

Ecological Site Inventory Case Study: Integration with NRCS Soil Survey in Montana

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Objectives

- Fundamentals of Montana's rangeland ecological site system
- Integration of soil survey and ecological sciences programs
- Unique ways we are gathering and using data
- Recommendations

Native plant communities are strongly influenced by soil properties and climatic factors.



Photo by Eve Wills

Lack of consistent assignment of ecological sites to soils between individuals and between different areas of the state.



Low resolution of ecological sites to account for climatic variations and their influence on plant communities



Fundamentals of the Montana Ecological Site System

1. Ecological Site Key
2. Relative Effective Annual Precipitation (REAP)
3. Temperature Moisture Regimes and Models
4. Land Resource Unit (LRU)

Montana Rangeland Ecological Site Key

MONTANA RANGELAND ECOLOGICAL SITE KEY - Version 8.2

NOTE: Part I of the key describes ecological sites existing individually within soil components. Refer to Part II of the key for sites that are ecological site complexes.

Part I. Soil Component Ecological Site Key

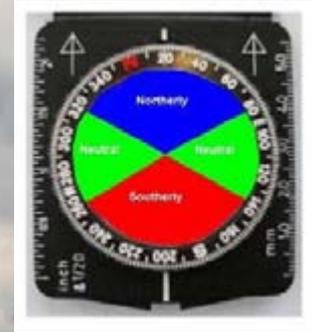
A. Site receives additional moisture¹

- 1a. Soil saline (EC > 4 within surface 4")
 - 2a. Seasonal high water table 24-42" from ground surface; salt tolerant plants dominate site - Saline Subirrigated (SSb)
 - 2b. Seasonal high water table ≥ 42 " from ground surface; salt tolerant plants dominate site; site regularly receives more than normal soil moisture because of run-in or stream overflow - Saline Overflow (SOv)
- 1b. Soil not saline (EC ≤ 4 within surface 4")
 - 3a. Site is a closed depression with run-in - Pothole (Ph)
 - 3b. Site is not a closed depression
 - 4a. Seasonal high water table ≥ 42 " from ground surface; site regularly receives more than normal soil moisture because of run-in or stream overflow - Overflow (Ov)
 - 4b. Seasonal high water table < 42" from ground surface
 - 5a. Soil organic (organic surface > 8" thick) - Wet Meadow, Organic (WMO)
 - 5b. Site located in the flood plain
 - 6a. Soil very poorly or poorly drained
 - 7a. Very poorly drained - Riparian Wet Meadow (RWM)
 - 7b. Poorly drained - Riparian Meadow (RM)
 - 6b. Soil not very poorly or poorly drained
 - 8a. Soil sandy-skeletal to within 20" of surface - Wet Gravelly (WGr)
 - 8b. Soil not sandy-skeletal - Riparian Subirrigated (RSb)
 - 5c. Site not located in flood plain
 - 9a. Soil very poorly or poorly drained
 - 10a. Very poorly drained - Wet Meadow (WM)
 - 10b. Poorly drained - Meadow (M)
 - 9b. Soil not very poorly or poorly drained - Subirrigated (Sb)

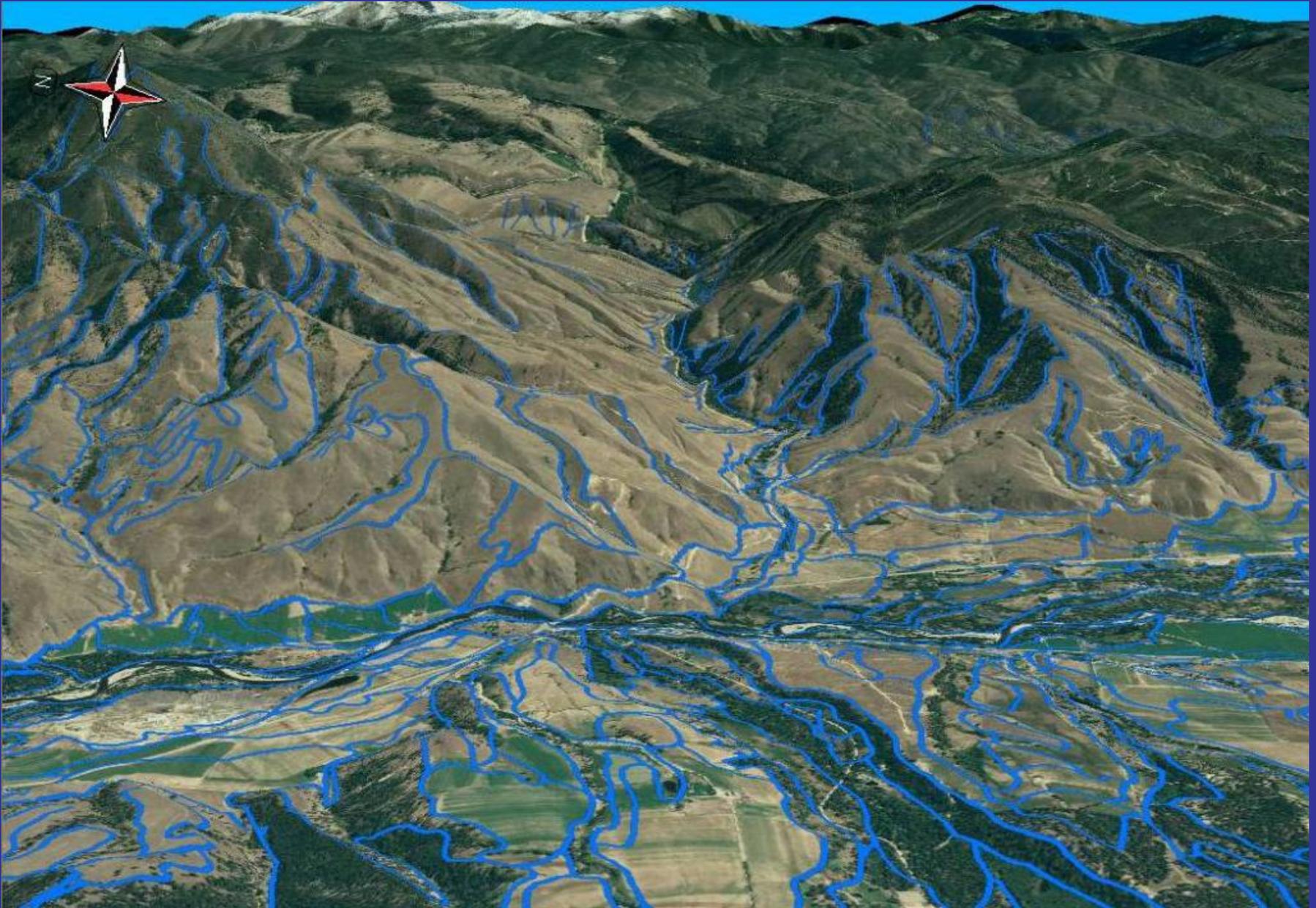
B. Site does not receive additional moisture¹

- 1a. Soil saline or saline-sodic (includes natric and relic natric)
 - 2a. No columnar or prismatic structure; site dominated by salt tolerant plants - Saline Upland (SU)
 - 2b. Columnar or prismatic structure present, abrupt root or water restrictive clay layer present within 8" of soil surface
 - 3a. Soil < 2" of surface over clay layer - Dense Clay (DC)
 - 3b. Soil 2 to 3.9" of surface over clay layer (evidenced by columnar or prismatic structure) - Thin Claypan (TCp)
 - 3c. Soil has 4 to 8" of surface over clay layer (evidenced by columnar or prismatic structure) - Claypan (Cp)
- 1b. Soil not saline or saline-sodic
 - 4a. Coarse granular clay (typically acid shales), site contains sandy vegetation (e.g. Prairie sandreed) - Coarse Clay (CoC)
 - 4b. Site not as above
 - 5a. Soils shallow to very shallow (< 20" deep to bedrock, lithic, or paralithic root restrictive layer)
 - 6a. Highly fractured lithic bedrock to soil surface.
 - 7a. Non-sedimentary bedrock that is lithic and or fractures dominates the site; roots penetrate into cracks; weak soil development. (Mountain mahogany usually present) - Fractured Rock (Fr)
 - 7b. Eroded exposed limestone of mostly shallow and very shallow limy ecological sites. (Mountain/mahogany and juniper are the dominant vegetation, > 15% cover) - Fractured Rock, Limy (FrLy)

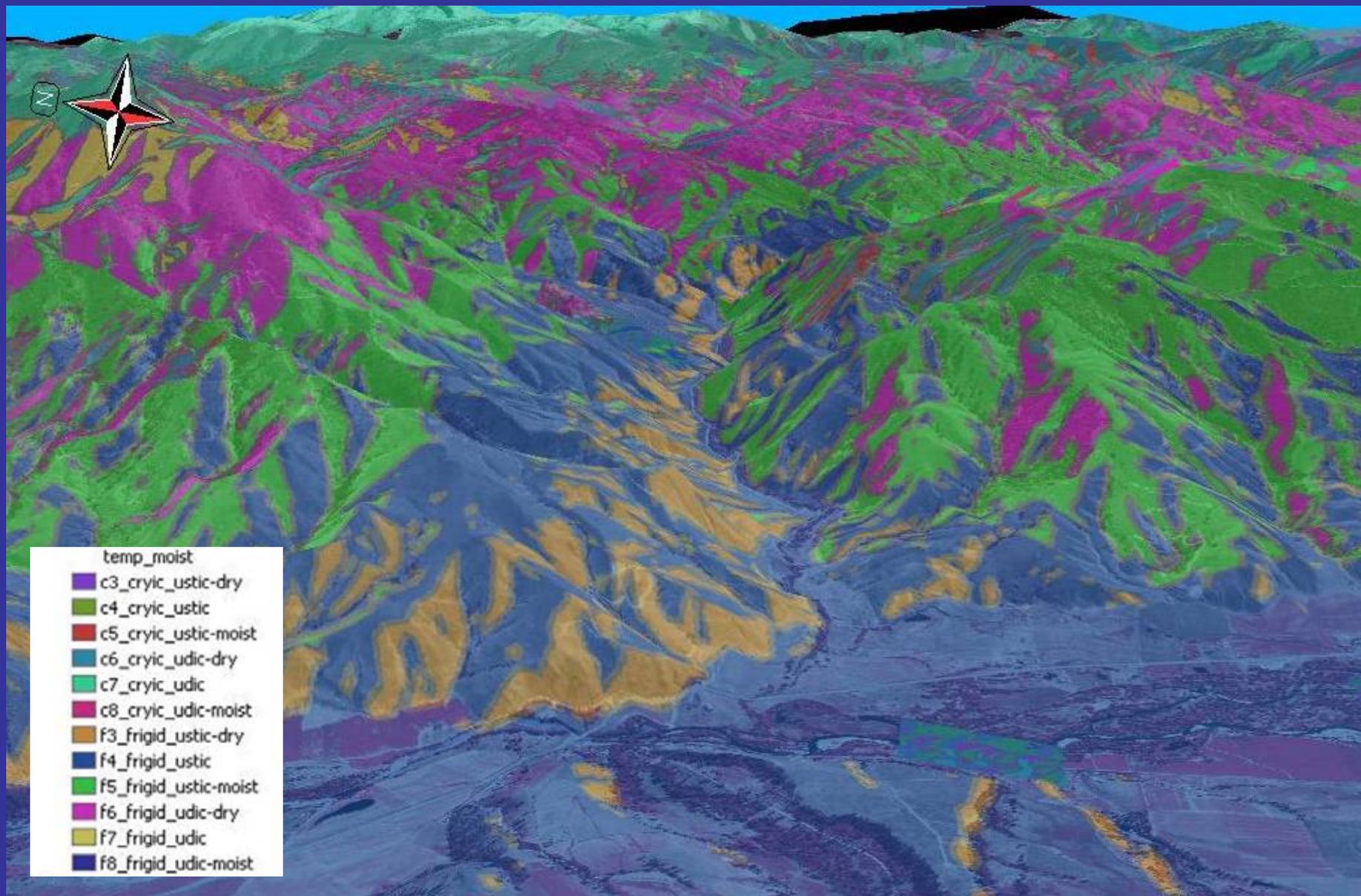
Incorporated relative effective annual precipitation (REAP) and soil temperature into our system



Map Unit Polygons

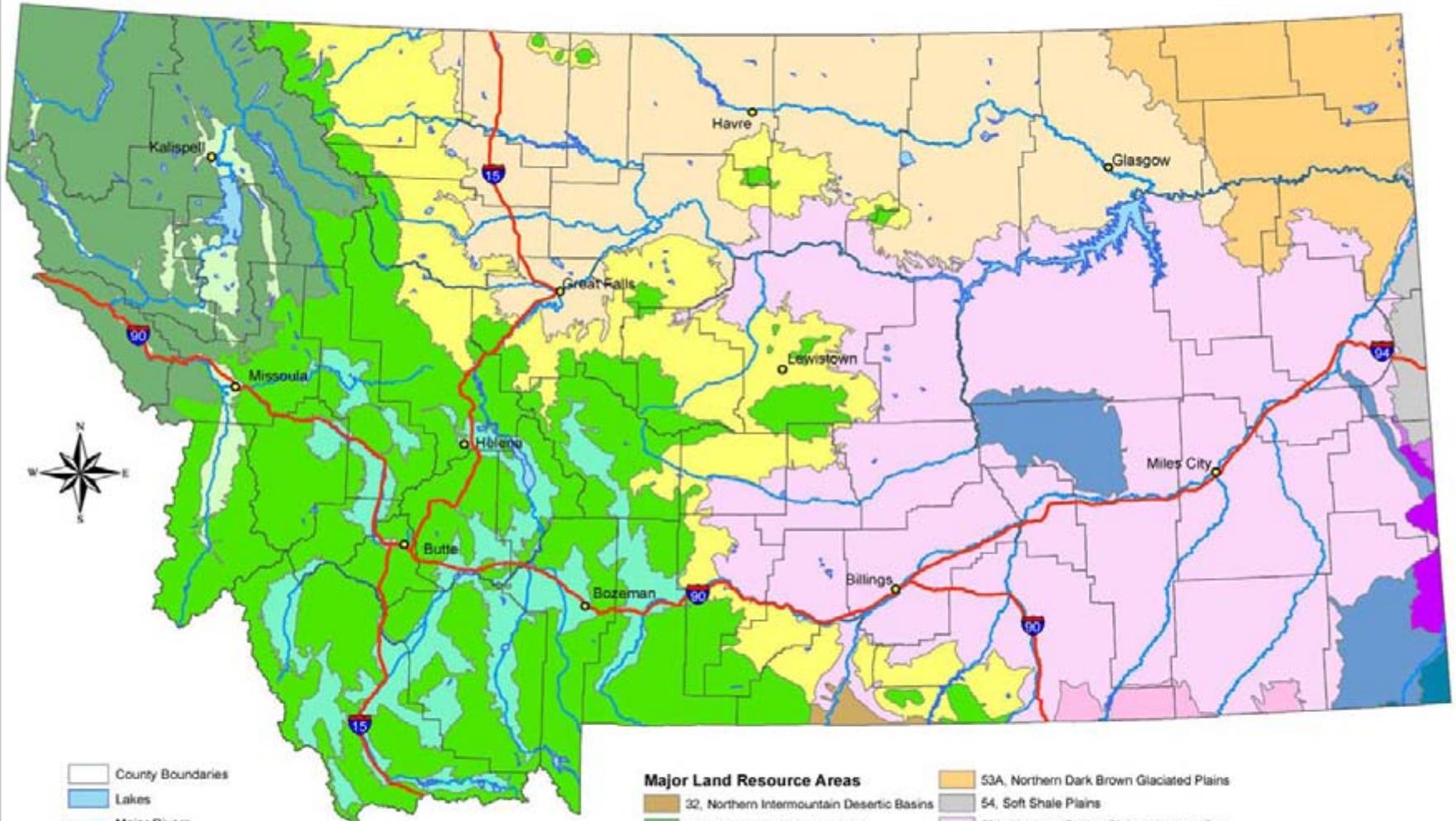


Temperature Moisture Model



Major Land Resource Areas

(MLRA with state subdivisions)



- County Boundaries
- Lakes
- Major Rivers
- Interstate Highways

Major Land Resource Areas

- | | |
|--|--|
| 22, Northern Intermountain Desertic Basins | 54, Soft Shale Plains |
| 43A, Northern Rocky Mountains | 58A, Northern Rolling Plains, Northern Part |
| 43B, Central Rocky Mountains | 58B, Northern Rolling Plains, Southern Part |
| 44A, Northern Rocky Mountain Valleys | 58C, Northern Rolling Plains, Northeastern Part |
| 44B, Central Rocky Mountain Valleys | 58D, Northern Rolling Plains, Eastern Part |
| 46, Northern Rocky Mountain Foothills | 60A, Pierre Shale Plains and Badlands |
| 52, Brown Glaciated Plains | 60B, Pierre Shale Plains and Badlands, Northern Part |

Land Resource Unit

MLRA's are further subdivided because of significant differences in climatic influences.

Moisture Temperature Regimes are tailored to each MLRA.

Land Resource Units in MLRA 43B

LRUs - 43B	MLRA	Moisture phase	Temperature Phase	Cover	RV PPT (inches)	RV FFD (days)
A	43B	Ustic, dry	frigid, cool	rangeland	9-14	70-100
B	43B	Ustic	frigid	forest	14-19	90-110
C	43B	Ustic	frigid, cool	rangeland	14-19	70-90
C	43B	Ustic	frigid, cool	forest	14-19	70-90
D	43B	Ustic	cryic, warm	rangeland	14-19	50-70
D	43B	Ustic	cryic, warm	forest	14-19	50-70
E	43B	Ustic, moist	frigid, cool	rangeland	19-22	70-90
E	43B	Ustic, moist	cryic, warm	rangeland	19-22	50-70
E	43B	Ustic, moist	frigid, cool	forest	19-24	70-90
E	43B	Ustic, moist	cryic, warm	forest	19-24	50-70
F	43B	Ustic, moist	cryic	rangeland	19-22	30-50
G	43B	Udic dry	frigid, cool	forest	24-30	70-90
H	43B	Udic dry	cryic, warm	forest	24-30	50-70
H	43B	Udic, dry	cryic	forest	24-30	30-50
I	43B	Udic	cryic	forest	30-40	30-50
J	43B	Udic, Moist	cryic, cool	forest	40-60	15-30
K	43B	Udic, Moist	cryic, cold (above tree line)	alpine	40-80	<15
Y	43B	any	any	any	12-80	<15-110

Unique ways we are gathering data



Collection of Ecological Site Data by Montana Field Soil Scientists



Soil Scientists during production calibration and vegetation ID training



Ecological information field soil scientists collect at each soil description site (Tier II):

- Determine MLRA (Major Land Resource Area)
- Determine LRU (Land Resource Unit)
- Determine Ecological Site
- Ocular estimate total dry weight of site in pounds/acre
- Ocular estimate dry weight for each species
- Ocular estimate percent soil surface cover
- Ocular estimate shrub canopy cover
- Management observations

Soils Site Data entered into PEDON PC and uploaded to NASIS



Ecological Site Data is entered directly into the Rangeland Database through a custom Montana data entry form

Main Menu

Exit Access

Help

Rangeland Database and Field Data Entry System

Version 1.4c - 03/28/2009



System Set-Up Data Administrator

Support Tables	Enter/Edit Data	Administrative Functions
Site and Plot Description	Reports	
	Enter/View Photos	
	View PDFs	

Data-Entry Method

Keyboard/Mouse Touch-Screen

Show 'Shortcut' Menu

C:\Documents and Settings\ecourtri\Desktop\DB Release 3_31_09\RangeDB 1.4c as of 2009-03-28.mdb

Montana Soil Survey Ecological Data Entry Form

Microsoft Access - [Data Entry: Vegetation Data]

File Edit View Insert Format Records Tools Window Help Adobe PDF

SYMBOLcv Arial 10 B I U

Vegetative Field Form

Add New Site and/or Plot

Existing Site/Plot: MLRA: LRU:

Rangeland Sites

Ecological Site (keyed):

Ecological Site (assigned):

Total Production (lbs/acre):

Forested Sites

Forest Habitat Type:

Data Collection Method

% Production

Production Class (default)

Production Classes (lbs/acre)

1 = < 1 %	2 = 1 - 4 %
3 = 5 - 10 %	4 = 11 - 25 %
5 = 26 - 33 %	6 = 34 - 50 %
7 = 51 - 75 %	8 = > 75 %

% Canopy Cover Classes

T = < 1 %	1 = 1 - 5 %
2 = 5 - 25 %	3 = 25 - 50 %
4 = 50 - 75 %	5 = 75 - 95 %
6 = 95 - 100 %	

Be sure to normalize the data before moving to the next record. You commit the data when you normalize it.

Vegetation

Surface Cover / Site Characteristics

Site Notes

PlantSymbol	Production Class	Equivalent lbs/acre	Normalized lbs/acre	CanopyCoverPercent
<input type="text"/>				

Normalize

Sort Plant Choice list by:

Counts

Plant symbol

Common name

Scientific name

Show Species by:

Plant symbol

Common name

The reasons it works

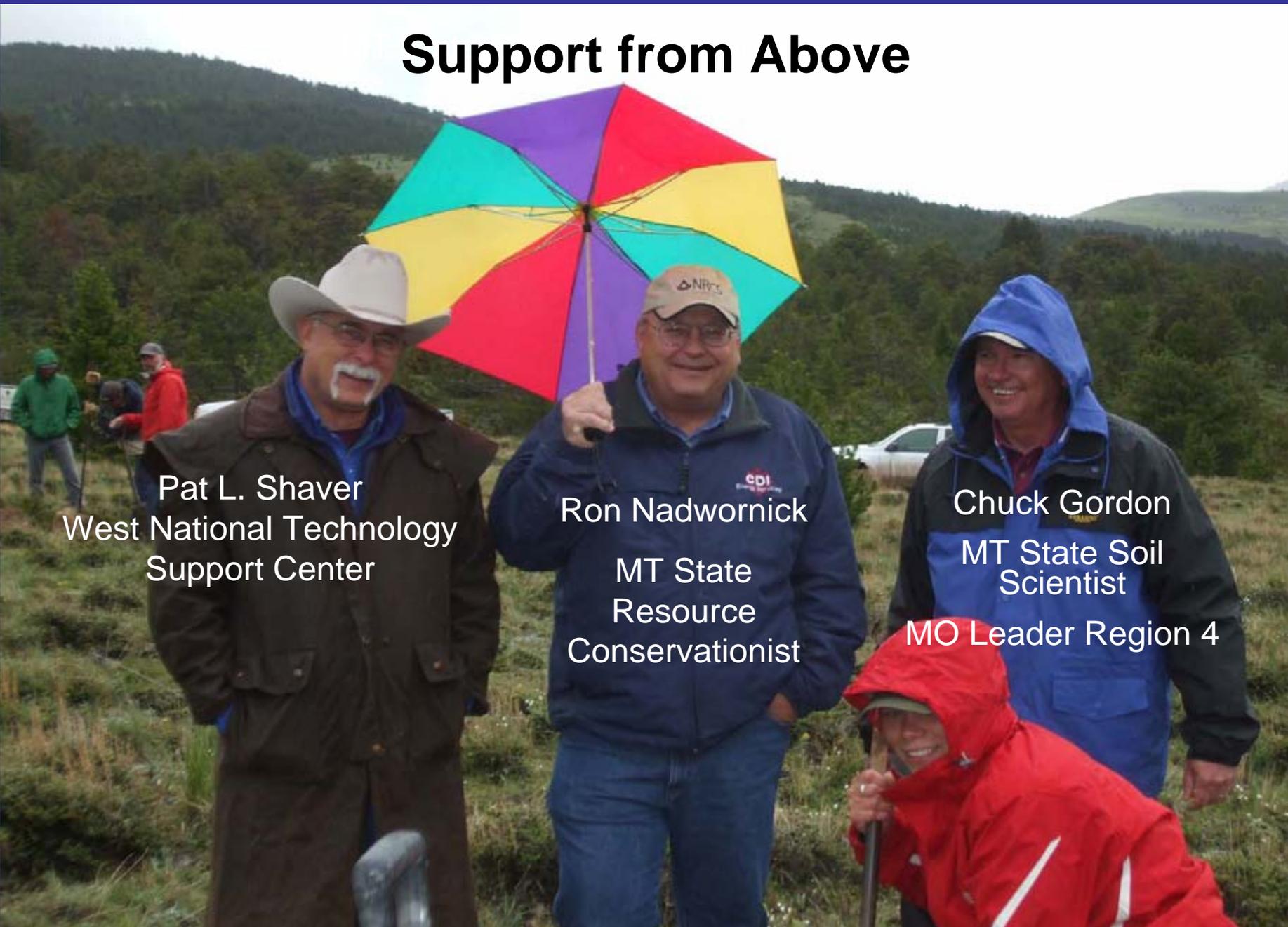
Support from Above



Pat L. Shaver
West National Technology
Support Center

Ron Nadwornick
MT State
Resource
Conservationist

Chuck Gordon
MT State Soil
Scientist
MO Leader Region 4



Old Fashion Stuff – Collaboration, Communication, and Ingenuity



Jay Skovlin

Party Leader
and Pedon
PC Plus
Guru

Mike Hansen

Assistant
State Soil
Scientist



Jon Siddoway
**State Range
Conservationist**

Additional Range Specialist brought on to support
Montana Soil Survey Program

Tammy DeCock

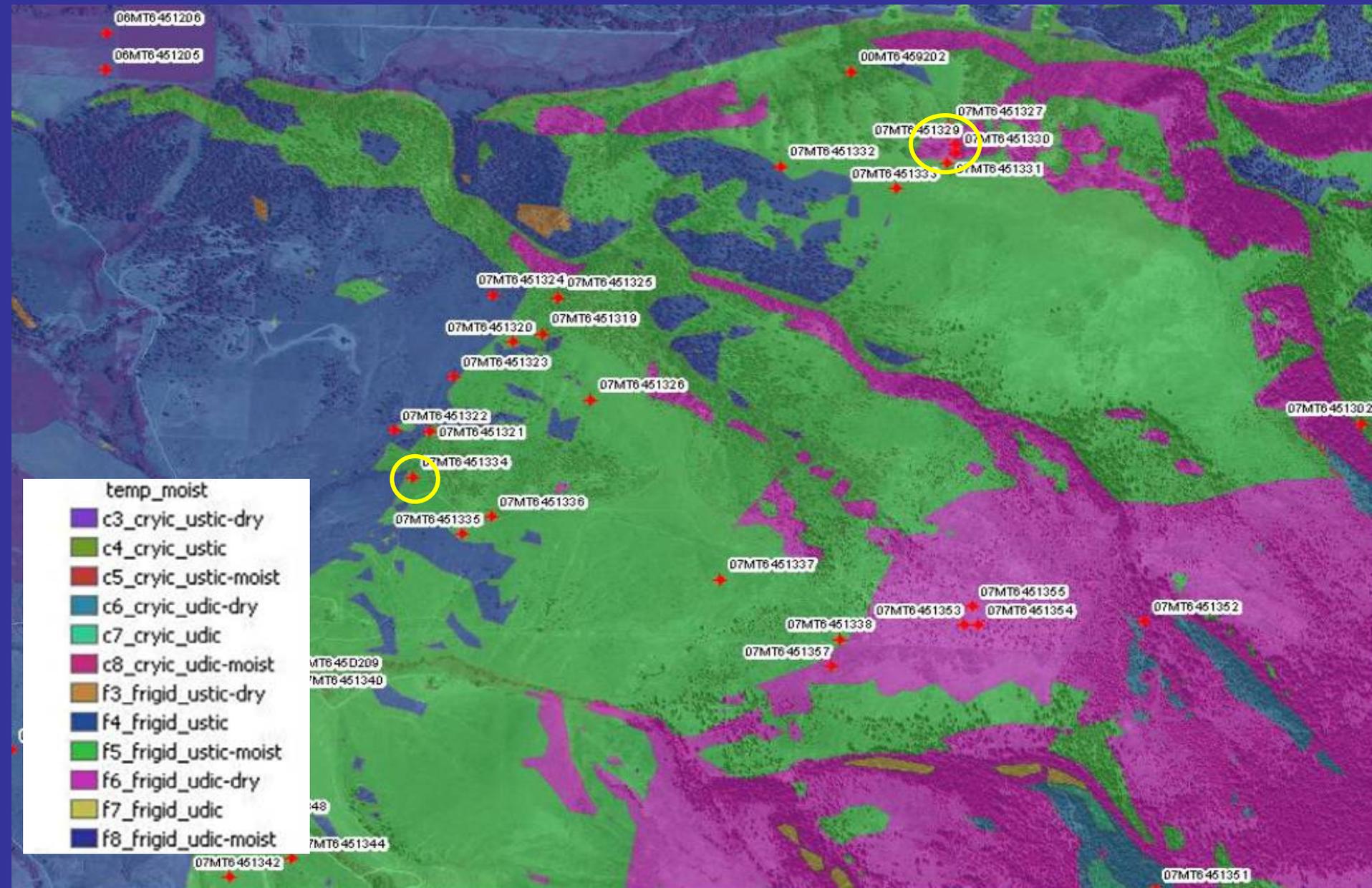


Example of the utility of this system and
how we use it to help us describe soils
and correlate vegetation differences

Color Infrared Display with Pedon Points in Soil Survey MT645



Temperature Moisture Model for Soil Survey 645



Mountain Big Sagebrush (*Artemisia tridentata* ssp. *vaseyana*)
dominated site



Soil of the mountain Big Sagebrush *Artemisia tridentata* ssp. *vaseyana* dominated site



USDA-NRCS Pedon Description

PC Form

USDA-NRCS PEDON DESCRIPTION Search by User Site ID: Check to Search by Pedon

Table hierarchy: site->siteobs->pedon->phorizon You are currently on site record: 208998 with a User Site ID: 07MT6451334

Elevation: 1344 Aspect: 320 Slope: 20 Drainage: W Permeability: Curv. Down: L Curve Across: L
 Pnd Freq: NO Pnd Dur: NO Fld Freq: Fld Dur: Geologic Formation:
 Upslope Length: Slope Length USLE: Slope Complexity: Runoff Class: Local Physiographic Name:
 Hillslope Prof.: BS Geo - Hills: SS Geo - Flats: Geo - Terrace: Geo - Mountain:

Pedon	Taxonomic	Diagnostic Features/Restrictions/FMP	Pedon Text	Surface Fragments				
Rec ID	UPEDID - User Pedon ID	SoilName - Soil Name	CorrSoil	PSCS Top	PSCS Bot	PedOr - Pedon	TempReg - Temp	MSub
206984	07MT6451334	Quast					frigid	ustic

Diagnostic Features:

Kind	TDep	BDep	Thk
mollic epipedon	0	29	
cambic horizon	29	80	

Restrictions:

Kind	Hrd - Hrd	TDep	BDep	Thk

Field Measured Properties:

Name	UOM - Unit	Val	Value

Record: 1 of 1

Pedon Horizon		Designation Suffix/Roots/Pores			Colors/Fragments/Texture/Structure				RMF/Concentrations/PVF			Feature/FMP/Cementing Agent			Sample/Horizon Text/Moties											
Seq	Disc	Mstr - M	Pr - Pr	Suffix	Vert	HorDes -	UpDe	LoDe	DH - D	DVal - D	DChr	MstHue	MstVal	MstChr	VarColors?	TexCl -	Lieu	TexMod	Sand%	Silt%	Clay%	ThkL	ThkR	ThkH	DiscBnd	T
0						A	0	29				10YR	3	2		sil			25		12				C	W
5						Bw	29	80				10YR	4	3		sil			25		13				C	W
7						Bk1	80	150				10YR	5	4		sil			30		14				C	W
3						2Bk2	150	160				10YR	4	4		l			40		14					

Rough fescue (*Festuca campestris*) dominated site



Soil of the rough fescue (*Festuca campestris*) dominated site



USDA-NRCS Pedon Description

PC Form

USDA-NRCS PEDON DESCRIPTION Search by User Site ID: Check to Search by Pedon

Table hierarchy: site-->siteobs-->pedon-->phorizon You are currently on site record: 208978 with a User Site ID: 07MT6451327

1388
 20
 37
 W

 L
 V

NO

 NO

BS
 NS

Rec ID	UPEDID - User Pedon ID	SoilName - Soil Name	CorrSoil	PSCS Top	PSCS Bot	PedOr - Pedon	TempReg - Temp	MSub
206964	07MT6451327	Hagan					frigid	ustic

Diagnostic Features:

Kind	TDep	BDep	Thk
ochric epipedon	0	17	
secondary carbonat	46	102	

Restrictions:

Kind	Hrd - Har	TDep	BDep	Thk

Field Measured Properties:

Name	UOM - Unit	Val	Valu

Site Soil Moisture:

Up (c Low	Moist - Moisture	Vol% - MoiTen

Site Soil Temperature:

Dep - Depth (cm)	Temp - Temperature (C)
50	12

Site Erosion:

Kind

Pedon Horizon	Designation Suffix/Roots/Pores	Colors/Fragments/Texture/Structure	RMF/Concentrations/PVF	Feature/FMP/Cementing Agent	Sample/Horizon Text/Mottles																
Seq	Disc	Mstr - NPr - Suffix	Vert	HorDes - UpDe	LoDe	DH - D	DVal - D	DChR	MstHue	MstVal	MstChr	VarColors?	TexCl - Lieu	TexMod	Sand%	Silt%	Clay%	ThkL	ThkR	ThkH	DiscBnd
1				Oi	0	2							spm								
0				A	2	17			10YR	2	2		l		35		18				C
0				E	17	31			10YR	4	2		vsl	ashy	55		12				C
6				Bt	31	46			10YR	3	4		sil		22		26				C
6				Btk	46	69			10YR	4	4		cl		40		28				C
7				Bk	69	102			10YR	5	4		l		35		16				

Ponderosa Pine (*Pinus ponderosa*) Snowberry (*Symphoricarpos albus*) habitat type



Soil of the Ponderosa Pine (*Pinus ponderosa*) Snowberry (*Symphoricarpos albus*) habitat type



USDA-NRCS Pedon Description

PC Form

USDA-NRCS PEDON DESCRIPTION Search by User Site ID: **07MT6451329** Check to Search by Pedon

Table hierarchy: site-->siteobs-->pedon-->phorizon You are currently on site record: 208980 with a User Site ID: 07MT6451329

Elevation: 1398 Aspect: 20 Slope: 30 Drainage: MW Permeability: Curv. Down: L Curve Across: C
 Pnd Freq: NO Pnd Dur: Fld Freq: Fld Dur: Geologic Formation:
 Upslope Length: Slope Length USLE: Slope Complexity: Runoff Class: Local Physiographic Name:
 Hillslope Prof.: BS Geo - Hills: HS Geo - Flats: Geo - Terrace: Geo - Mountain:

Pedon	Taxonomic	Diagnostic Features/Restrictions/FMP	Pedon Text	Surface Fragments				
Rec ID	UPEDID - User Pedon ID	SoilName - Soil Name	CorrSoil	PSCS Top	PSCS Bot	PedOr - Pedon	TempReg - Temp	MSub
206966	07MT6451329	Breton					frigid	ustic

Diagnostic Features:

Kind	TDep	BDep	Thk
mollic epipedon	0	48	
cambic horizon	48	60	

Restrictions:

Kind	Hrd - Hrd	TDep	BDep	Thk

Field Measured Properties:

Name	UOM - Unit	Val - Value

Pedon Horizon	Designation Suffix/Root/Pores	Colors/Fragments/Texture/Structure	RMF/Concentrations/PVF	Feature/FMP/Cementing Agent	Sample/Horizon Text/Mottles																			
Seq	Disc	Mstr - M Pr - Suffix	Vert	HorDes	UpDe	LoDe	DH - D	DVal - D	DChr	MstHue	MstVal	MstChr	VarColors?	TexCl -	Lieu	TexMod	Sand%	Silt%	Clay%	ThkL	ThkR	ThkH	DiscBnd	To
0				A1	0	12				10YR	3	3		l	gr		50	13					A	S
2				2A2	12	48				10YR	2	1		sil			15	12					A	S
3				2Bw1	48	60				10YR	3	2		sil			30	14					C	S
3				3Bw2	60	88				10YR	5	4		sl	gr		60	17						

Record: 1 of 1

USDA-NRCS Pedon PC Plus



Rangeland Database – Data Entry Form with “Vegetation” Child Table Example

Data Entry: Vegetation Data

Vegetative Field Form

Add New Site and/or Plot

Existing Site/Plot: MLRA: LRU:

Rangeland Sites

Ecological Site (keyed):

Ecological Site (assigned):

Total Production (lbs/acre):

Forested Sites

Forest Habitat Type:

Data Collection Method

% Production

Production Class (default)

Production Classes (lbs/acre)

1 = < 1 %	2 = 1 - 4 %
3 = 5 - 10 %	4 = 11 - 25 %
5 = 26 - 33 %	6 = 34 - 50 %
7 = 51 - 75 %	8 = > 75 %

% Canopy Cover Classes

T = < 1 %	1 = 1 - 5 %
2 = 5 - 25 %	3 = 25 - 50 %
4 = 50 - 75 %	5 = 75 - 95 %
6 = 95 - 100 %	

Be sure to normalize the data before moving to the next record. You commit the data when you normalize it.

Vegetation

Surface Cover / Site Characteristics

Site Notes

	PlantSymbol	Production Class	Equivalent lbs/acre	Normalized lbs/acre	CanopyCoverPercent
▶	AGSP	6	294	299	
	ARTRV	5	206	210	
	FEID	4	126	128	
	ARTR4	2	21	21	
	POA	2	21	21	
	KRLA2	1	4	4	
	ACMIO	1	4	4	
	PHLOX	1	4	4	
	LUPIN	1	4	4	
	ERIOG	1	4	4	
	shrub canopy				
*					

Normalize

Sort Plant Choice list by:

Counts

Plant symbol

Common name

Scientific name

Show Species by:

Plant symbol

Common name

Rangeland Database – Data Entry Form with “Surface Cover/Site Characteristics” Child Table Example

Data Entry: Vegetation Data

Vegetative Field Form

Add New Site and/or Plot

Existing Site/Plot: MLRA: LRU:

Rangeland Sites

Ecological Site (keyed):

Ecological Site (assigned):

Total Production (lbs/acre):

Forested Sites

Forest Habitat Type:

Data Collection Method	Production Classes (lbs/acre)	% Canopy Cover Classes	
<input type="radio"/> % Production	1 = < 1 % 2 = 1 - 4 % 3 = 5 - 10 % 4 = 11 - 25 % 5 = 26 - 33 % 6 = 34 - 50 % 7 = 51 - 75 % 8 = > 75 %	T = < 1 % 1 = 1 - 5 % 2 = 5 - 25 % 3 = 25 - 50 % 4 = 50 - 75 % 5 = 75 - 95 % 6 = 95 - 100 %	Be sure to normalize the data before moving to the next record. You commit the data when you normalize it.
<input checked="" type="radio"/> Production Class (default)			

Vegetation

Surface Cover / Site Characteristics

Site Notes

Basal Surface Cover

	Cover Type	LPISurfaceBasal
<input type="checkbox"/>	bare ground	80
<input type="checkbox"/>	rock or logs	10
<input type="checkbox"/>	*	

Shrub and Tree Canopy Cover

	Cover Type	CanopyCoverPercent
<input type="checkbox"/>	shrub canopy	10
<input type="checkbox"/>	*	

Rangeland Database – Data Entry Form with “Site Notes” Child Table Example

Data Entry: Vegetation Data
Add New Site and/or Plot

Existing Site/Plot: MLRA: LRU:

Rangeland Sites

Ecological Site (keyed):

Ecological Site (assigned):

Total Production (lbs/acre):

Forested Sites

Forest Habitat Type:

Data Collection Method

% Production

Production Class (default)

Production Classes (lbs/acre)

1 = < 1 %	2 = 1 - 4 %
3 = 5 - 10 %	4 = 11 - 25 %
5 = 26 - 33 %	6 = 34 - 50 %
7 = 51 - 75 %	8 = > 75 %

% Canopy Cover Classes

T = < 1 %	1 = 1 - 5 %
2 = 5 - 25 %	3 = 25 - 50 %
4 = 50 - 75 %	5 = 75 - 95 %
6 = 95 - 100 %	

Be sure to normalize the data before moving to the next record. You commit the data when you normalize it.

Vegetation

Surface Cover / Site Characteristics

Site Notes

ppt-moist, temp-cool.

Enter growing year information in site note. Example: ppt-moist, temp-normal

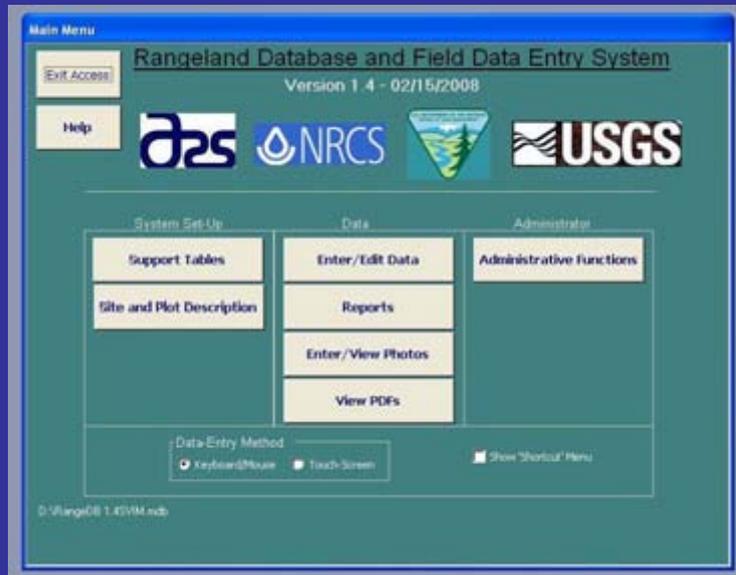
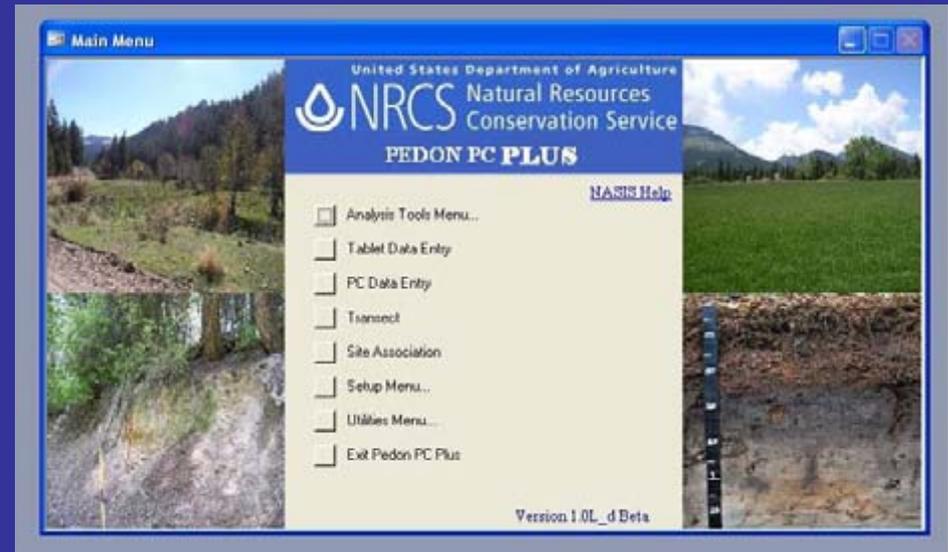
Precipitation

V. Dry	Dry	Normal	Moist	Wet
-10%	-5%		+5%	+10%

Temperature

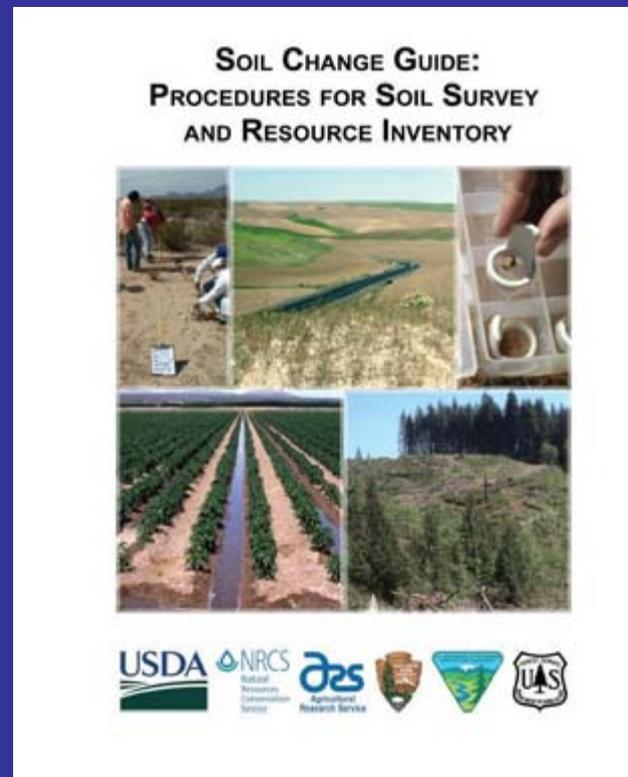
Cold	Cool	Normal	Warm	Hot
-10%	-5%		+5%	+10%

Vegetation and soils databases are linked via Pedon site ID to facilitate analysis



but a more complete integration is desired

Montana will be prepared to incorporate soil change procedures into our understanding of ecological relationships. Data on species composition and production will also be useful in MLRA Soil Survey Update.



Summary



Brandon Bestelmeyer

USDA-ARS Jornada Experimental Range
and USDA-NRCS

Elements of a successful approach to data gathering as part of soil survey and ESD development

- 1) One or more range cons working with soil scientists
- 2) Range cons that understand soils
- 3) A vegetation/soil surface sampling protocol that matches the pace of soil sampling

Elements of a successful approach to data gathering as part of soil survey and ESD development

- 4) A coding system that relates vegetation measurements, soil measurements, and coordinates at points
- 5) Many points with varying levels of detail at a regional scale, rather than a few points with unnecessarily high precision
- 6) A database to house these data and their relationships

Recommendations

- Soil and ecological science disciplines need to collaborate at all levels
- MLRA offices should have a vegetation person dedicated to Soil Survey
- Cross-train soil and range scientists so we know what questions to ask

Recommendations

- Incorporate Pedon PC Plus protocol into all soil survey activities
- Vegetative and soil databases need to be integrated to facilitate analysis capabilities
- University soil science and ecology curriculums must include cross-training

Thank you for your time!

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