Multi-disciplinary development of state and transition models

An Example from Northwestern Colorado

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[1]USDA-Agricultural Research Service
[2]Colorado State University

Outline

- Introduction
- Integrating Local Knowledge and Field Data to Create STMs in northwestern Colorado
- Lessons Learned

Models help us learn about the way the world works

State and Transition Models: A Road Map to Ecological Change

STMs also help us learn

- Tacit → explicit knowledge
- Store our current understanding of vegetation dynamics
- Allow it to be updated as we learn more

Adaptive Management Cycle

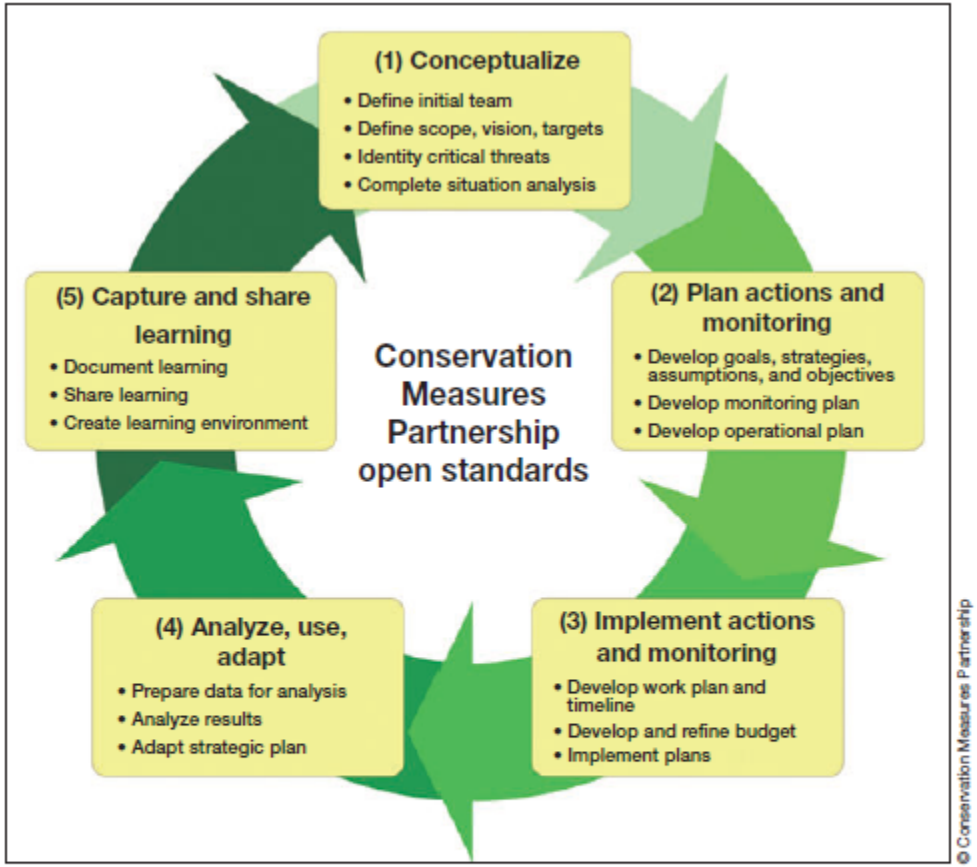
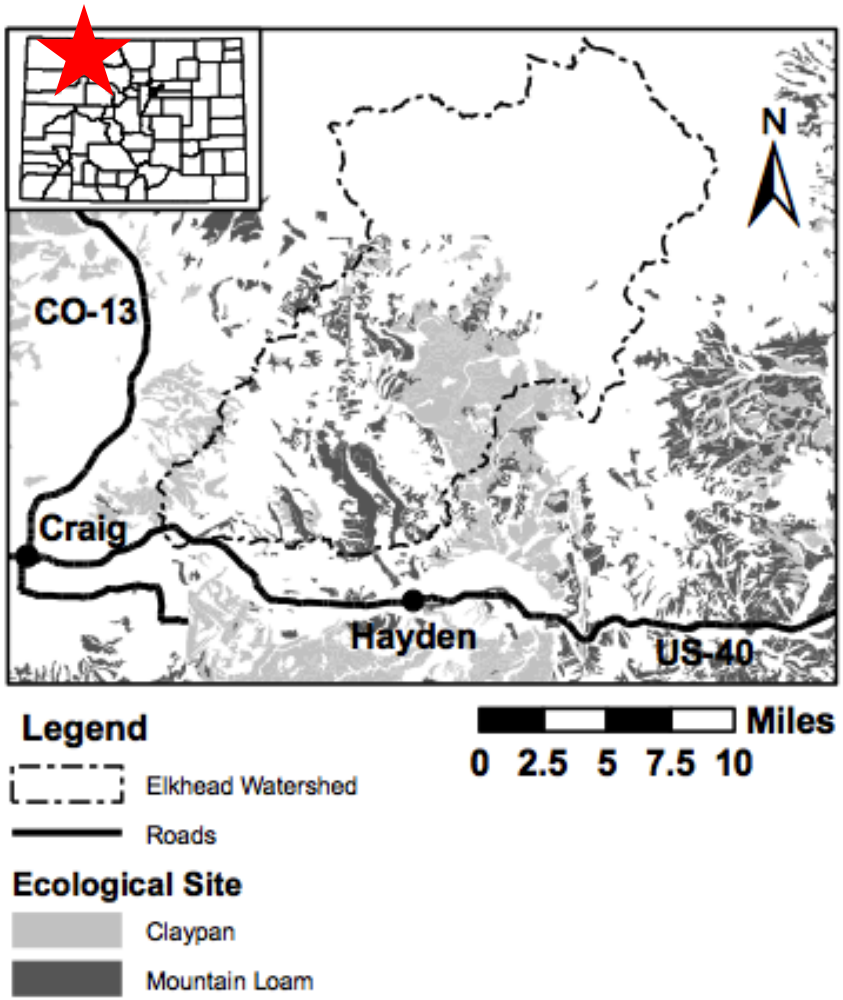


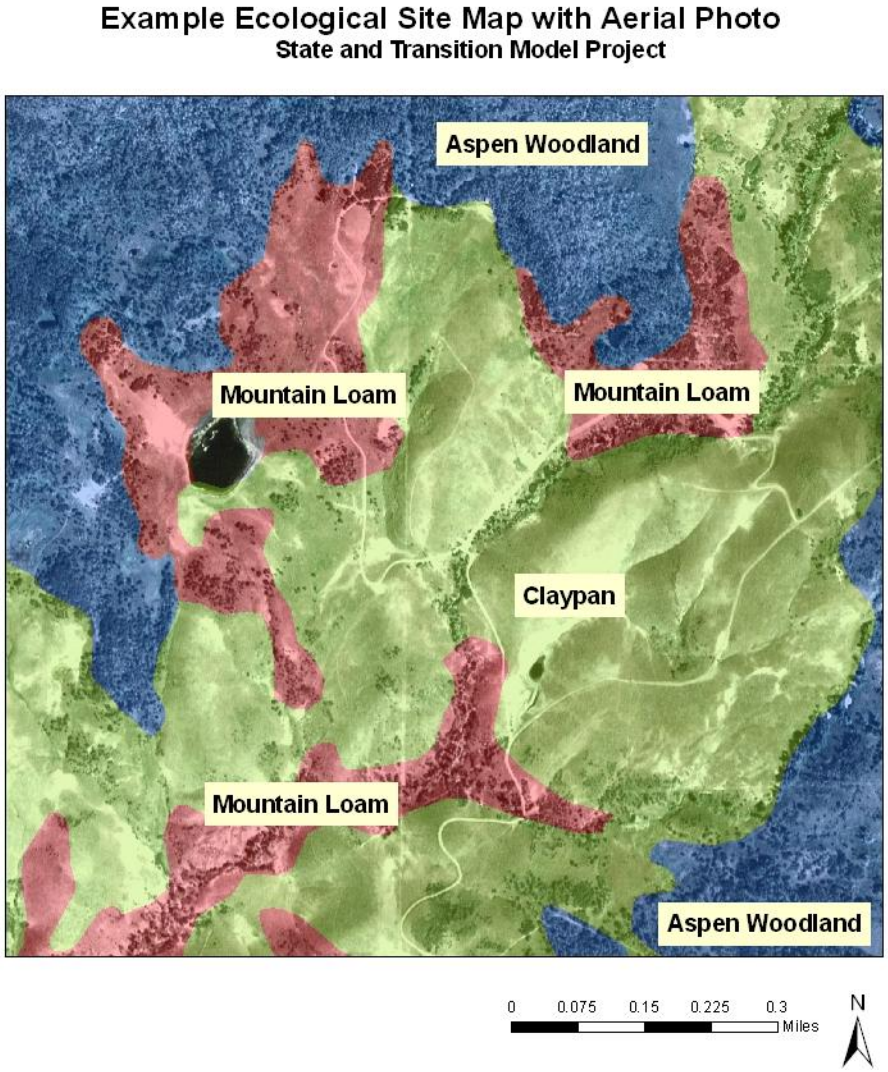
Figure 2. *The Open Standards Project Management Cycle. These are from the Conservation Measures Partnership. The standards are five steps that comprise the project management cycle: (1) conceptualizing the project vision and context; (2) planning actions and monitoring; (3) implementing actions and monitoring; (4) analyzing data, using the results, and adapting the project; and (5) capturing and sharing learning. It is a constantly evolving framework. Information can be found at www.conservationmeasures.org/CMP/.*

Grantham et al. 2010 Front. Ecol. Environment

Study Area: Elkhead Watershed, northwestern Colorado

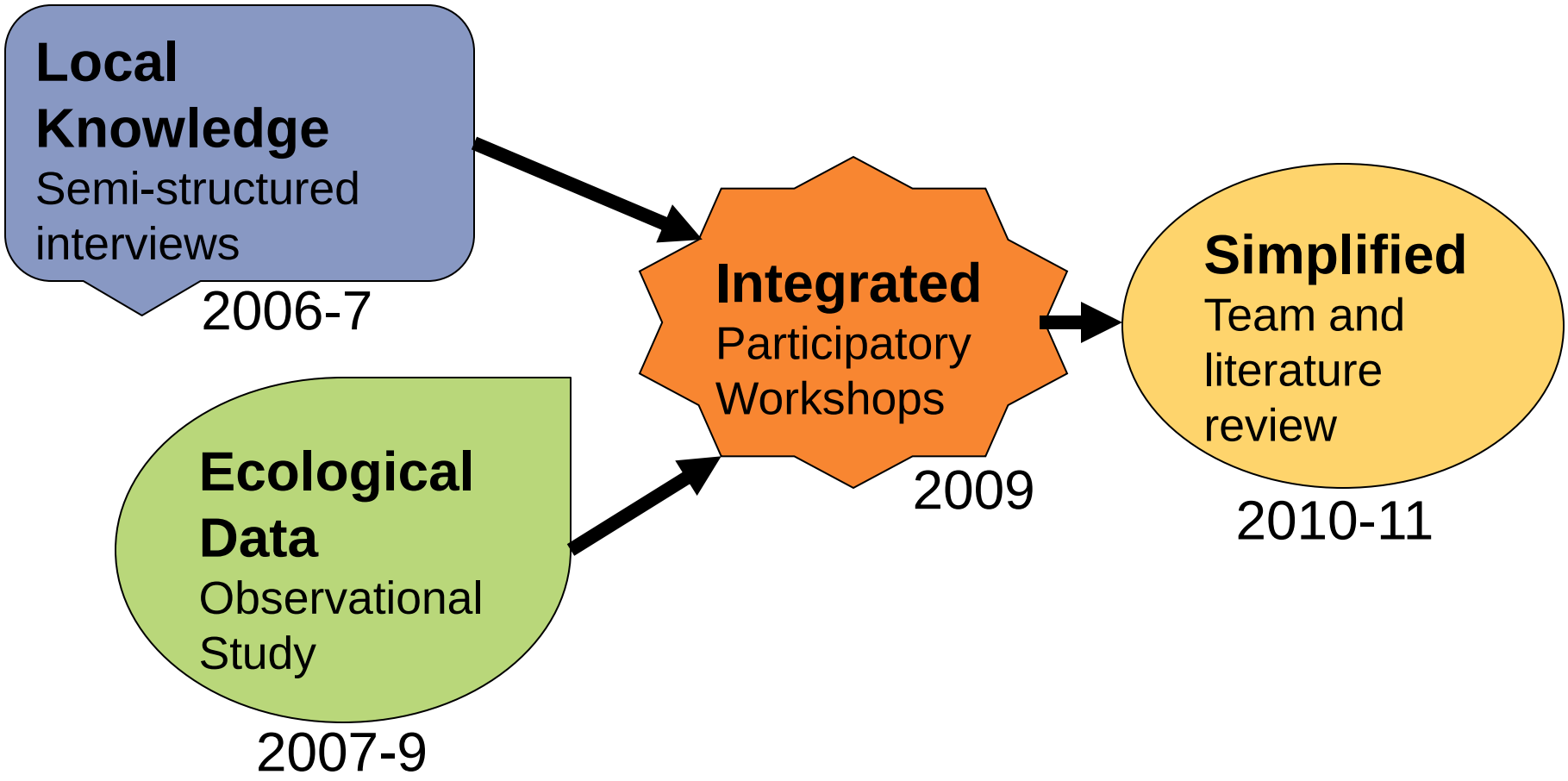


A Patchwork of Ecological Sites



Learning from the Land in Northwest Colorado

How did we Learn from the Land in Northwest Colorado?



Sagebrush Steppe State-and-Transition Model

Based on Local Knowledge

Corrie Knapp, MS in Rangeland Ecology
Colorado State University

Local Knowledge Documentation

Participant Identification

- **County Ownership Records**
- **Community Referrals**

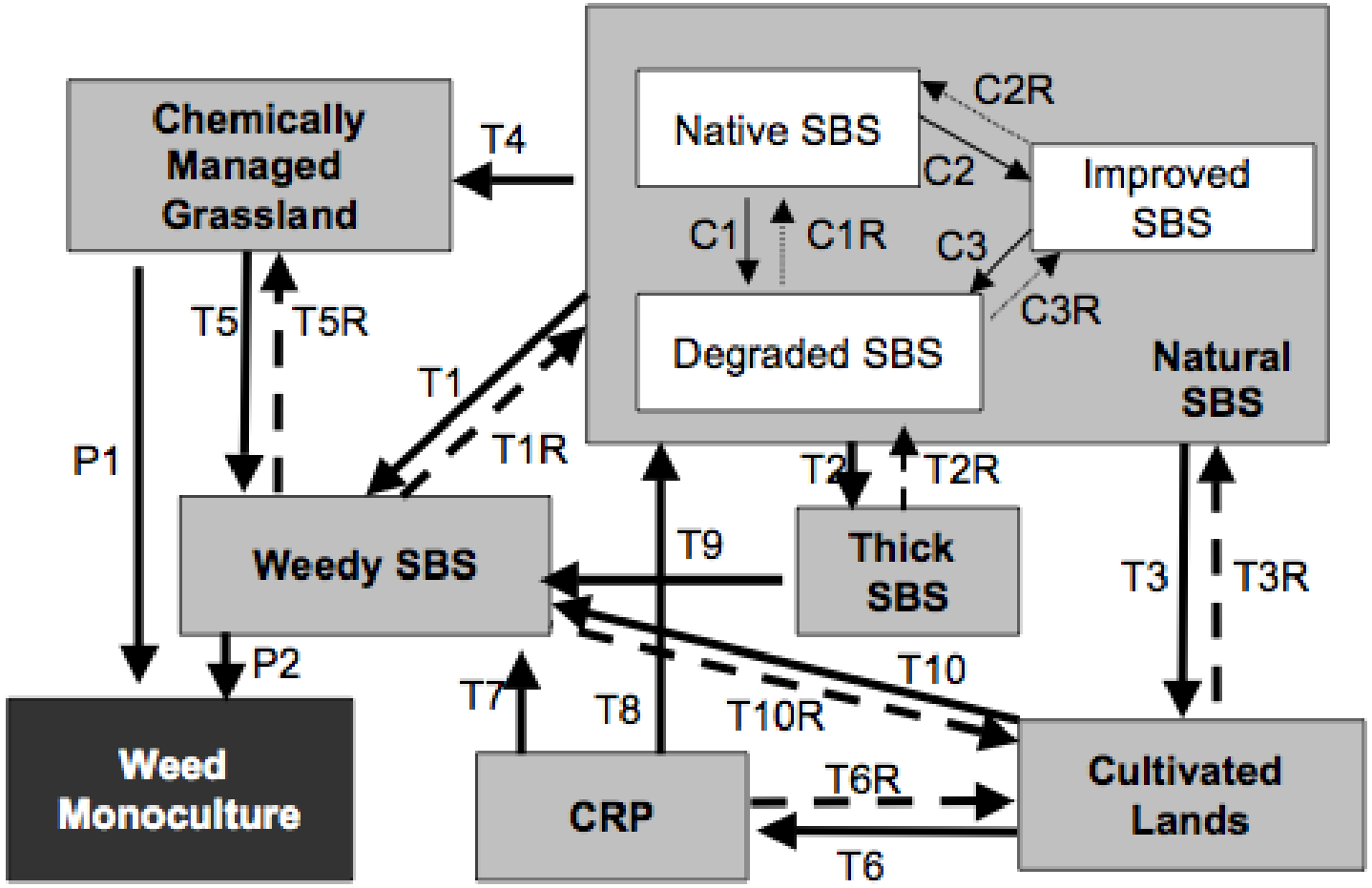
Interviews (43)

- **Semi-structured interviews (32)**
- **Field Interviews (11)**

Community Meetings

- **Validation**

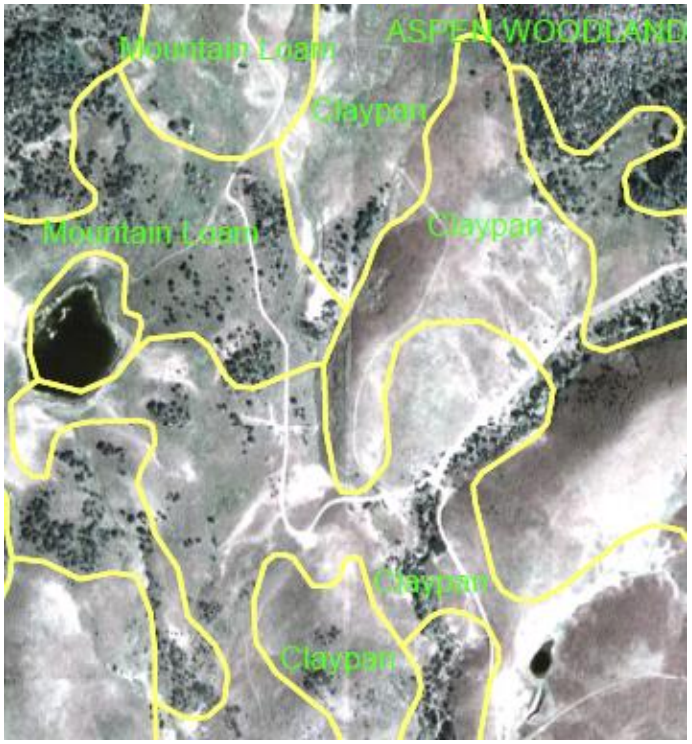
LOCAL KNOWLEDGE STM FOR SAGEBRUSH STEPPE VEGETATION TYPE



Building Data-Driven State-and-Transition Models

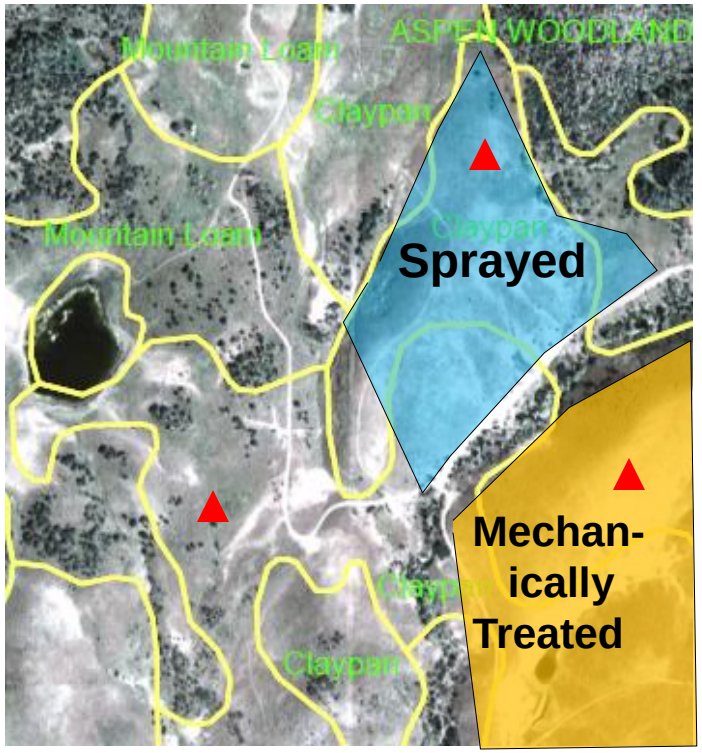
Emily Kachergis
PhD in Ecology, Colorado State University

Where did we collect data?



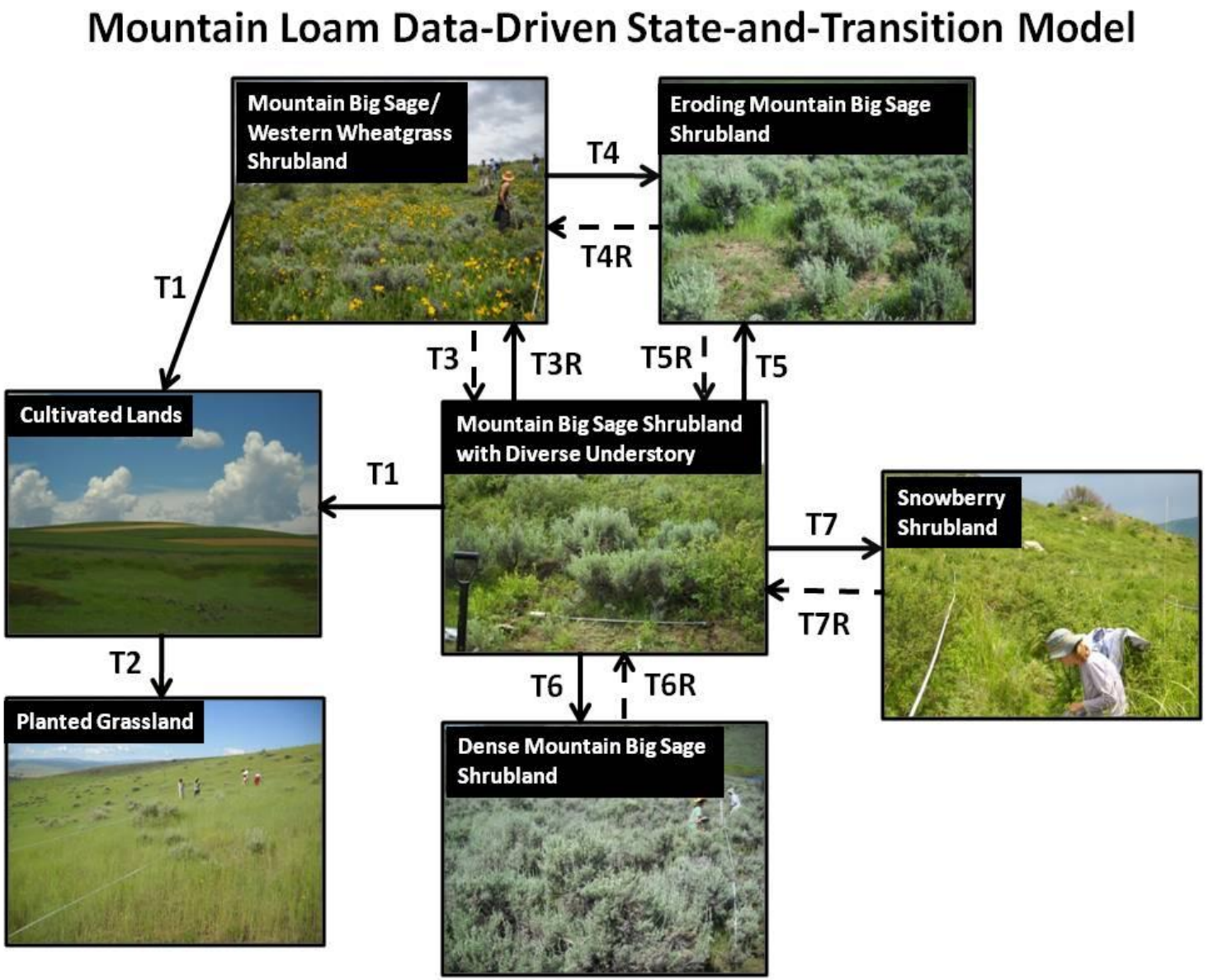
Claypan and Mountain Loam Ecological Sites based on NRCS soil maps

+



Different Combinations of Management Practices

Mountain Loam STM

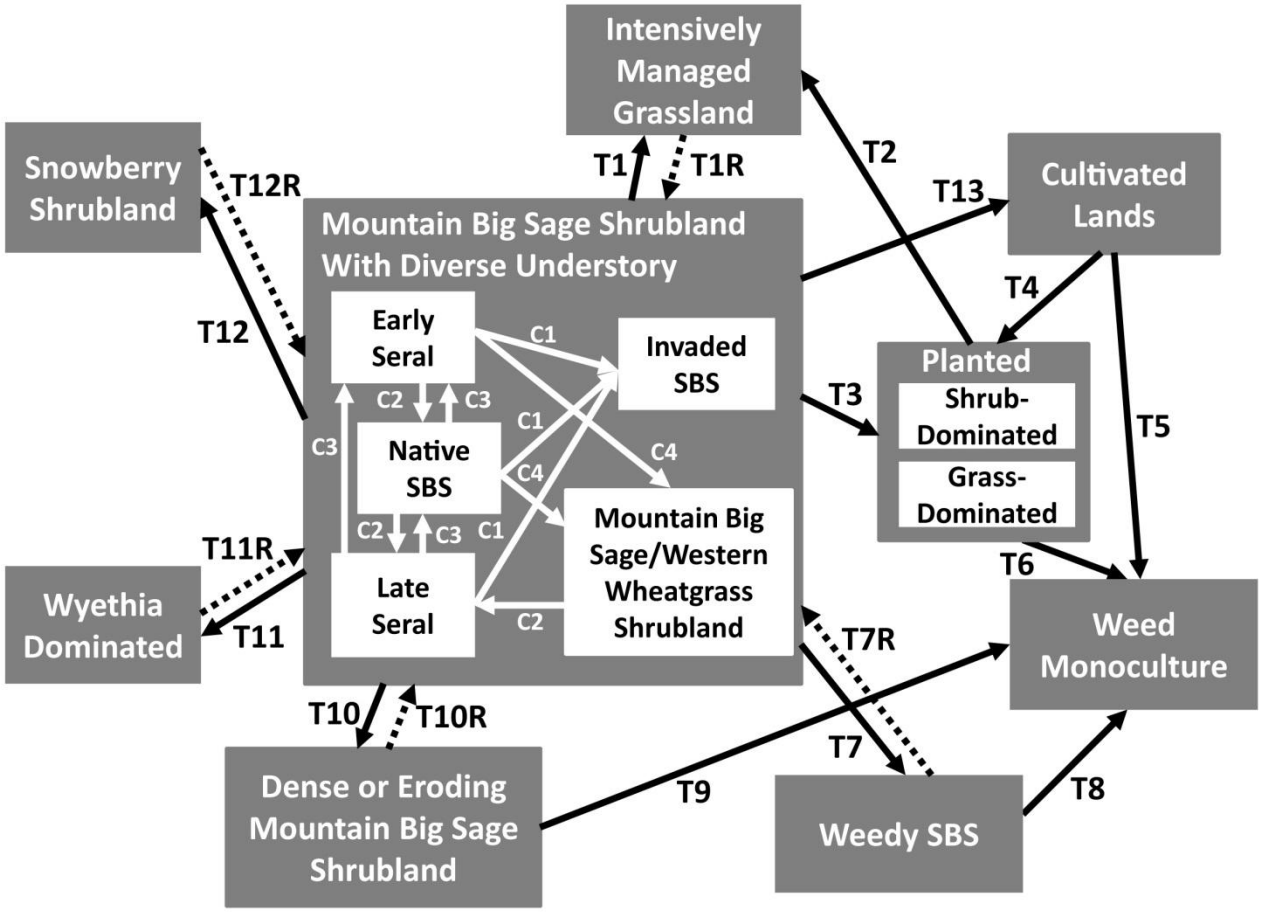


Model Evaluation & Integration Workshops

2009 Model Integration Workshops -- Process

1. Brief introduction to STMs and concepts
2. Brief introduction to each model
3. Small-group breakout sessions with a large paper copy of each model
4. Group modeling process
5. Assessing agreement
6. Survey

Integrated Mt. Loam Model



Model Simplification

- **Maximum of four states, in order to quantify**
- **Review by inter-disciplinary team: 3 human ecologists, 4 rangeland ecologists, 2 ag economists)**
- **Literature review**
- **Transition probability elicitation**

Transition Probability Elicitation

1.3 Imagine a situation like that described by the conditions in row A—land that has been aerial sprayed in the last 3 years. How many pastures out of 10 that had been aerially sprayed but not burned in the last 3 years have Moderate-High Shrub Cover? Circle that number.

	Fire	**Aerial Spraying**	**Probability Moderate-High Shrub Cover**
A	No	Yes	**1 2 3 4 5 6 7 8 9 10**

Mountain Loam STM-Simplified for Simulation Model

Mt. Big Sagebrush-Diverse Understory

T2

T2R

Mt. Big Sagebrush-Wheatgrass Shrubland

T1

T1R

T3

Dense or Eroding Mt. Big Sagebrush-Shrubland

T1 Reduction of the herbaceous understory, caused by heavy grazing and/or drought, combined with lack of disturbance that reduces shrub cover.

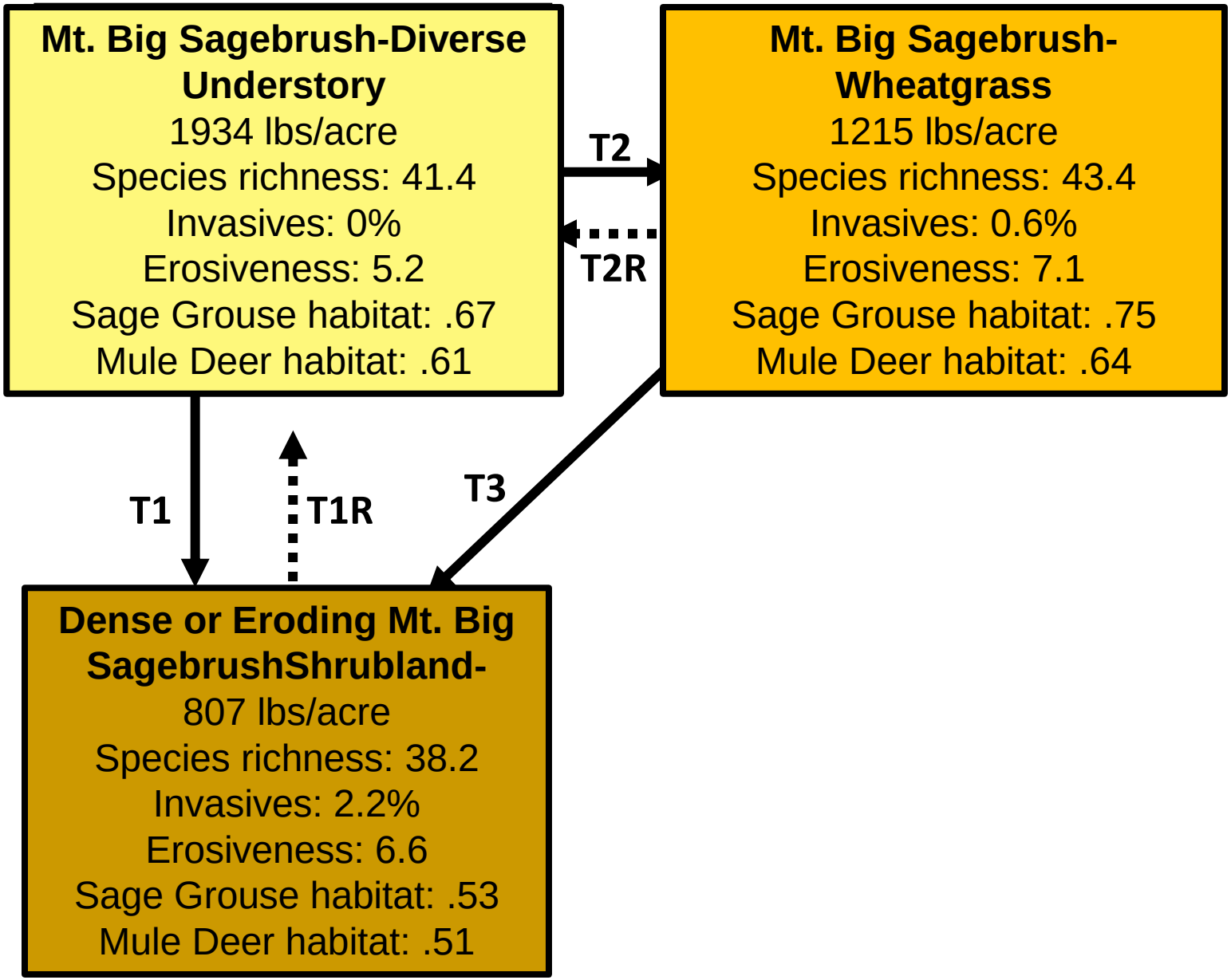
T1R Disturbance that reduces shrub cover (fire,herbicide) combined with recovery of the herbaceous understory under lower grazing pressure and/or more precipitation

T2 Moderate grazing in wetter years allows western wheatgrass to become dominant

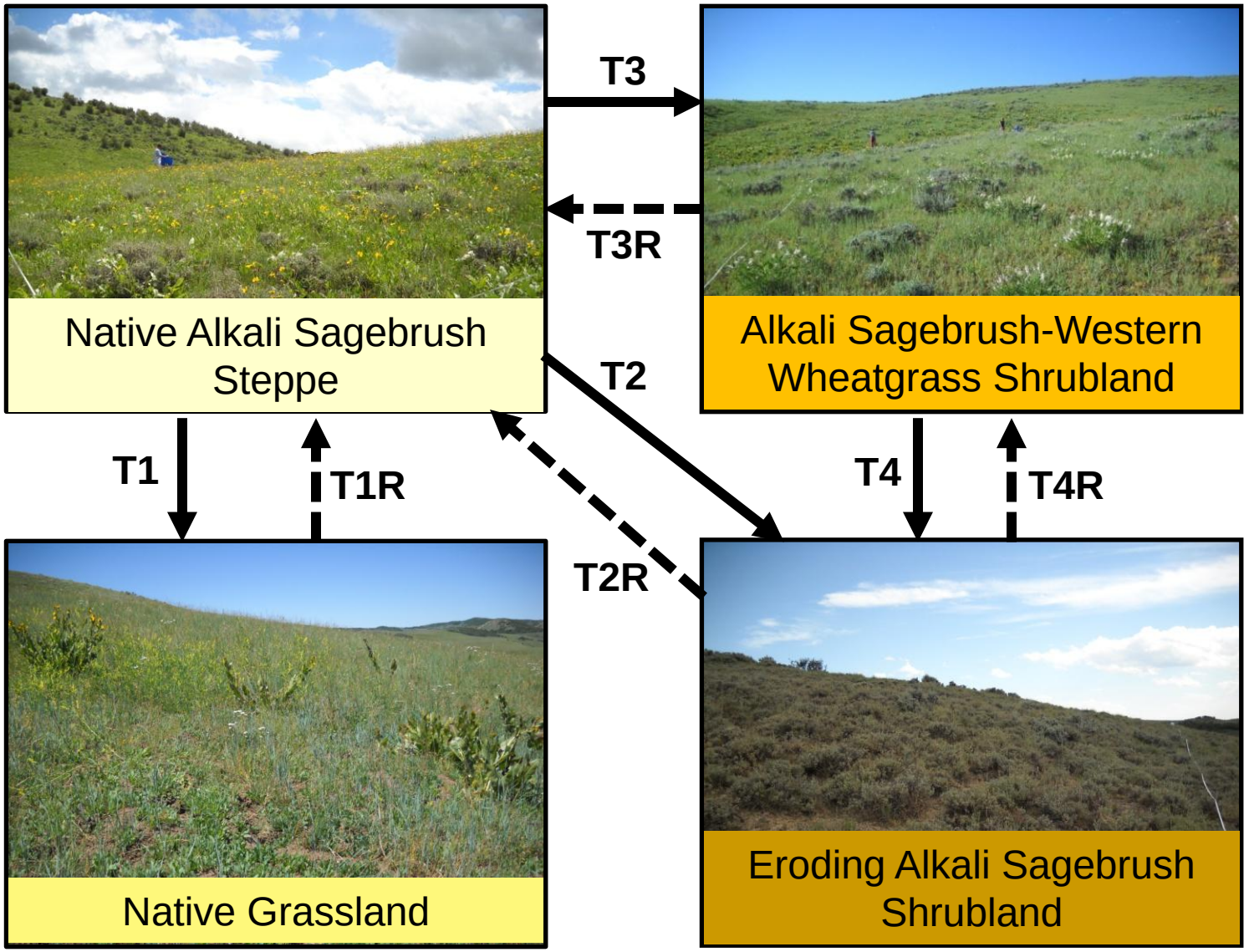
T2R Low grazing pressure combined with drought decrease wheatgrass cover; also occurs under heavy grazing pressure

T3 Heavy grazing causes continued reduction in wheatgrass cover and an increase in shrub cover

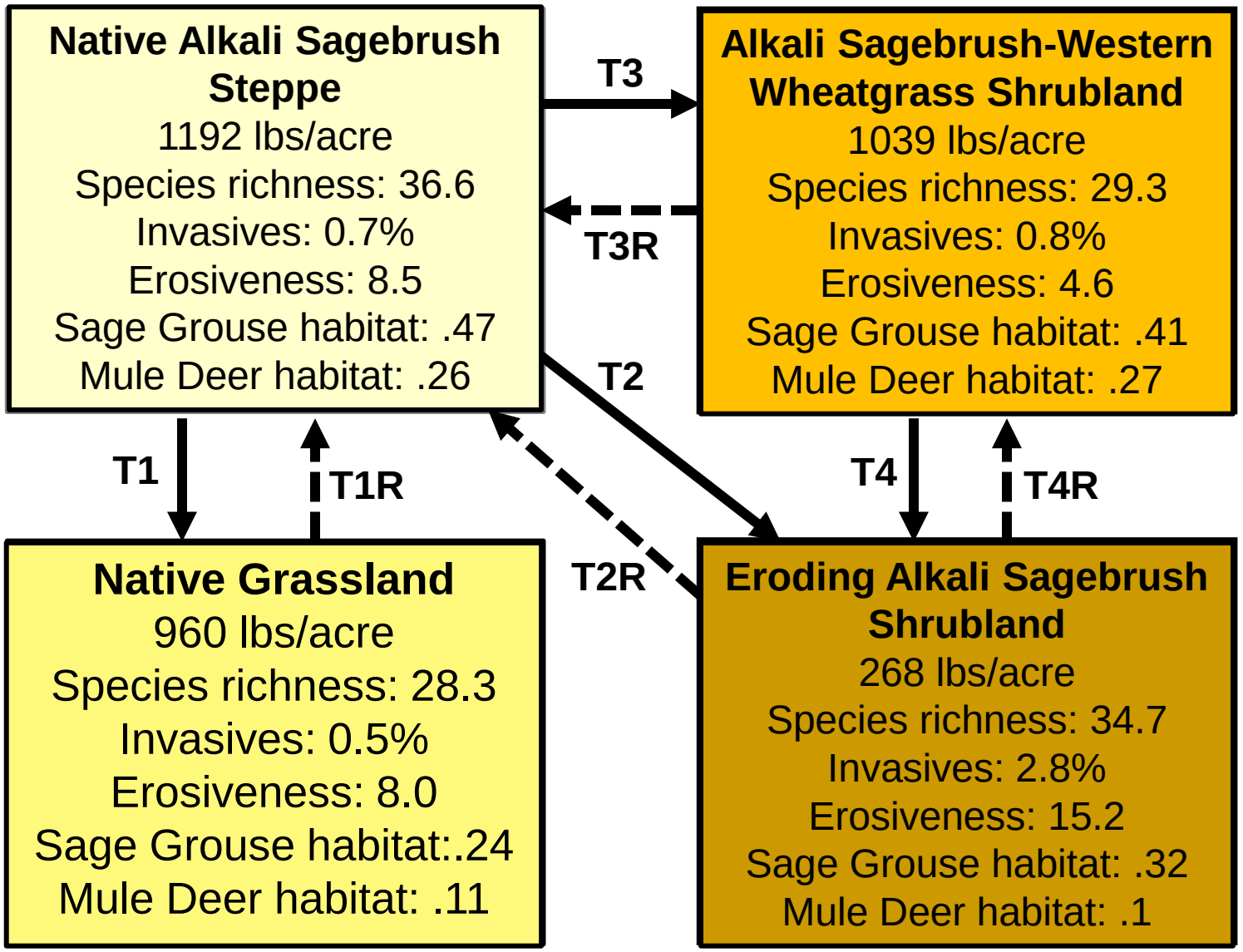
Mountain Loam STM--**Ecosystem Services**



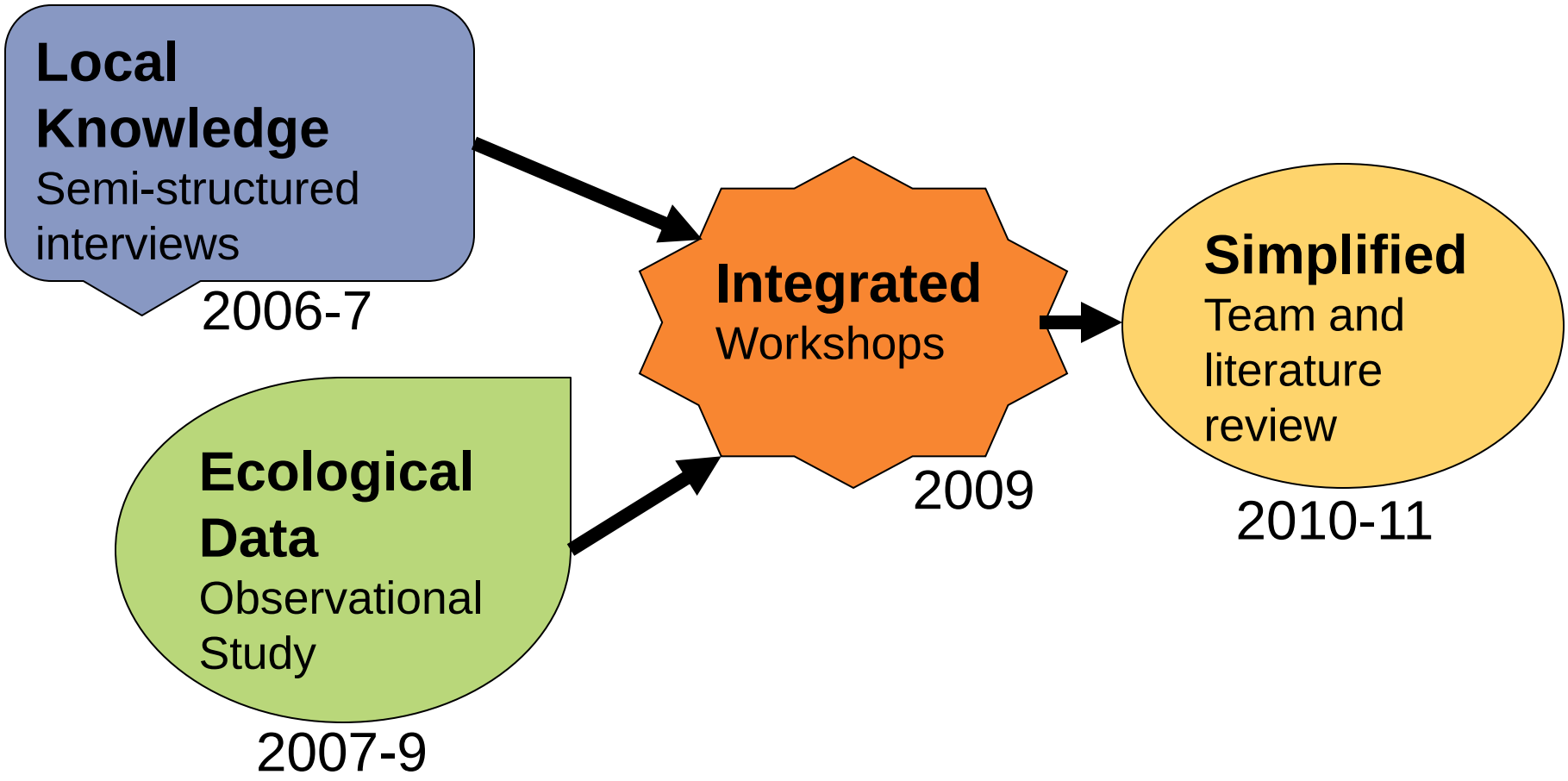
Claypan STM-Simplified for Simulation Model



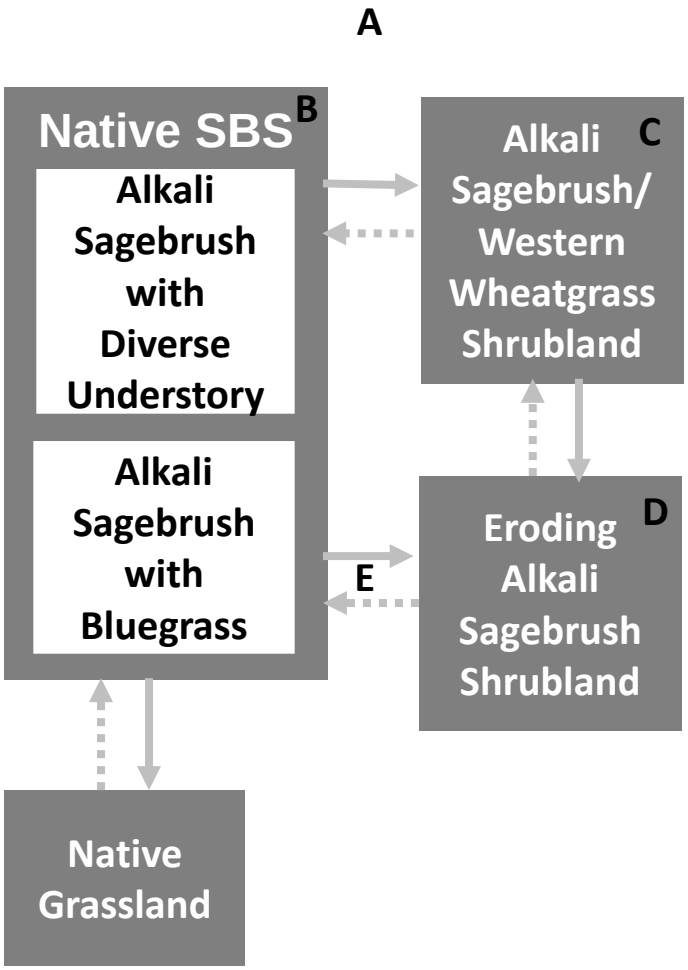
Claypan STM-**Ecosystem Services**



What did we learn?



Model development is a process…



A. Soil descriptions and plant species composition differ from other ecological sites, justifying the separation into the Claypan ecological site (ED)

B. "Diverse" and "Bluegrass" are perceived to shift easily between each other/not make a big difference for management, so are grouped within a "Native Sagebrush Steppe" state (LK, ED, IN)

C. Alkali Sagebrush/Western Wheatgrass is perceived to be different from the Native SBS because of soil dynamic property differences (ED); LK, IN, SI varied from seeing this as part of the range of variability of Native SBS (weather or soil texture-related) to seeing it as a degraded state to seeing it as a desirable state for grazing

D. Eroding Alkali sagebrush shrubland is a separate state because the process of erosion is accelerated here (LK, ED, IN)

E. High grazing pressure, drought, and/or fire reduce herbaceous plant cover, causing erosion; reverse transition caused by the opposite (LK, ED, IN, SI)

…of accumulating evidence

Different knowledge types have different strengths and limitations…

Type	Strength	Limitation	Output
Local Knowledge	- Long time frame - Variety of management practices/disturbances - Identifies social drivers - Improves communication	- No quantitative evidence - Not as specific about biophysical dynamics	STM for a vegetation type in a region (or, with field trips, ecological site)
Ecological Data (Obser-vational)	- Quantitative evidence - Records a variety of biophysical indicators	- Misses temporal variability - May miss value-defined states	STM for an ecological site in a region
Model Integration	- Reconciles different knowledge sources - Complex - More accurate	- Representing areas of disagreement - Complex	Complex STM for an ecological site, incorporating more drivers
Simplified	- Easier to use and quantify	- Lacks complexity and nuance of real world	Simple STM for an ecological site, focused on the most frequent/ important dynamics

Local Knowledge	Ecological Data	Integrated	Simplified
Natural sagebrush steppe	Mountain big sagebrush/ diverse understory	Mountain big sagebrush/ diverse understory	Mountain big sagebrush/ diverse understory
		Early seral	
Native sagebrush steppe		Native sagebrush steppe	
		Late seral	
Degraded sagebrush steppe	Mountain big sagebrush/western wheatgrass	Mountain big sagebrush/western wheatgrass	Mountain big sagebrush/western wheatgrass
Improved sagebrush steppe			
		Invaded sagebrush steppe	
Chemically managed grassland		Intensively managed grassland	
Weedy sagebrush steppe		Weedy sagebrush steppe	
Thick sagebrush steppe	Dense mountain big sagebrush shrubland	Dense/eroding mountain big sagebrush shrubland	Dense/eroding mountain big sagebrush shrubland
	Eroding mountain big sagebrush shrubland		
Cultivated lands	Cultivated lands	Cultivated lands	
Conservation Reserve Program	Planted grasslands	Planted	

…but are ultimately complementary

Disagree-ments happen…

…but they are fruitful for future research and learning

Hypotheses that can be tested using Adaptive Management:

Claypan Eroding

- Transition to Eroding caused by heavy grazing, drought, and/or fire
- Transition back to Diverse is caused by reduction in grazing and favorable precipitation, although it is very unlikely

Mountain Loam Dense

- Transition to Dense caused by heavy grazing and/or drought that reduces shrub cover
- Transition back requires shrub disturbance in addition to favorable precipitation and reduced grazing, and is fairly likely given these conditions

Implications for STM development

- Integrating multiple knowledge sources makes better models
- Increases buy-in, willingness to use models on the ground
- Increases potential for learning
- **Next step:** apply STMs on the ground in an adaptive management context

Thanks!

Project team: Maria Fernandez-Gimenez, Emily Kachergis, Windy Kelley, Corrie Knapp, Kira Puntenney, Willow Hibbs, Jay Parsons, James Pritchett, John Ritten, Roy Roath, Monique Rocca, Ryan Wattles

Community Advisory Group: Ranchers of the Elkhead watershed and Moffatt County, Routt County Extension, Routt National Forest, BLM Little Snake Field Office, CO Division of Wildlife, TNC Carpenter Ranch, NRCS, Community Agricultural Alliance, Tread of Pioneers Museum.

Funding provided by: USDA NIFA AFRI,
CO Agricultural Experiment Station, USDA NRCS

Questions?

Summing it all up…

Ways of incorporating local knowledge

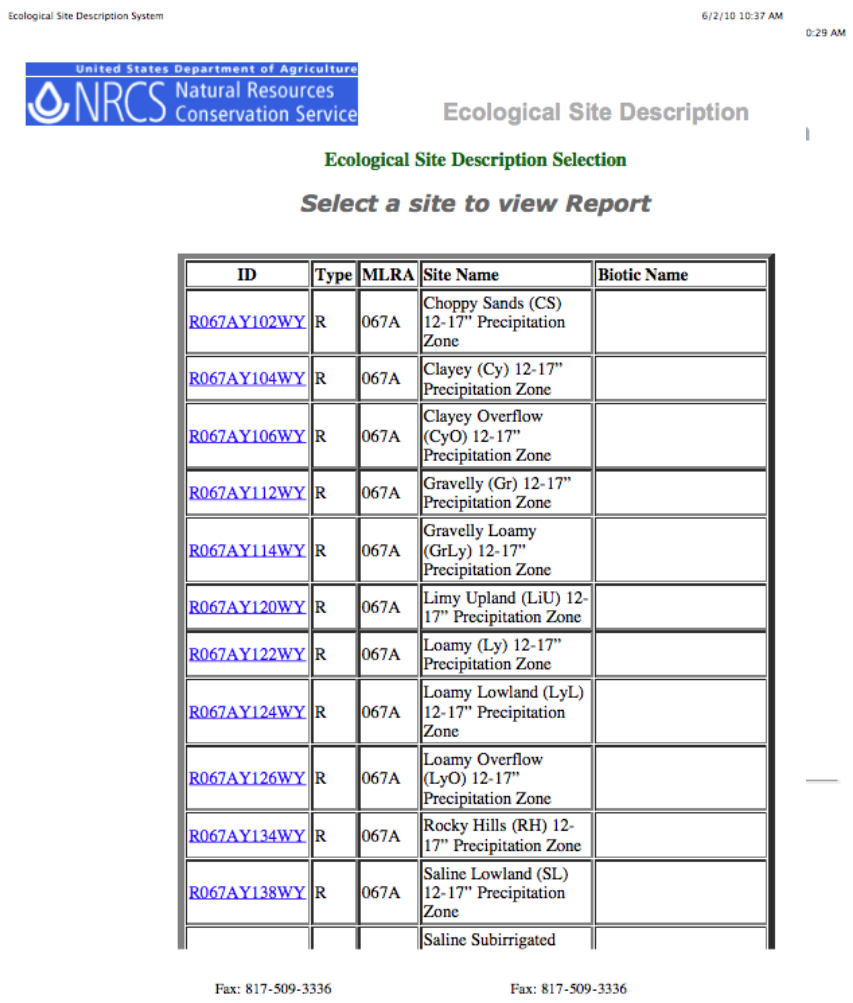
Table 1. Comparison of knowledge elicitation techniques[1]

Method	Number needed per ecological site[2]	Opportunity for ranchers to learn about state-and-transition models	Time commitment for ranchers	Time required for analysis	Interaction among participants
Development team	Single ongoing process (4–8 meetings)	High	Weeks–months	None	High
Workshops	1–2	Medium	3–8 hours	4–8 hours	Medium–High
Interviews	5–10	Medium	1–3 hours	1–2 days	None
Focus groups	1–2	Low	2 hours	2–6 hours	Medium–High
Surveys	30–50	Low	30 minutes–1 hour	1–2 days	None
Feedback meeting	1–2	Low	1–2 hours	2–4 hours	Low–Medium

[1]The time estimations provided in this table serve as a general reference and will vary based on the individual and prior experience with methods.
[2]Number of events will vary based on the heterogeneity and spatial scale of the ecological site.

Knapp et al. 2010 Rangelands

Where to Find ESDs?



Ecological Site Description System 6/2/10 10:37 AM

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United States Department of Agriculture
NRCS Natural Resources Conservation Service

Ecological Site Description

Ecological Site Description Selection

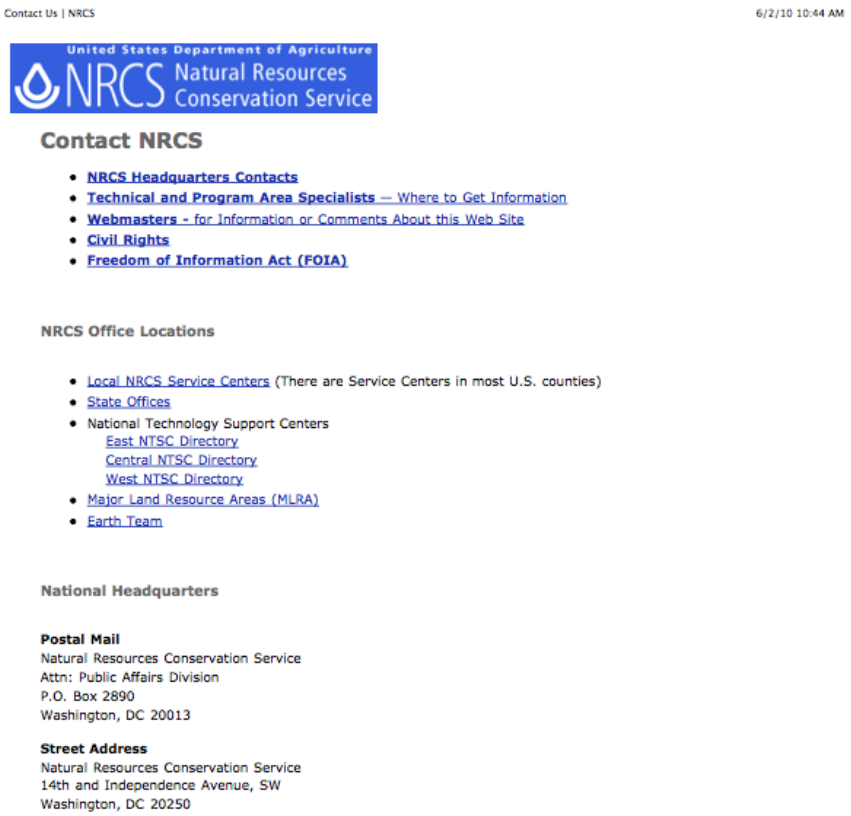
Select a site to view Report

ID	Type	MLRA	Site Name	Biotic Name
R067AY102WY	R	067A	Choppy Sands (CS) 12-17" Precipitation Zone	
R067AY104WY	R	067A	Clayey (Cy) 12-17" Precipitation Zone	
R067AY106WY	R	067A	Clayey Overflow (CyO) 12-17" Precipitation Zone	
R067AY112WY	R	067A	Gravelly (Gr) 12-17" Precipitation Zone	
R067AY114WY	R	067A	Gravelly Loamy (GrLy) 12-17" Precipitation Zone	
R067AY120WY	R	067A	Limy Upland (LiU) 12-17" Precipitation Zone	
R067AY122WY	R	067A	Loamy (Ly) 12-17" Precipitation Zone	
R067AY124WY	R	067A	Loamy Lowland (LyL) 12-17" Precipitation Zone	
R067AY126WY	R	067A	Loamy Overflow (LyO) 12-17" Precipitation Zone	
R067AY134WY	R	067A	Rocky Hills (RH) 12-17" Precipitation Zone	
R067AY138WY	R	067A	Saline Lowland (SL) 12-17" Precipitation Zone	
			Saline Subirrigated	

Fax: 817-509-3336 Fax: 817-509-3336

Reviewed and completed ESDs: http://esis.sc.egov.usda.gov

Where to Get Additional Information?



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- **NRCS Headquarters Contacts**
- **Technical and Program Area Specialists** — Where to Get Information
- **Webmasters** - for Information or Comments About this Web Site
- **Civil Rights**
- **Freedom of Information Act (FOIA)**

NRCS Office Locations

- Local NRCS Service Centers (There are Service Centers in most U.S. counties)
- State Offices
- National Technology Support Centers
  - East NTSC Directory
  - Central NTSC Directory
  - West NTSC Directory
- Major Land Resource Areas (MLRA)
- Earth Team

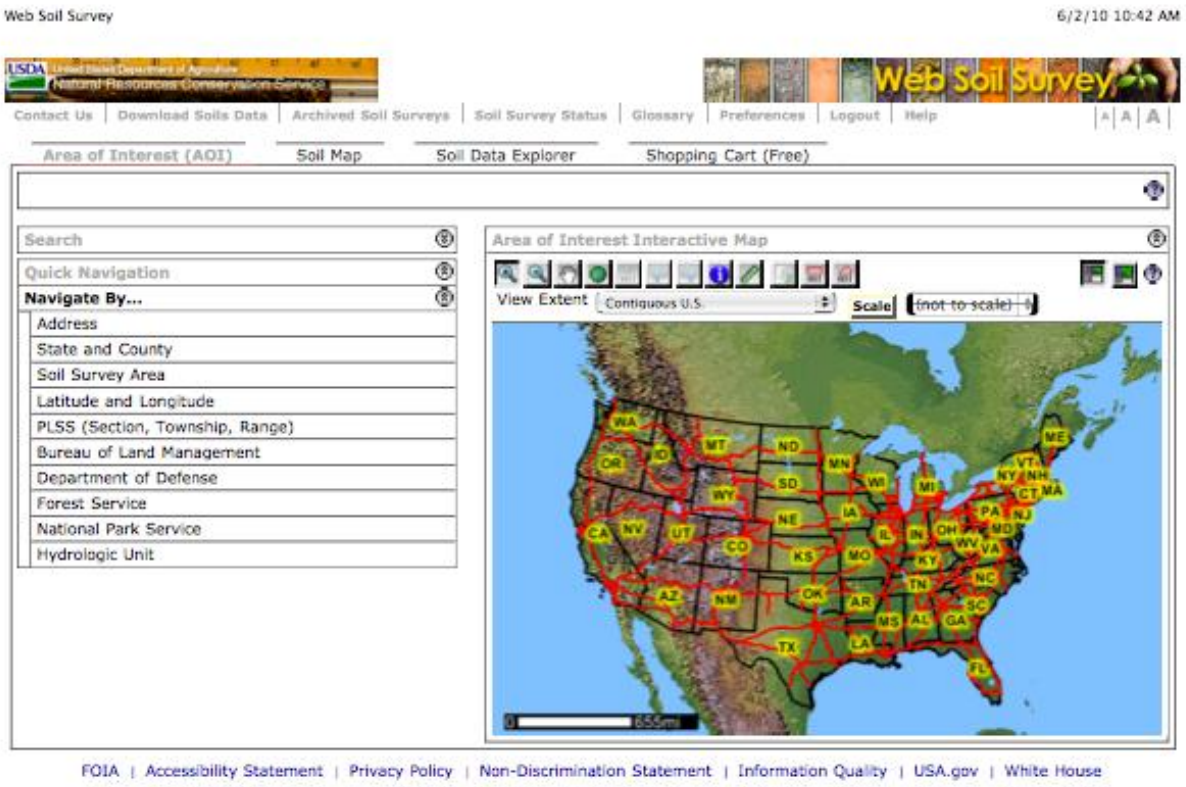
National Headquarters

Postal Mail
Natural Resources Conservation Service
Attn: Public Affairs Division
P.O. Box 2890
Washington, DC 20013

Street Address
Natural Resources Conservation Service
14th and Independence Avenue, SW
Washington, DC 20250

Local NRCS office: http://www.nrcs.usda.gov/

Where to Find Soil Maps?



http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Identifying Ecological Sites on Your Ranch

1. Gather Information	2. Go to the field	3. Compare physical characteristics	4. Compare vegetation
• Key to Ecological Sites • Topographical Map • Soil Map • Soil Survey Descriptions • Ecological site descriptions (ESD)	• Go to a site. • Find out where you are on the maps. • According to the soil and topographic maps, what ecological site should you be on?	• Do you have the same topography as the ESD? • Are you at the same elevation as the ESD? • Is the site in the same aspect as the ESD? • Are the soil properties the same as described in the ESD?	• What plants are on the site? • Which state or community are you in?