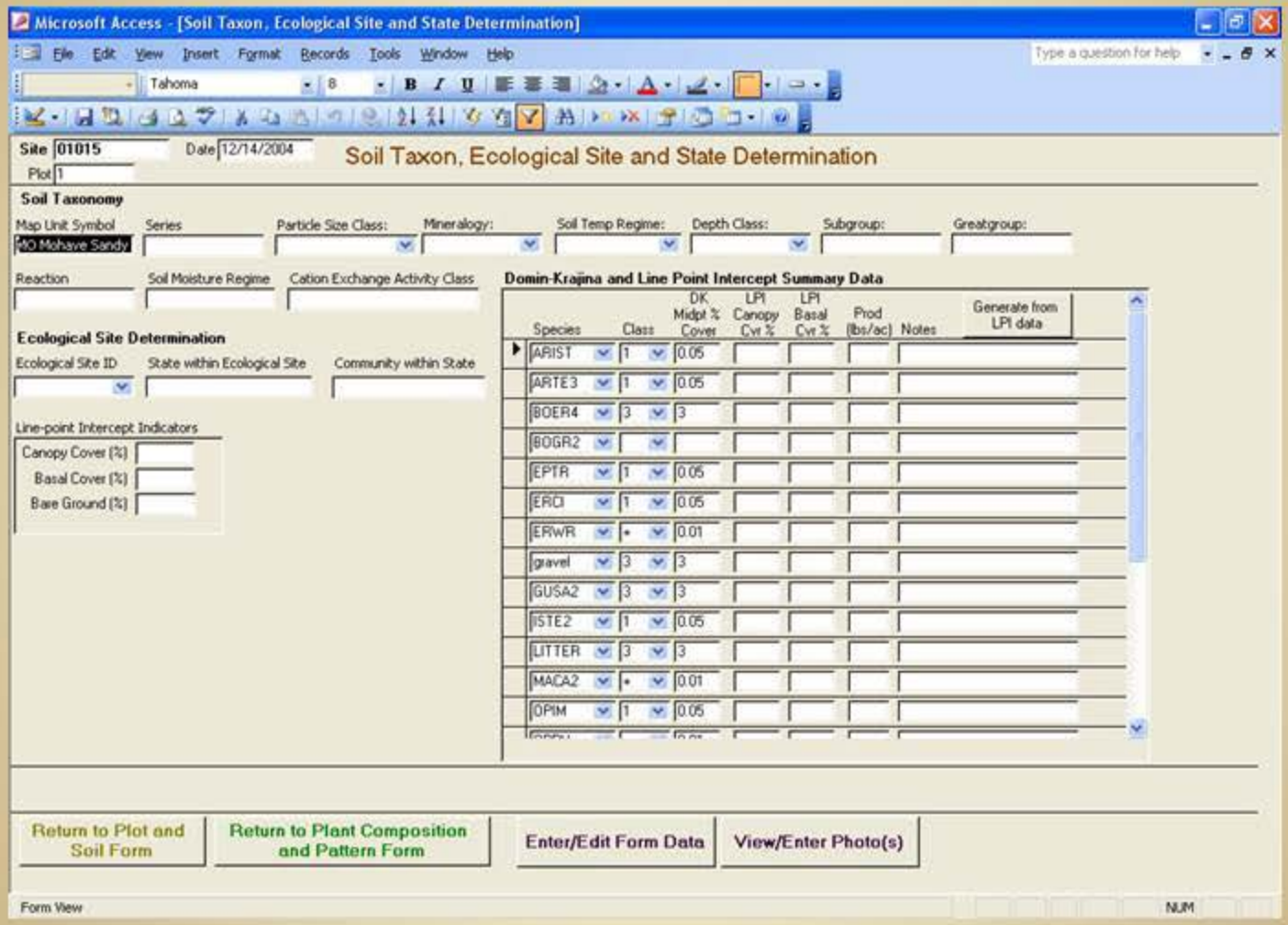
= 1/10th acre plot

or



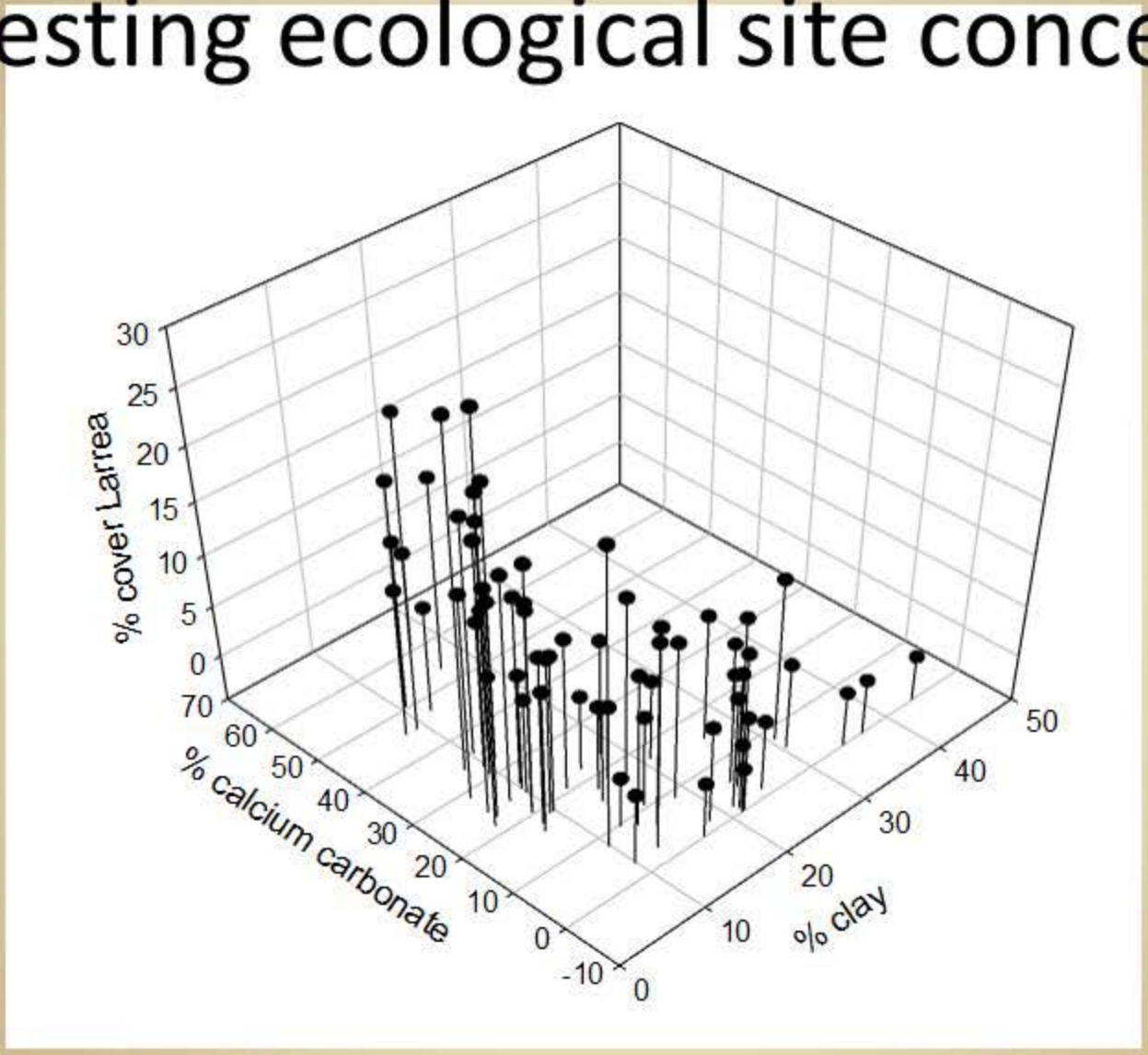
Link observations of vegetation and soils: cover estimated ocularly or using LPI, but must be quick enough to get replication

Testing ecological site concepts



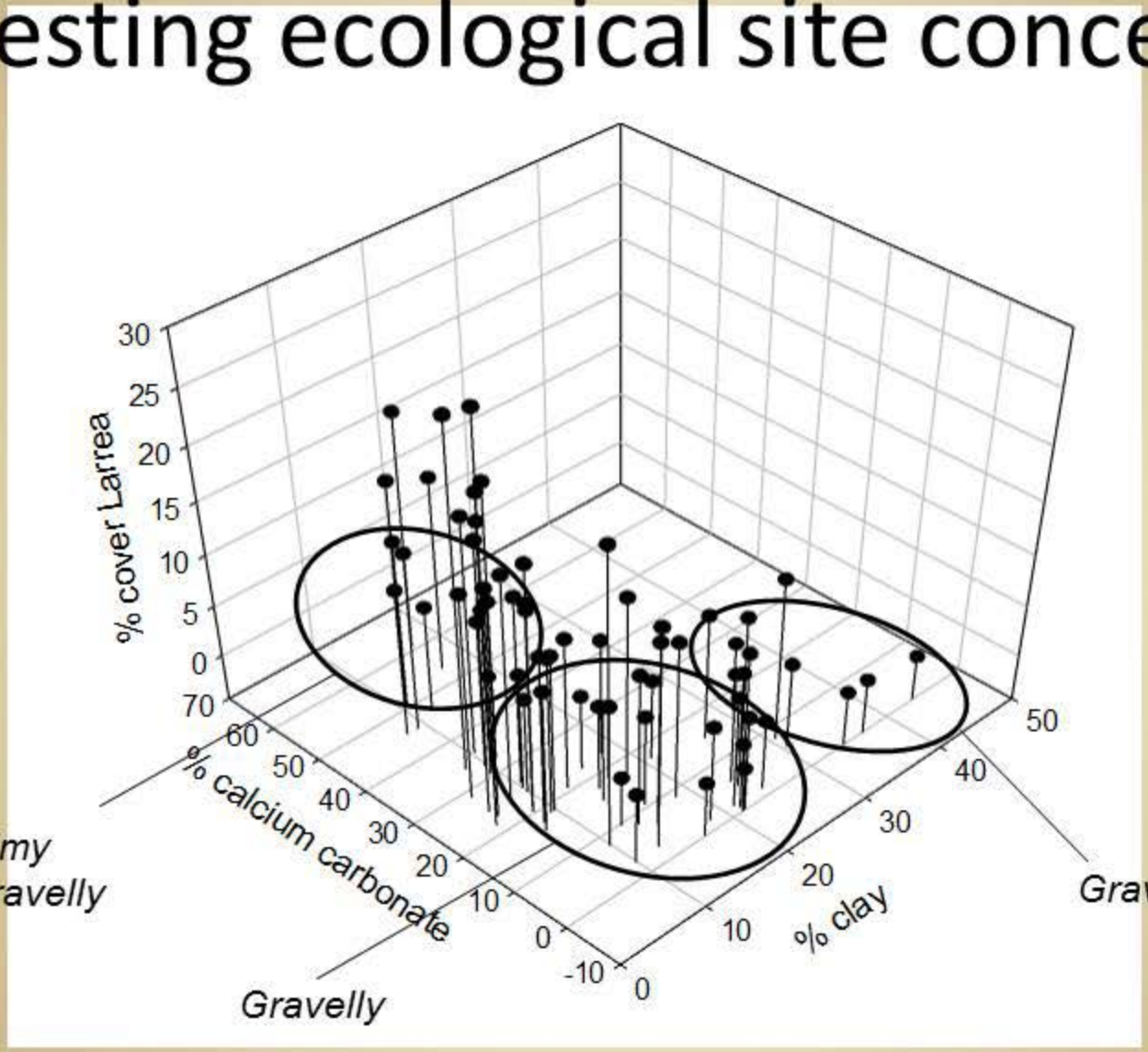
Vegetation and soils data must be databased together (JER and others have used the DIMA database)

Testing ecological site concepts



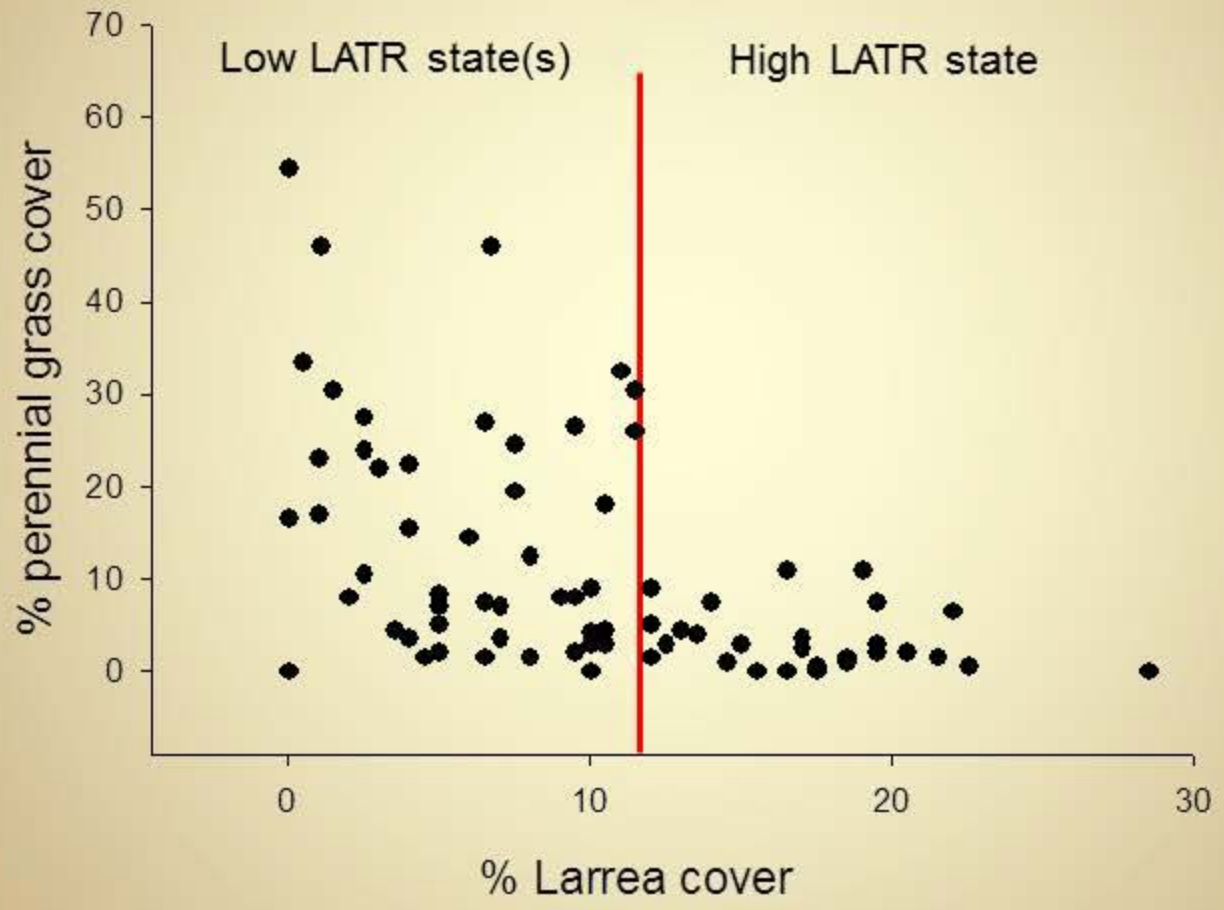
Larrea cover has complex relationships to clay and carbonate in argillic horizon

Testing ecological site concepts



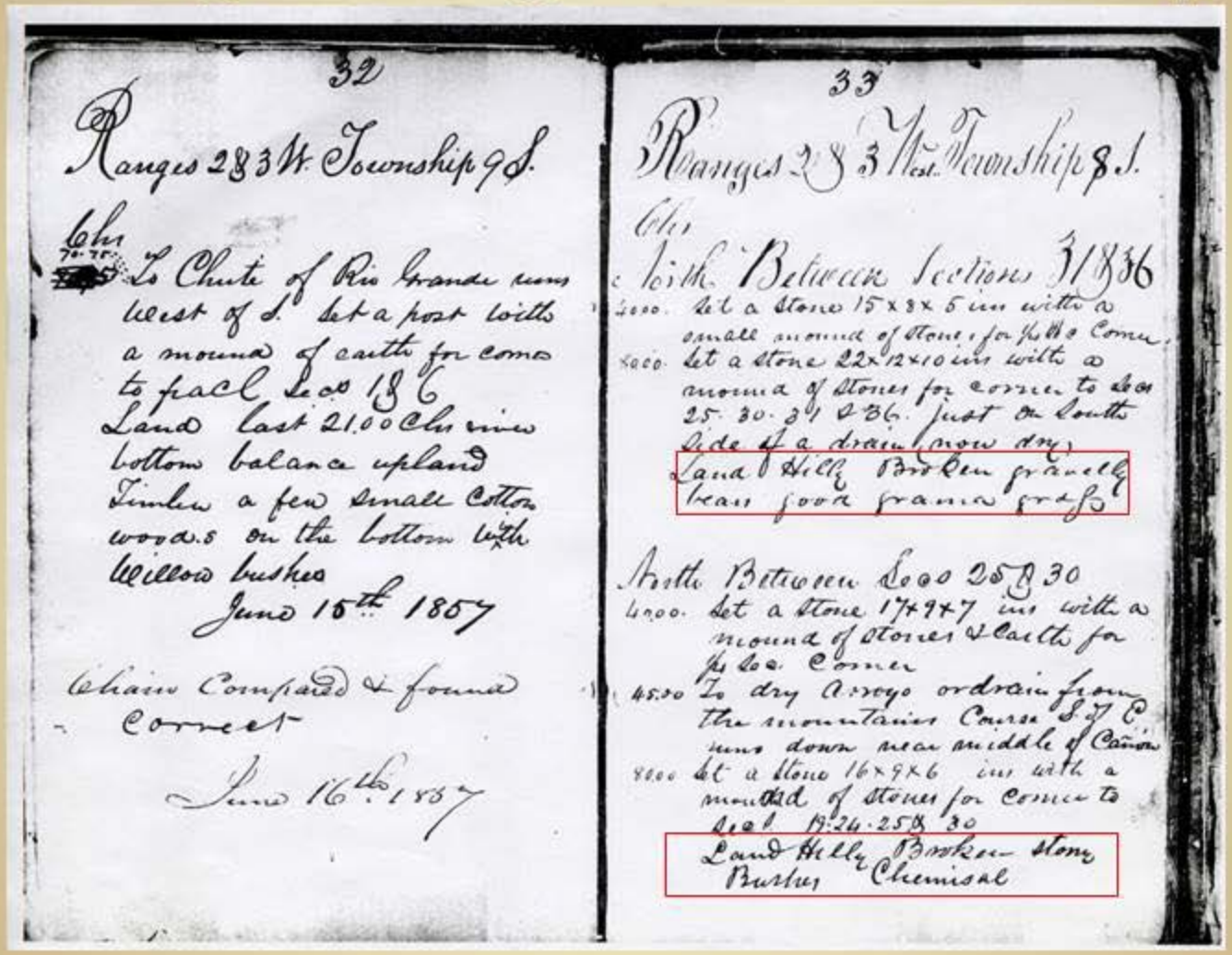
Three ecological sites potentially represented in this sample

Testing ecological site concepts



Inventory data support existence of alternative states (12% creosotebush canopy cover is a good break)

Testing ecological site concepts



32

Ranges 2 & 3 W. Township 9 S.

6 Chs
70.75 Lo Chute of Rio Grande runs West of S. Set a post with a mound of earth for corner to sec 1 & 6
Land last 21.00 Chs river bottom balance upland Timber a few small Cotton woods on the bottom with Willow bushes
June 16th 1857

Chain Compared & found Correct

June 16th 1857

33

Ranges 2 & 3 West Township 8 S.

6 Chs
Norths Between Sections 31 & 36
4.00 Set a Stone 15 x 8 x 5 ins with a small mound of Stones for Sec Corner
40.00 Set a stone 22 x 12 x 10 ins with a mound of Stones for corner to Secs 25. 30. 31 & 36. just on South side of a drain now dry
Land Hilly Broken gravelly bean good grama grass

Norths Between Secs 25 & 30
4.00 Set a stone 17 x 9 x 7 ins with a mound of Stones & Earth for Sec Corner
45.00 To dry Arroyo ordrain from the mountains Course S 87 E runs down near middle of Cañon
48.00 Set a Stone 16 x 9 x 6 ins with a mound of Stones for corner to Secs 19. 24. 25 & 30
Land Hilly Broken Stony Bushes Chemisal

Historical evidence tied to inventory: in the 1850s, evidence of grass-dominated and *Larrea*-dominated patches in area: which soil?

Soil-site correlation

Nickel-Tencee-Delnorte complex, moderately sloping, soil map unit

		Ecological Site			
Soil map unit component		**MLRA**	**LRU**	**Ecological Site**	**State**
Nickel very fine gravelly sandy loam		042X	B	Gravelly	NM
Del Norte gravelly loam		042X	B	Gravelly	NM
Tencee very gravelly sandy loam		042X	B	*Limy gravelly	NM
*proposed new site					

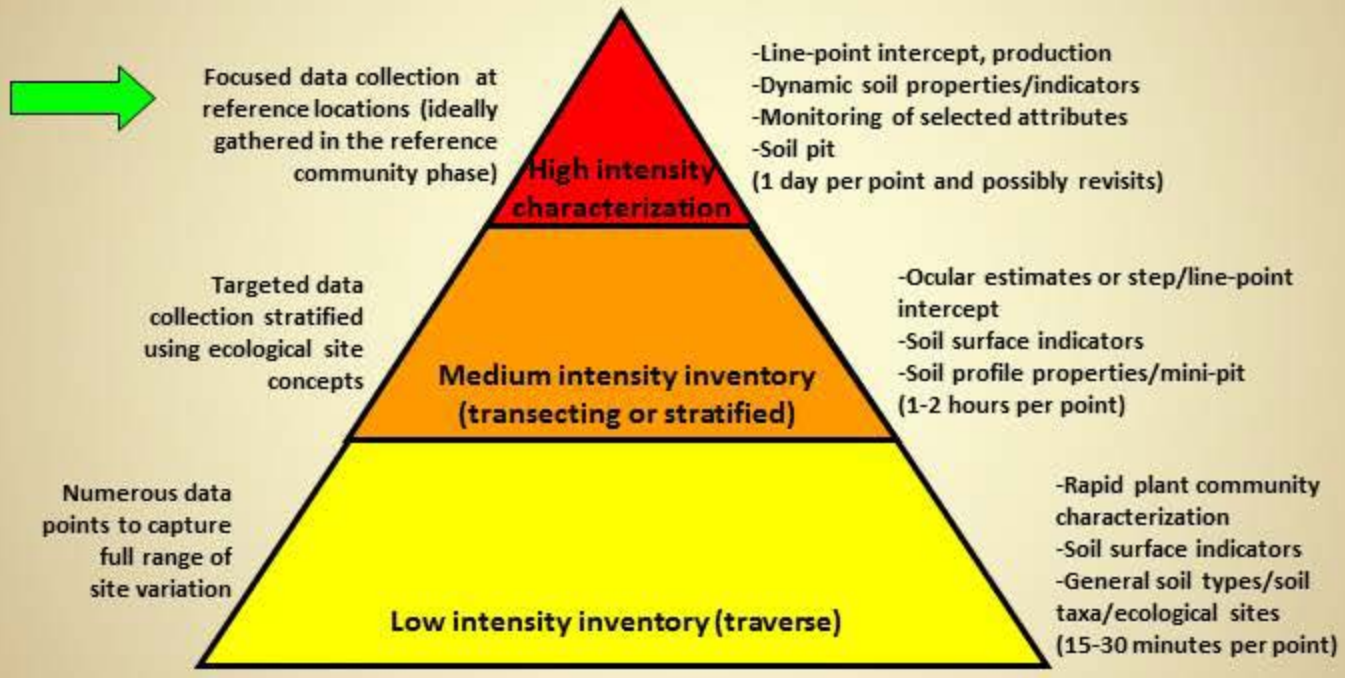
Soil-site correlation “rules”

An ***ecological site*** can include more than one soil series, provided that the soils are similar

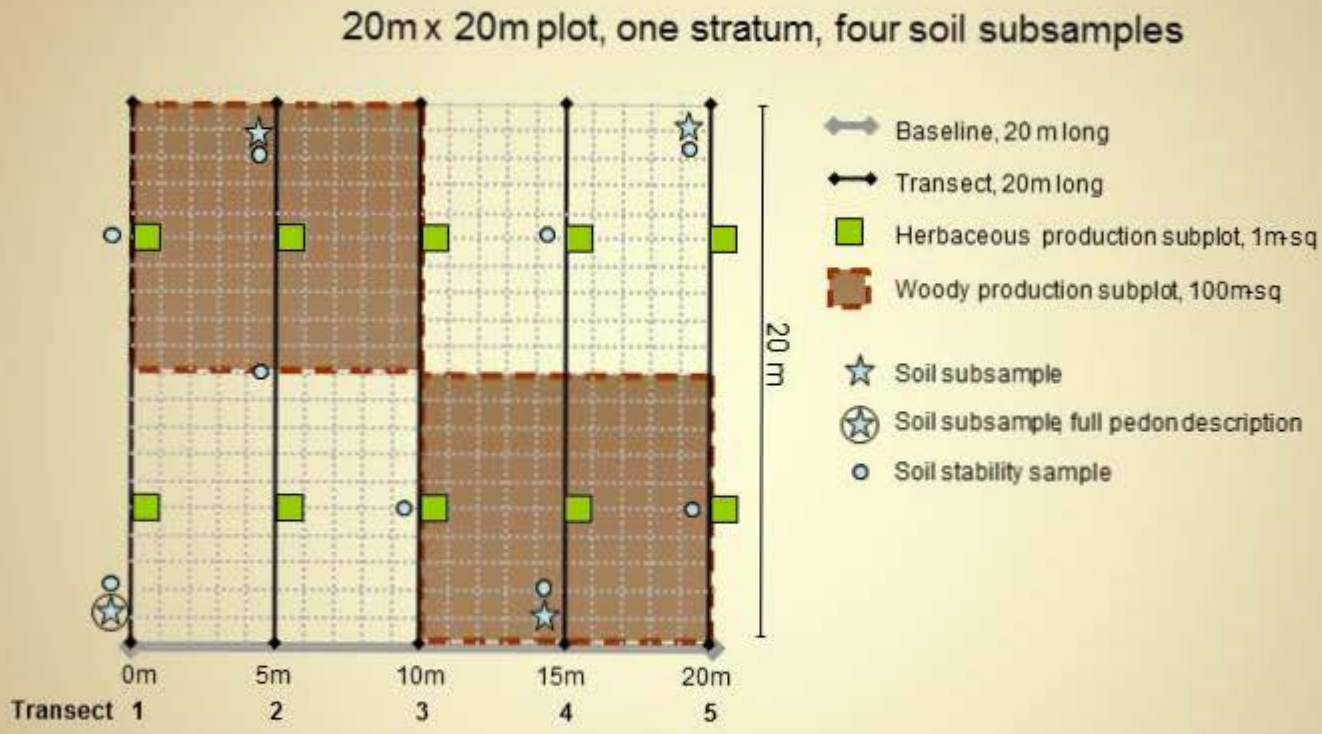
A ***soil map unit*** can include more than one ecological site. Soil map units often include many different soils, with different potentials to support plant communities

Even a ***soil series*** can include more than one ecological site. Soil surface texture often varies within a soil series. Soil surface texture is very important in distinguishing ecological sites.

High intensity Samples



High intensity Samples



- Three replicates per state per site
- Consider monitoring to document temporal variations due to climate

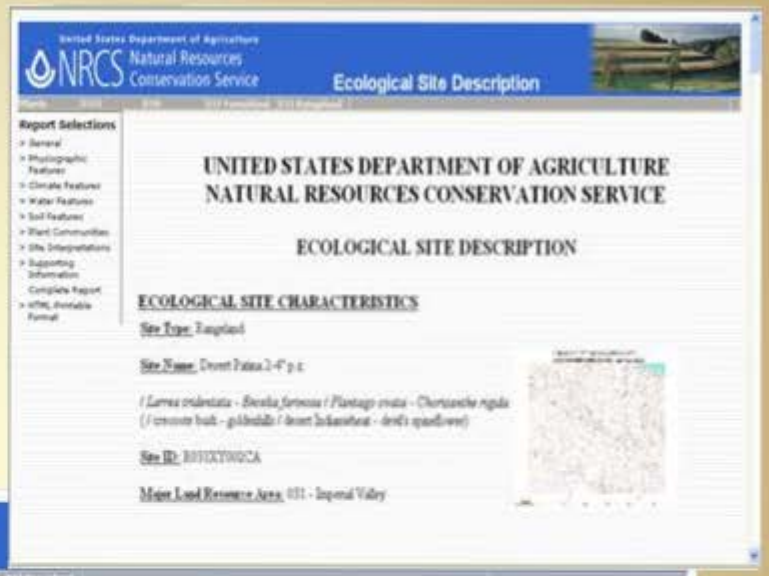
Develop interpretations

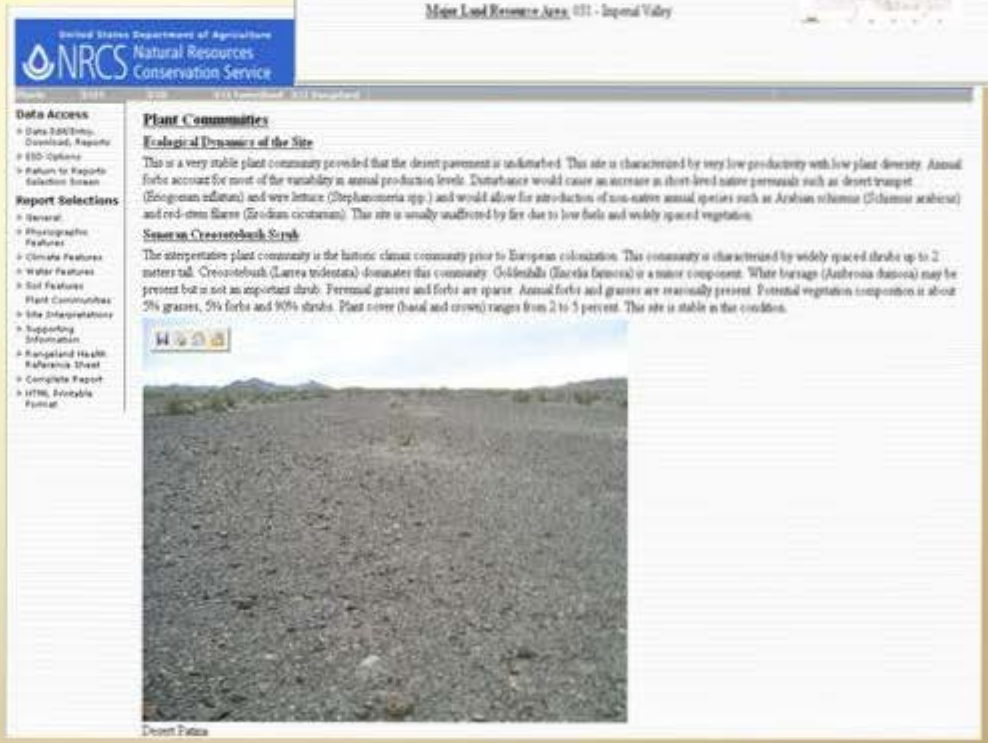
- High intensity data and other data:
  - Domestic animal uses/forage
  - Wildlife habitat (by state or community)
    (see Holmes and Miller, JWM, 2010)
  - Hydrologic functions
  - Recreation
  - Future options (carbon sequestration, dust control, more detail on wildlife habitat)

Ecological Site Description

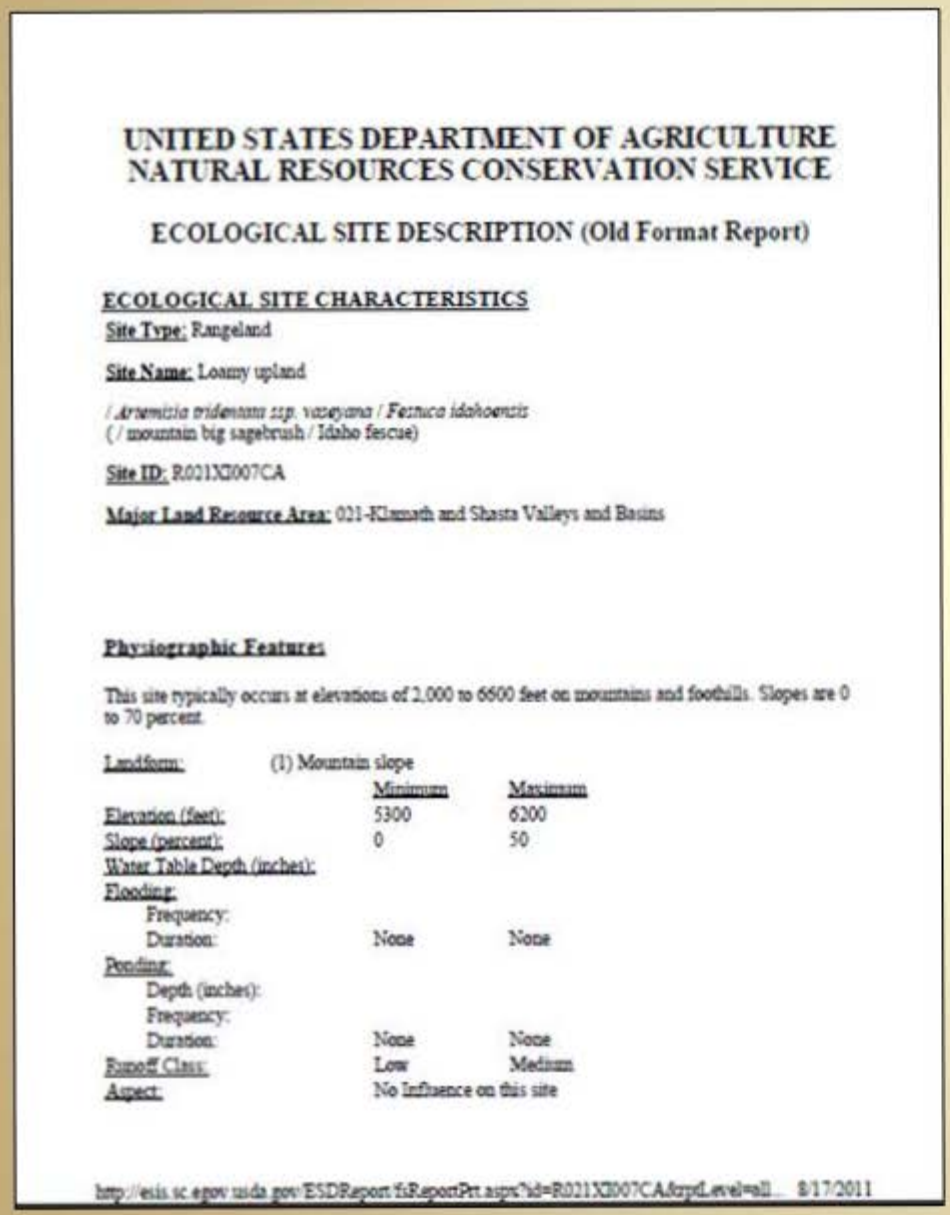
After vegetation data has been compiled and analyzed and placed with the proper ecological site, all data should be entered into the ESD section of ESIS.

The ESD section of ESIS is also where the ecological dynamics, photos, and STM are kept. This is also where ecological interpretations and range health reference sheets are housed. It is the primary database to store all Ecological Site Descriptions.





Ecological Site Description



UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

ECOLOGICAL SITE DESCRIPTION (Old Format Report)

ECOLOGICAL SITE CHARACTERISTICS

Site Type: Rangeland

Site Name: Loamy upland

/ *Artemisia tridentata ssp. vaseyana* / *Festuca idahoensis*
(/ mountain big sagebrush / Idaho fescue)

Site ID: R021XI007CA

Major Land Resource Area: 021-Klamath and Shasta Valleys and Basins

Physiographic Features:

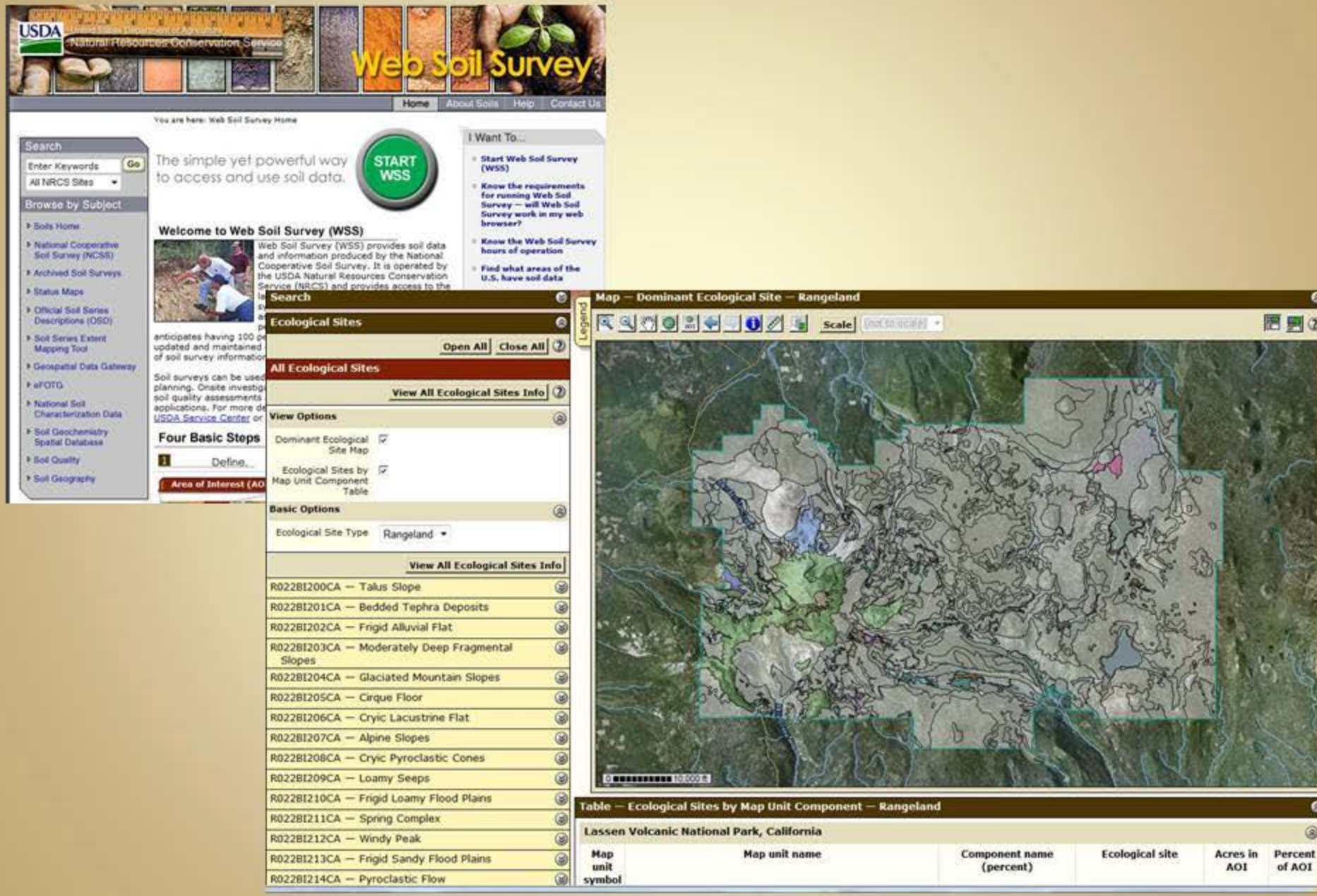
This site typically occurs at elevations of 2,000 to 6600 feet on mountains and foothills. Slopes are 0 to 70 percent.

Landform:	(1) Mountain slope	
	Minimum	Maximum
Elevation (feet):	5300	6200
Slope (percent):	0	50
Water Table Depth (inches):		
Flooding:		
Frequency:		
Duration:	None	None
Ponding:		
Depth (inches):		
Frequency:		
Duration:	None	None
Runoff Class:	Low	Medium
Aspect:	No Influence on this site	

http://esis.sc.egov.usda.gov/ESDReport/fsReportPrt.aspx?id=R021XI007CA&rptLevel=all... 8/17/2011

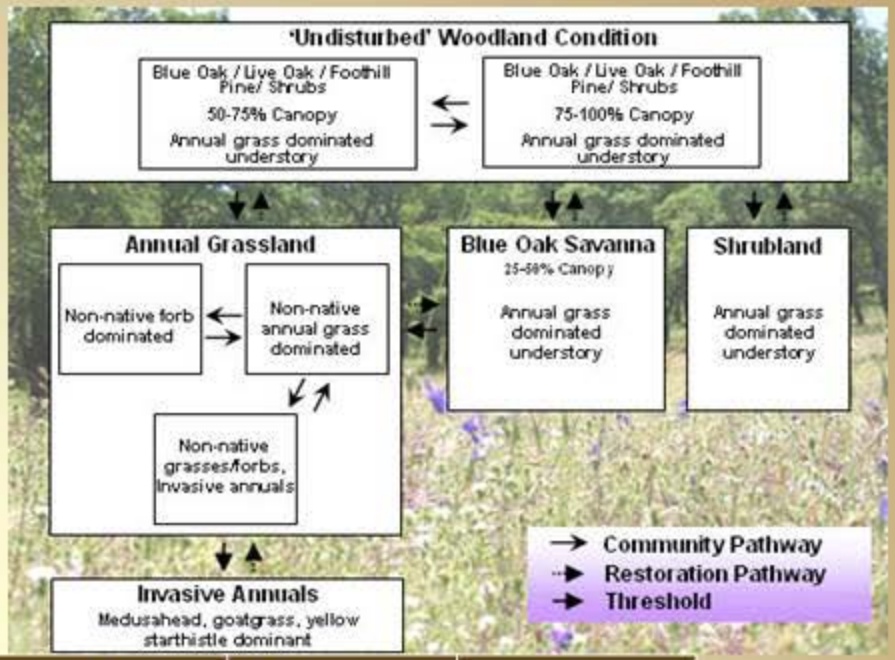
- Name/ID Number
- MLRA Description
- Ecological Site Concept Narrative
- Physiographic Features
- Climatic Information
- Water Features
- Soils Narrative
- Ecological Dynamics of the Site
- State-and-Transition Model & Narratives
- Vegetation Data
- Ecological Interpretations
- Rangeland Health Reference Sheets
- Inventory Sources
- References

Ecological Site Descriptions & Web Soil Survey



Using Ecological Sites for Ecosystem Services

Major Land Resource Area: 018 - Sierra Nevada Foothills
Ecological Site-Gravelly loam foothill
Site ID: R018XI001CA

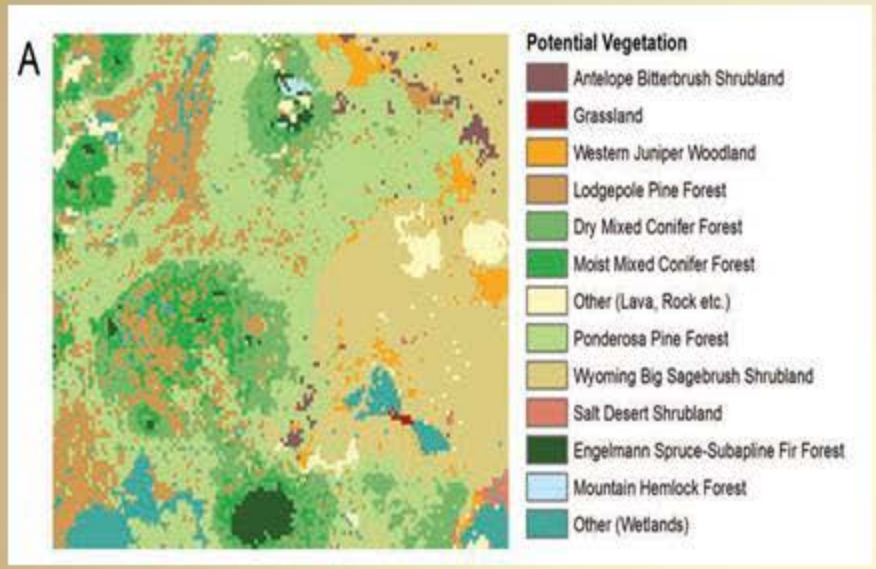


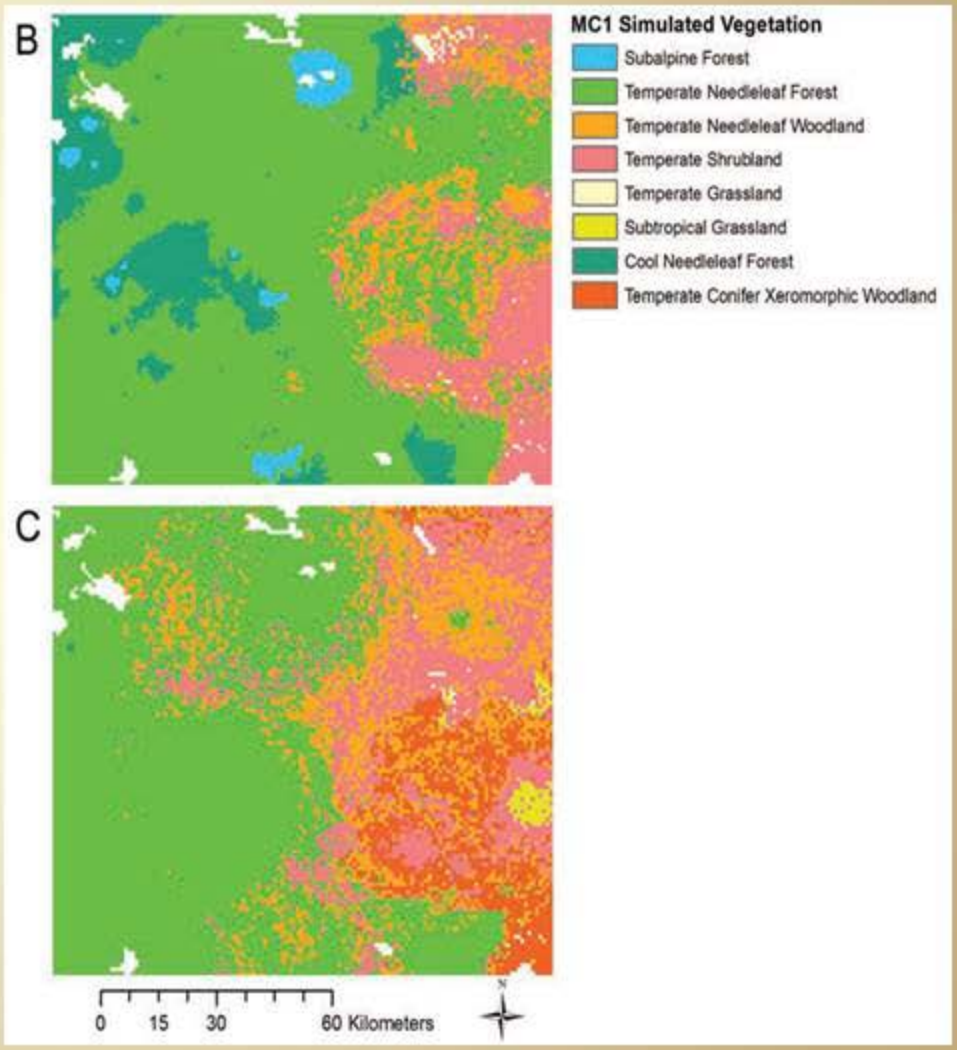
STATE/ ECOSYSTEM SERVICE	Water Supply Infiltration (cm/hr)	Nutrient Cycling N, C/kg	Biotic Integrity (diversity H')	Agricultural Production (ANPP kg/ha)	Bulk Density (g/m^3)
Undisturbed Woodland	218	3.6 52	2.05	1030	1.2
Annual Grassland	21	2.5 28	1.84	3343	1.4
Invasive Annuals	20	2.4 27	1.03	3672	1.4
Blue Oak Savanna	72	2.9 37	1.71	1670	1.2

Dr. Ken Tate
UC Davis

Using Ecological Sites to Predict Effects of Climate Change

Vegetation change on a landscape in Central Oregon



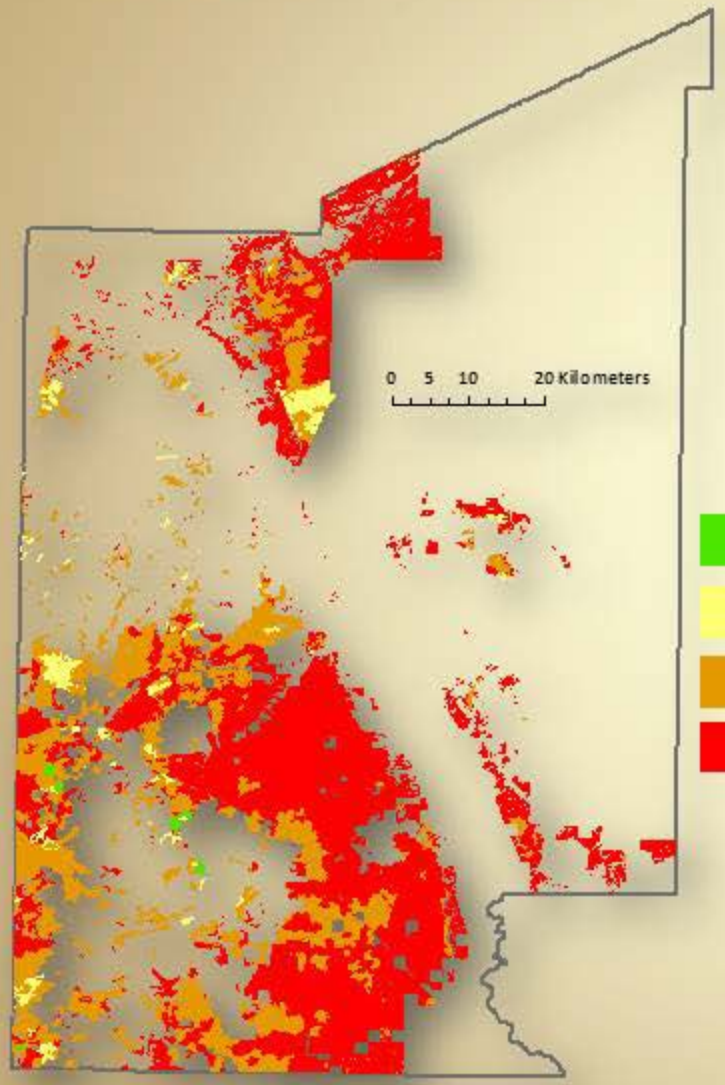


Used STMs and a combination of mechanistic models to predict vegetation change

A current
B +30 y
C + 100 y

Approaches to incorporating climate change effects in state and transition simulation models of vegetation
B.K. Kerns et al

Spatially-explicit management prescriptions and monitoring



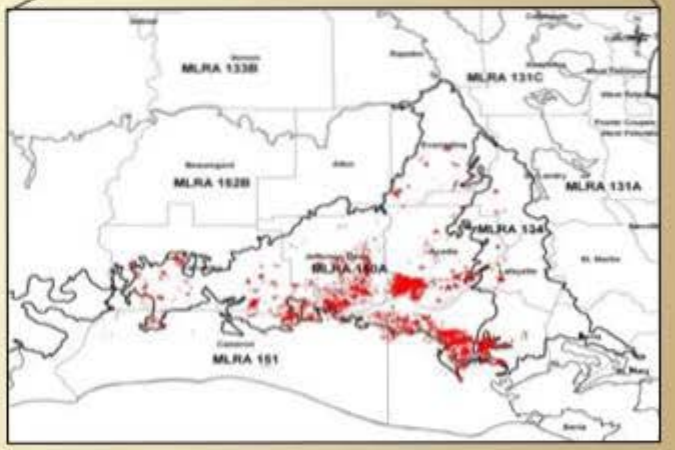
Site ID: R042XA051NM
MLRA: 42
Site: Sandy
Dona Ana County, NM

Ecological state	management priority
Black grama grassland	manage stocking rates
Altered grassland type	maintain cover
Shrub-invaded type	shrub removal
Shrubland	rest or alternative uses

Dr. Brandon Bestelmeyer ARS

Restoring Gulf Coast Wetlands

Site ID: 150 AY013
Name: Clayey Terrace Prairie



Summary

By providing all of this information about a piece of land, ecological sites offer a land manager the critical information on the ecological functions and processes that characterize the site.

This information allows land users and land managers to make informed decisions about the management they choose to apply to their land.


Thank you!