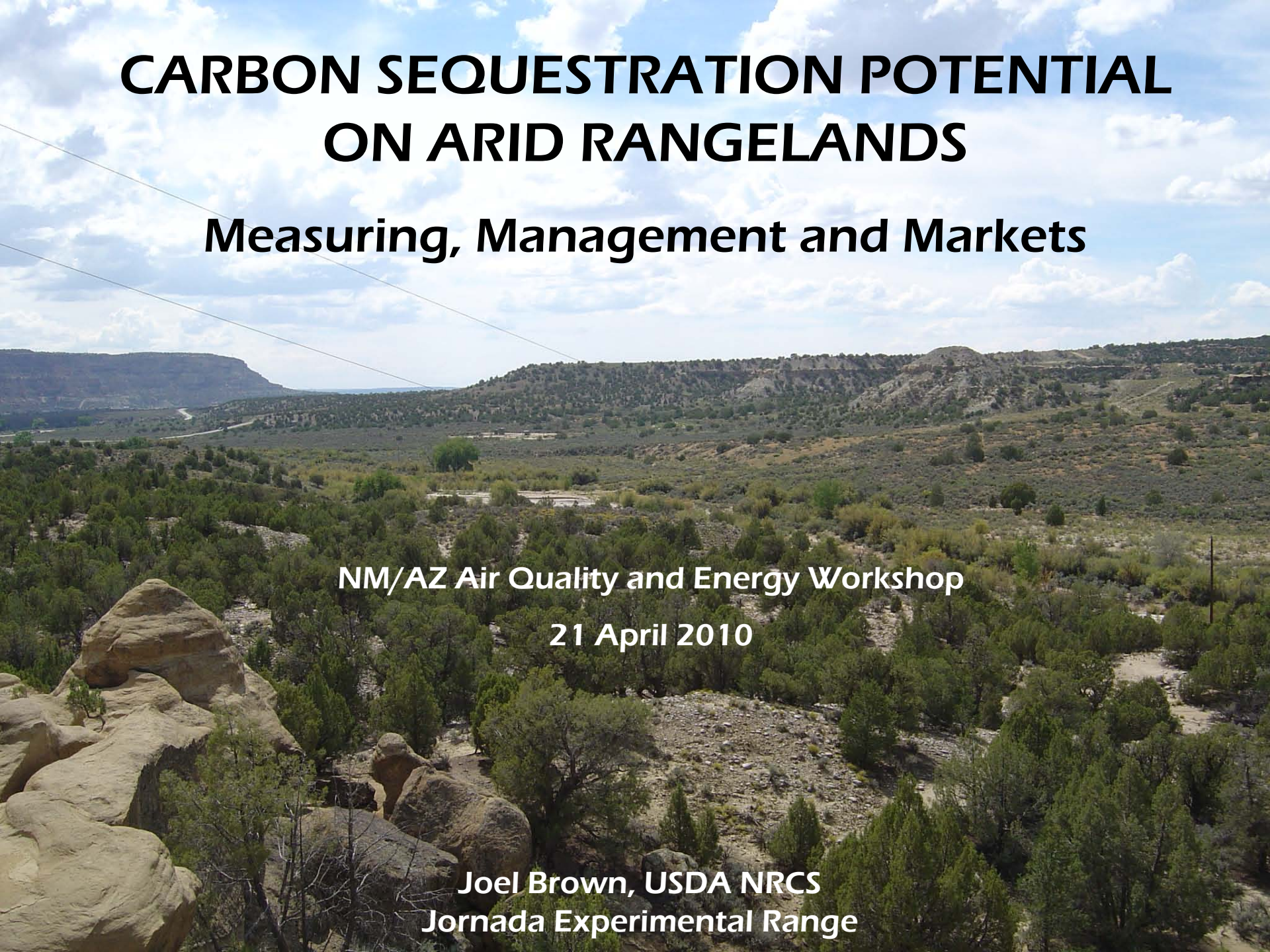
CARBON SEQUESTRATION POTENTIAL ON ARID RANGELANDS

Measuring, Management and Markets

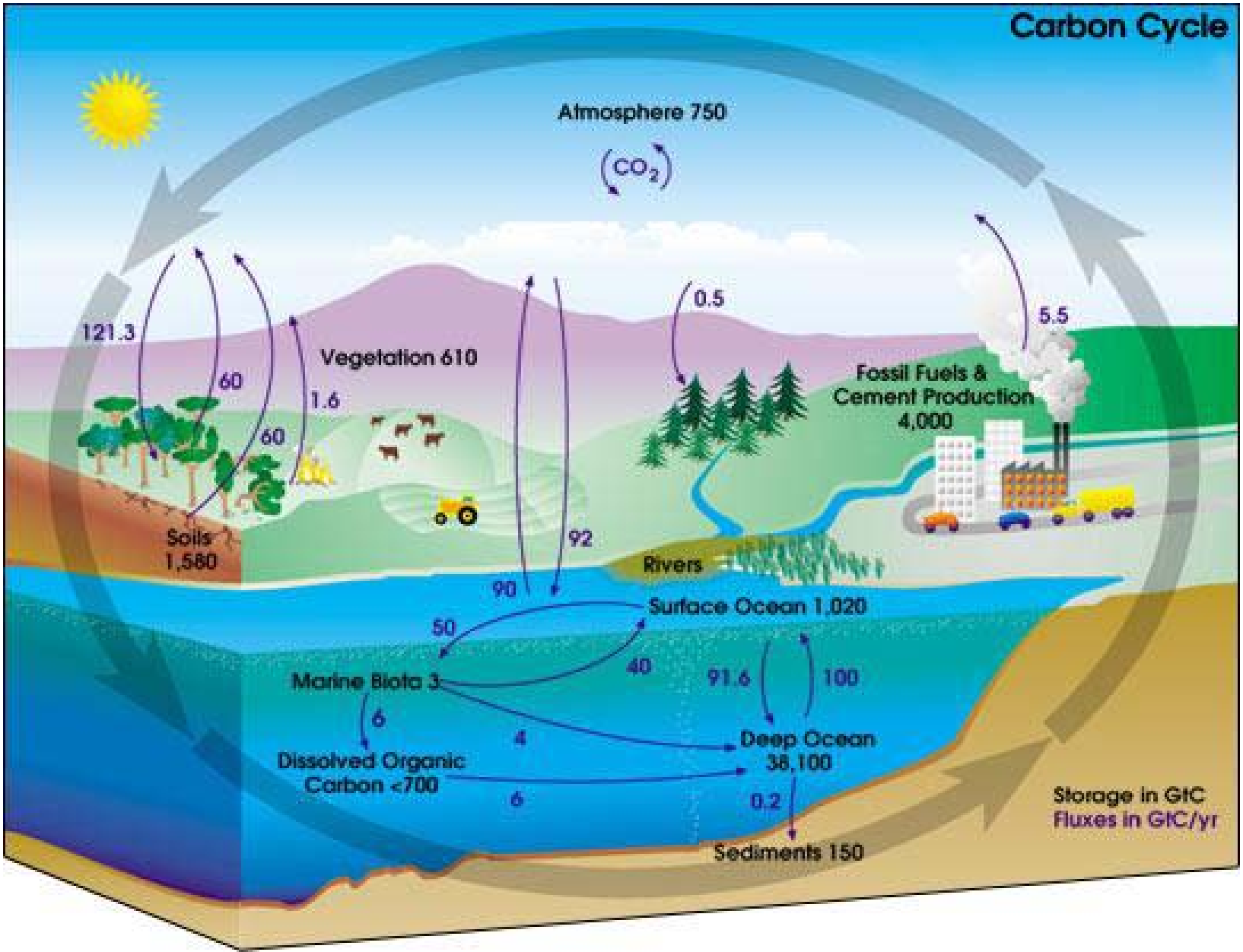


NM/AZ Air Quality and Energy Workshop

21 April 2010

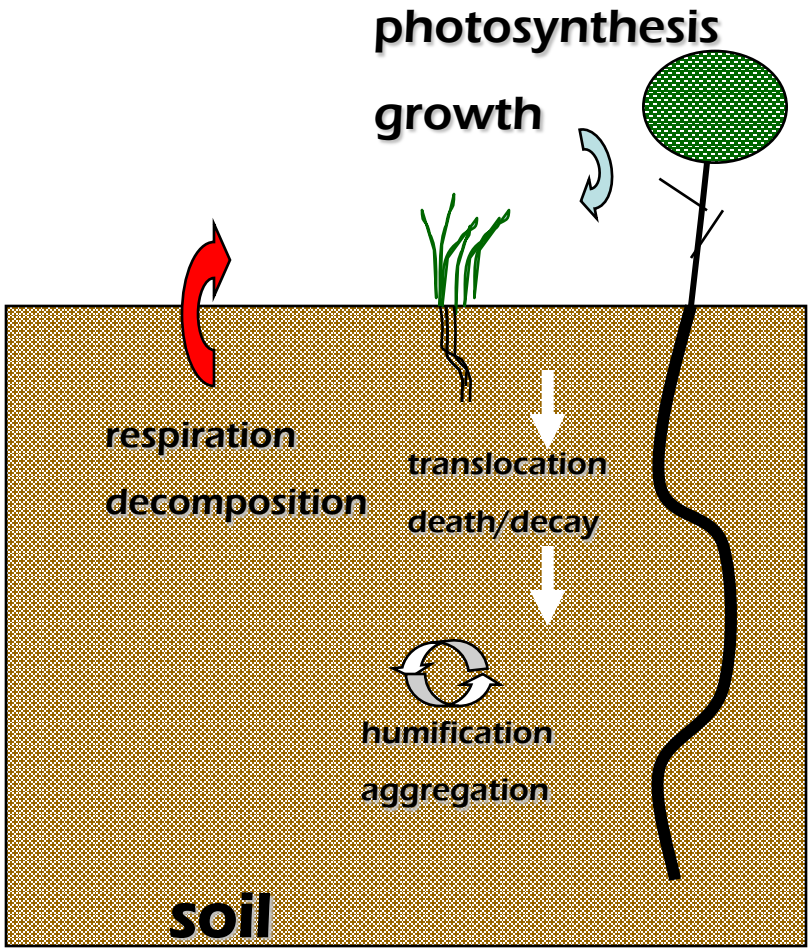
Joel Brown, USDA NRCS
Jornada Experimental Range

THE CARBON CYCLE



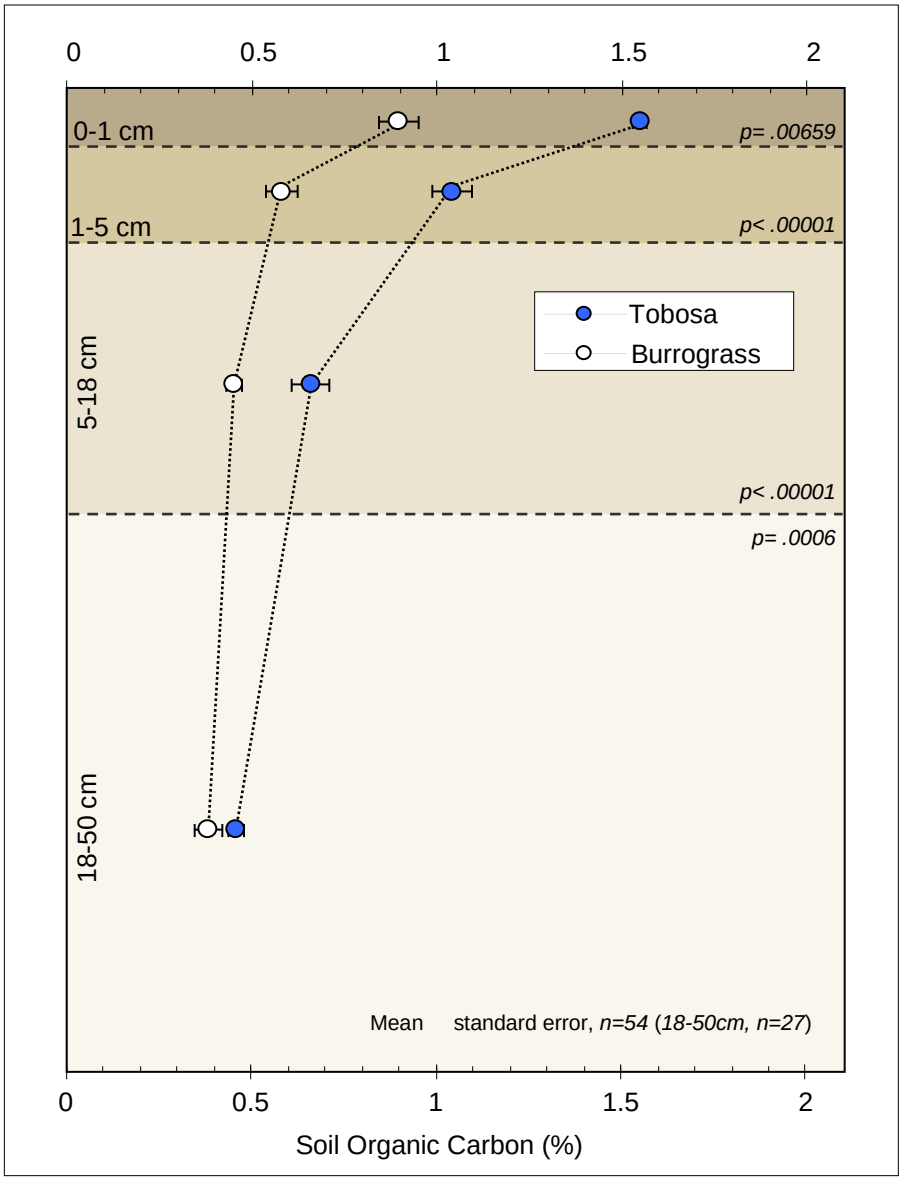
WHAT IS SOIL CARBON SEQUESTRATION?

- THE LONG-TERM STORAGE OF CARBON IN THE SOIL VIA THE PROCESSES OF PHOTOSYNTHESIS, HUMIFICATION AND AGGREGATION
- EXPOSING CARBON COMPOUNDS TO THE ATMOSPHERE RELEASES CO_2
- THREE FORMS-SHORT (ANNUAL), MEDIUM (DECADES), LONG (CENTURIES TO MILLENIA) TERM



Soil carbon levels reflect vegetation

Management x climate
10-20 y



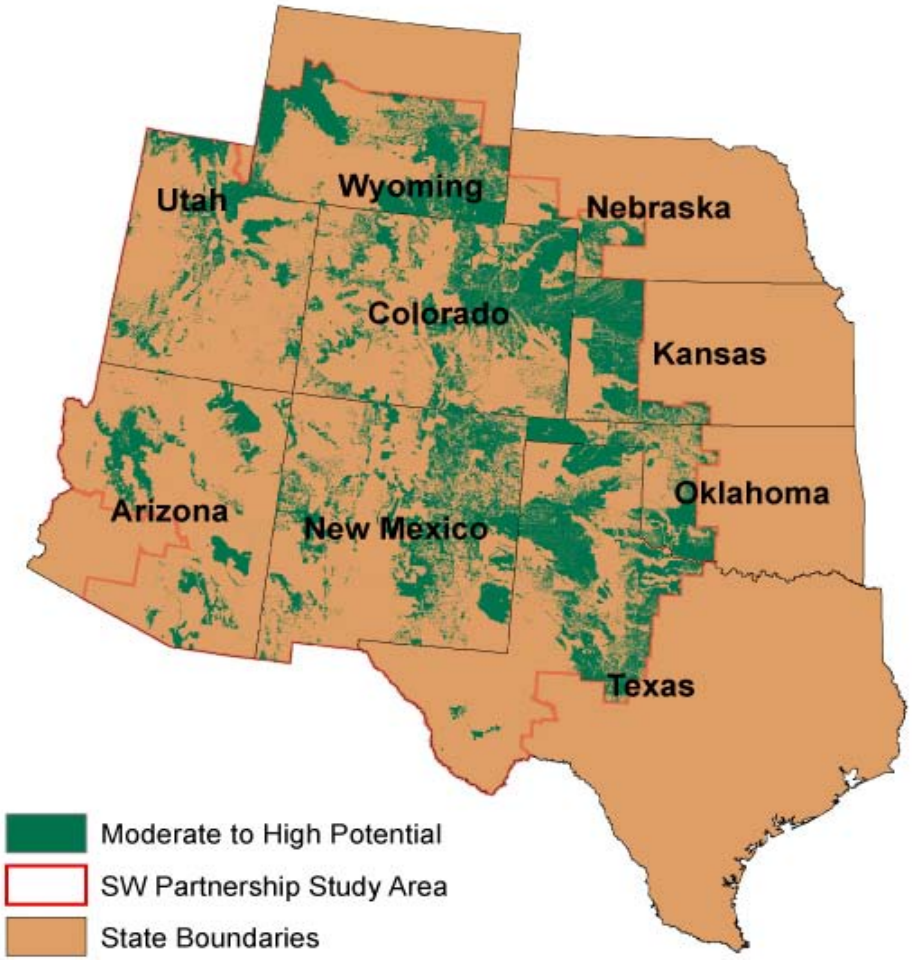
Estimating carbon sequestration potential

Land inventory

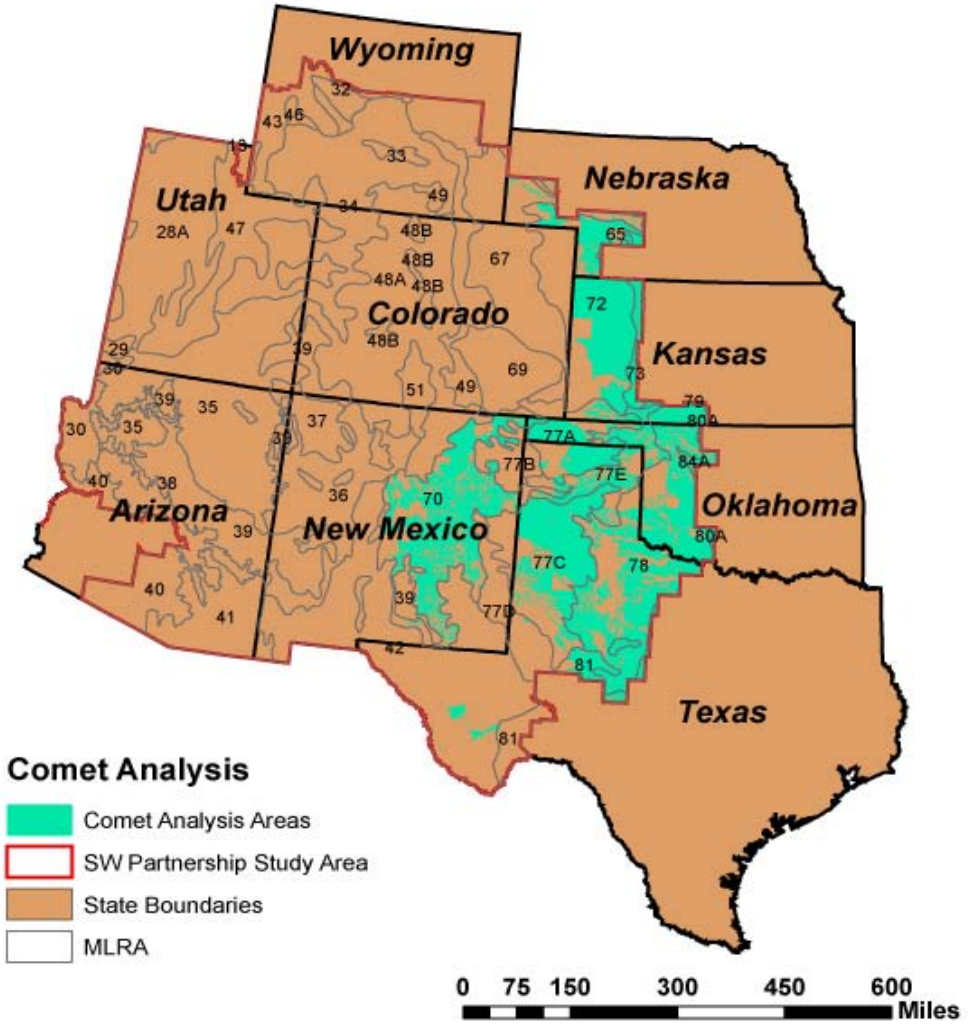
- soils (potential)
- vegetation (current state)

Management options

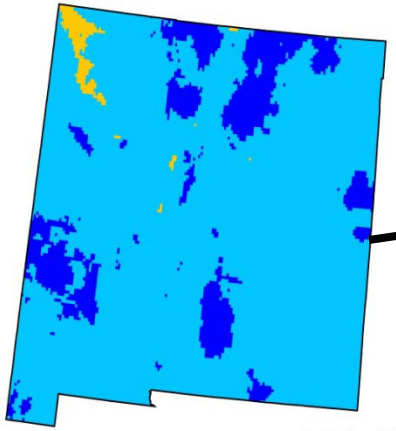
- probability of success

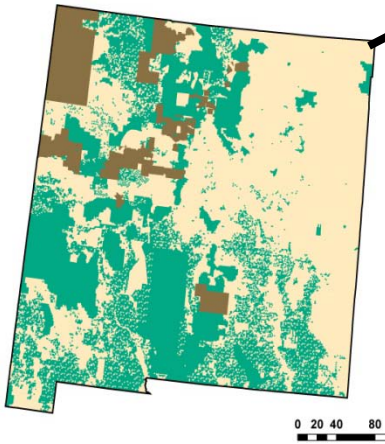


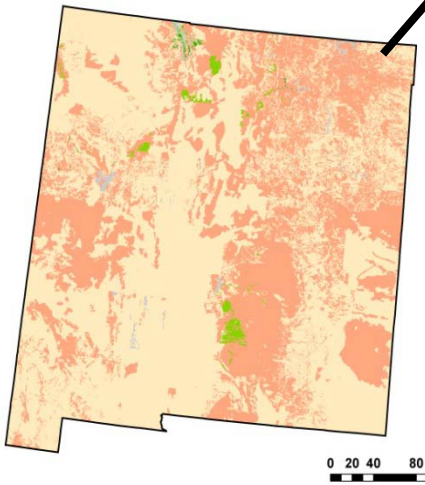
Moderate to high potential

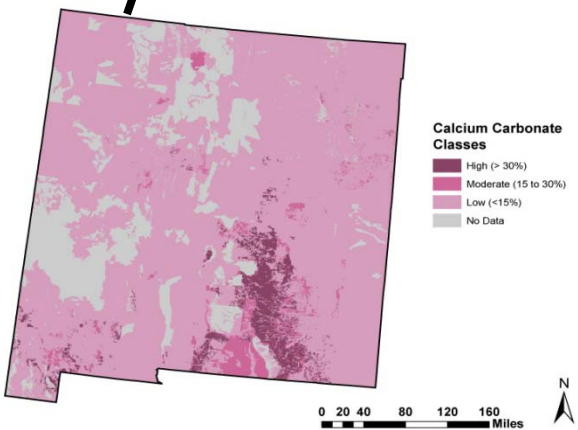


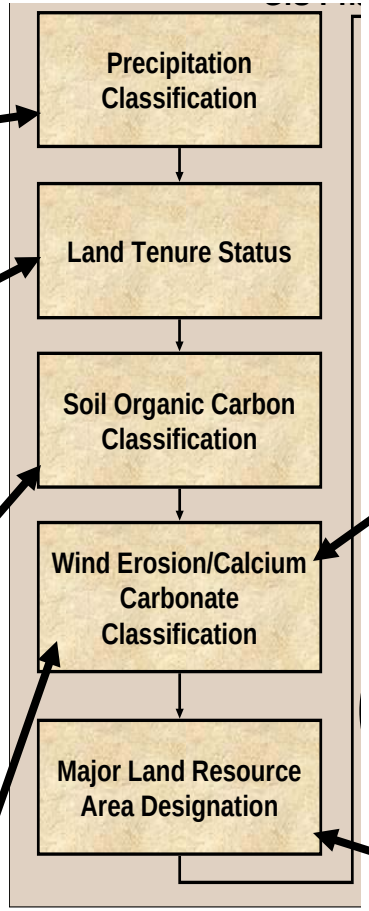
Target areas for assessing potential with COMET VR

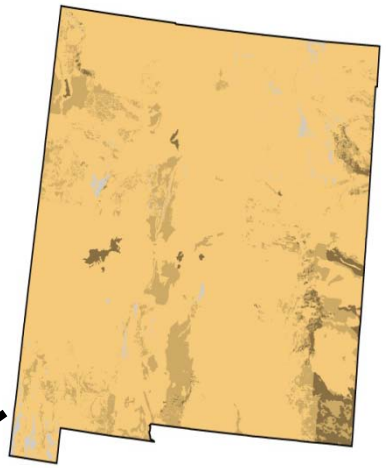

Precipitation Potential Classes
High Potential
Moderate Potential
Low Potential
0 20 40 80 120 160
Miles
N

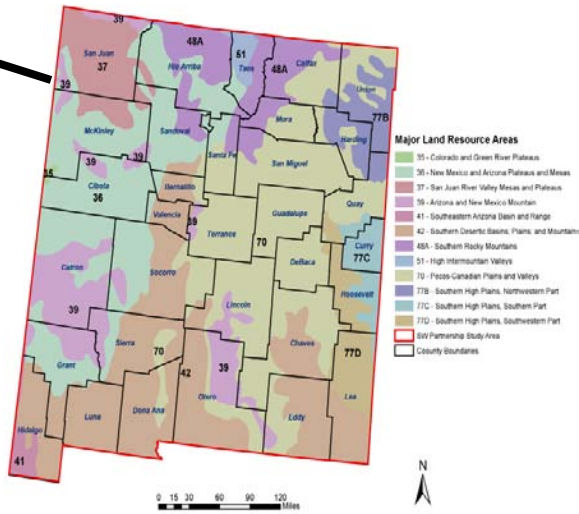

Land Tenure Class
Federal
Indian Reservation
Private/Non-Federal
0 20 40 80 120 160
Miles
N


Soil Organic Carbon Classes
Very High (>10%
High (1.75 to 10
Moderate (0.75 t
Low (<0.75%)
No Data
0 20 40 80 120 160
Miles

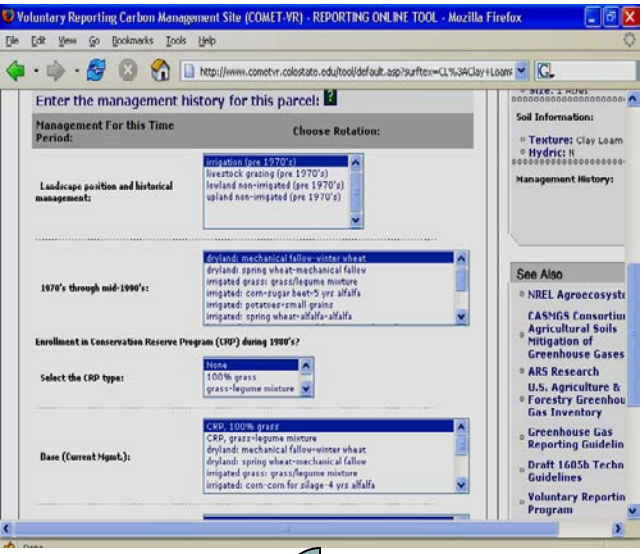

Calcium Carbonate Classes
High (> 30%)
Moderate (15 to 30%)
Low (<15%)
No Data
0 20 40 80 120 160
Miles
N

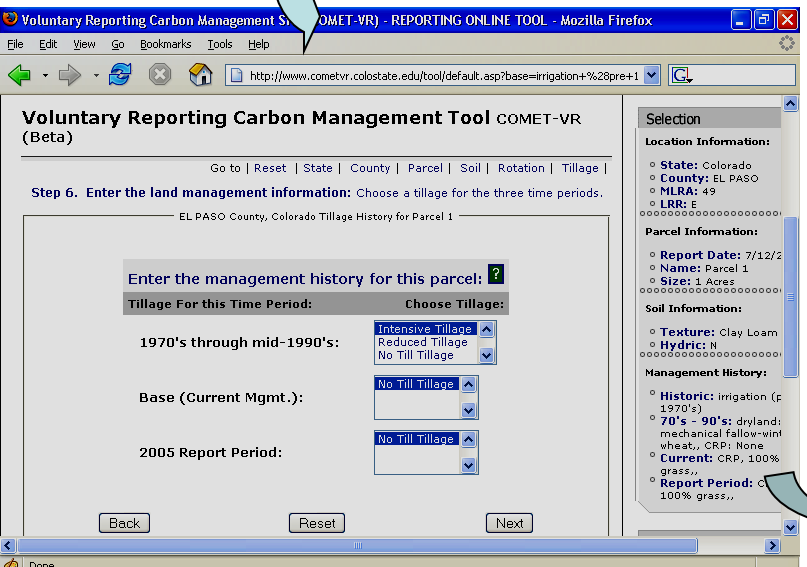

Precipitation Classification
Land Tenure Status
Soil Organic Carbon Classification
Wind Erosion/Calcium Carbonate Classification
Major Land Resource Area Designation

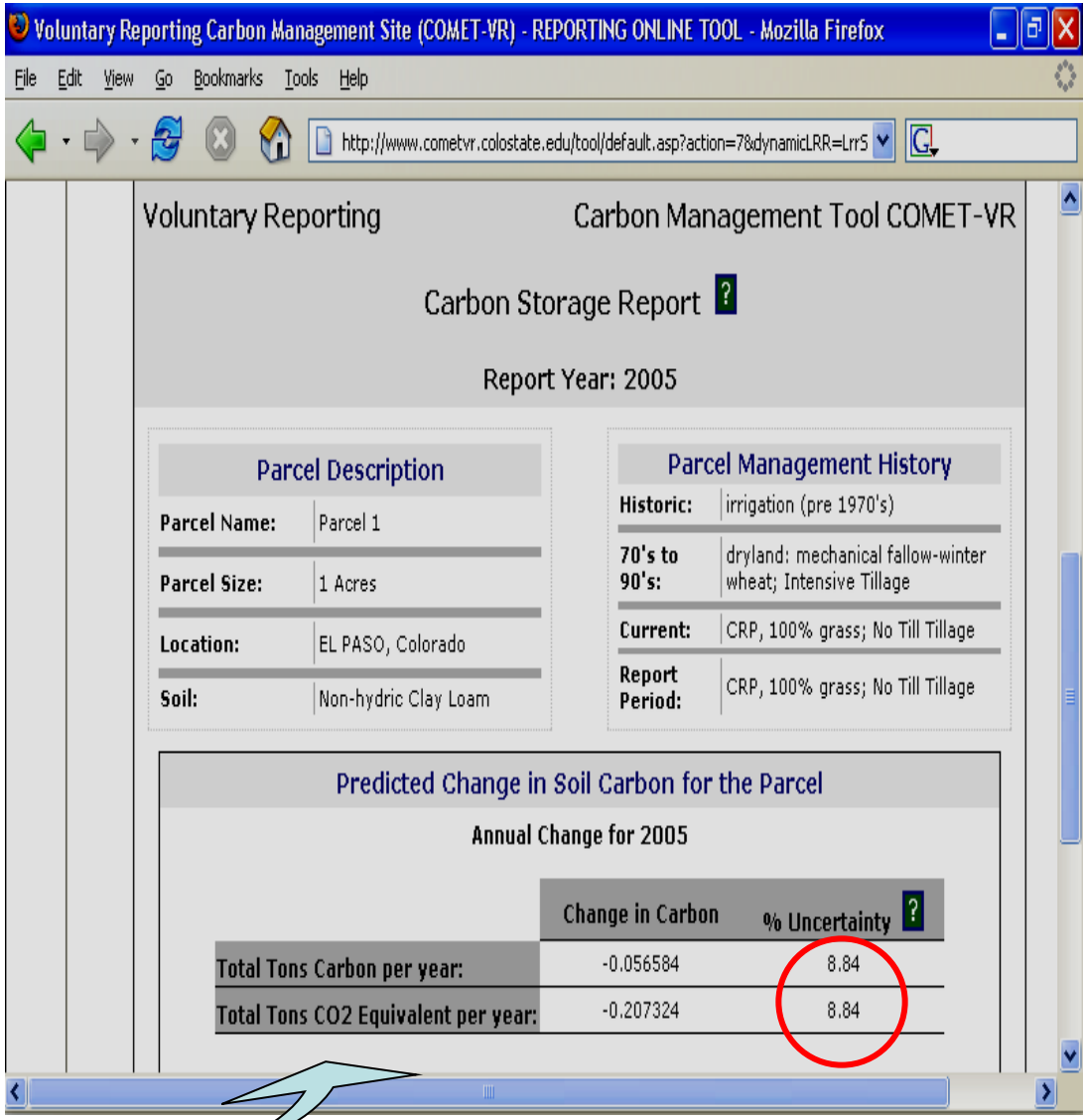

Wind Erodibility Index Classes
High (>200 t/ha)
Moderate (100 to 200 t/ha)
Low (<100 t/ha)
No Data

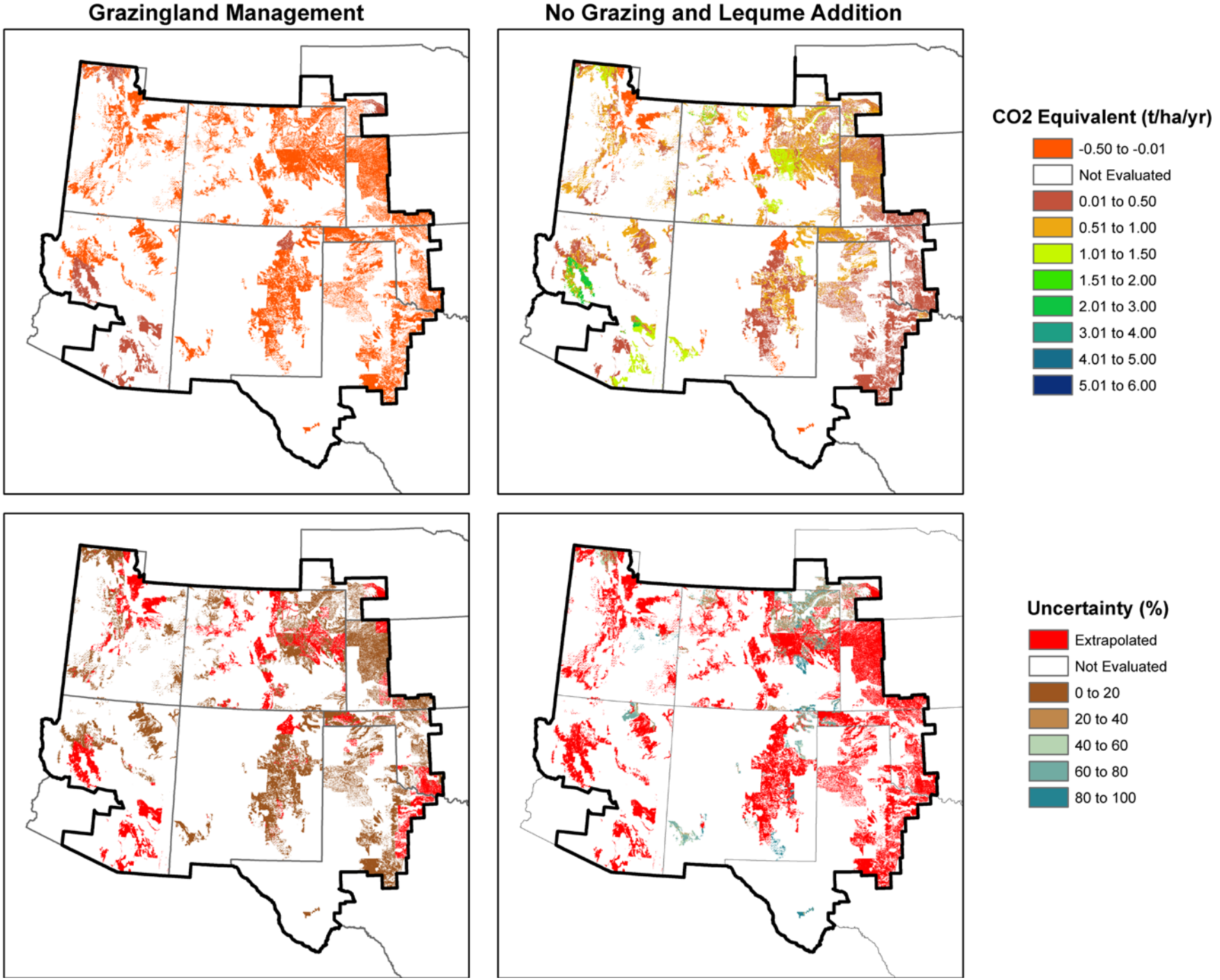

Major Land Resource Areas
35 - Colorado and Green River Plateaus
36 - New Mexico and Arizona Plateaus and Mesas
37 - San Juan River Valley Mesas and Plateaus
39 - Arizona and New Mexico Mountain
41 - Southeastern Arizona Basin and Range
42 - Southern Desertic Basins, Plains, and Mountains
48A - Southern Rocky Mountains
51 - High Intermountain Valleys
70 - Pecos-Canadian Plains and Valleys
77B - Southern High Plains, Northwestern Part
77C - Southern High Plains, Southern Part
77D - Southern High Plains, Southwestern Part
SW Partnership Study Area
County Boundaries
0 15 30 60 90 120
Miles
N

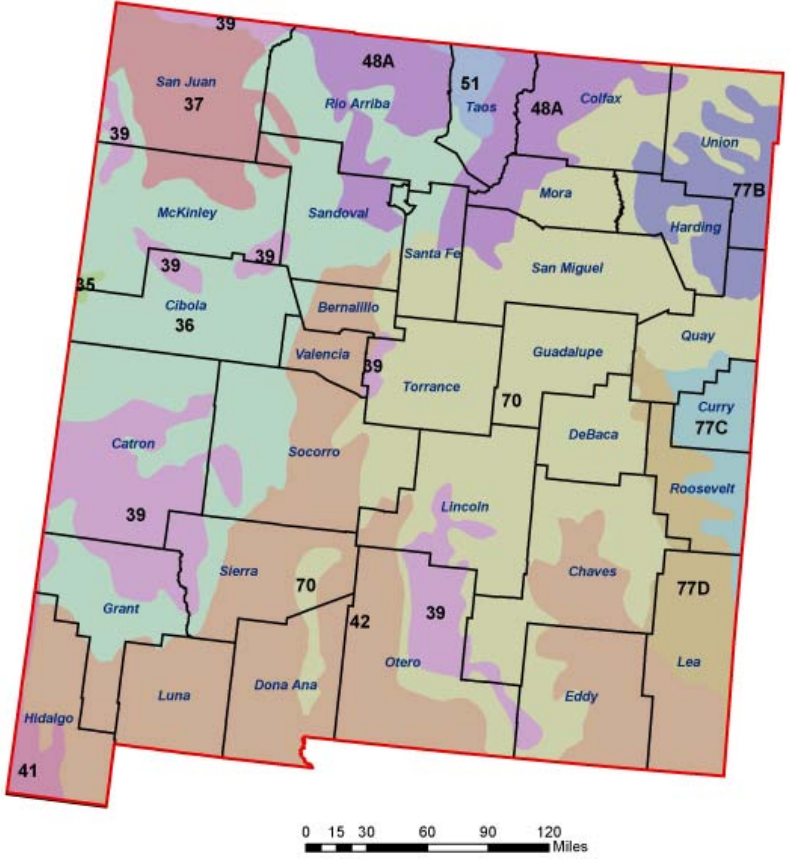
COMET VR


Voluntary Reporting Carbon Management Site (COMET-VR) - REPORTING ONLINE TOOL - Mozilla Firefox
Enter the management history for this parcel:
Management For This Time Period:
Choose Rotation:
Landscape position and historical management:
1970's through mid-1990's:
Enrollment in Conservation Reserve Program (CRP) during 1990's?
Select the CRP type:
Base (Current Mgmt.):
Soil Information:
Management History:
See Also


Voluntary Reporting Carbon Management Tool COMET-VR (Beta)
Go to | Reset | State | County | Parcel | Soil | Rotation | Tillage |
Step 6. Enter the land management information: Choose a tillage for the three time periods.
EL PASO County, Colorado Tillage History for Parcel 1
Enter the management history for this parcel:
Tillage For This Time Period:
Choose Tillage:
1970's through mid-1990's:
Base (Current Mgmt.):
2005 Report Period:
Intensive Tillage
Reduced Tillage
No Till Tillage
Back
Reset
Next
Selection
Location Information:
State: Colorado
County: EL PASO
MLRA: 49
LRR: E
Parcel Information:
Name: Parcel 1
Size: 1 Acres
Soil Information:
Texture: Clay Loam
Hydric: N
Management History:


Voluntary Reporting Carbon Management Site (COMET-VR) - REPORTING ONLINE TOOL - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
Voluntary Reporting
Carbon Management Tool COMET-VR
Carbon Storage Report
Report Year: 2005
Parcel Description
Parcel Name: Parcel 1
Parcel Size: 1 Acres
Location: EL PASO, Colorado
Soil: Non-hydric Clay Loam
Parcel Management History
Historic: irrigation (pre 1970's)
70's to 90's: dryland: mechanical fallow-winter wheat; Intensive Tillage
Current: CRP, 100% grass; No Till Tillage
Report Period: CRP, 100% grass; No Till Tillage
Predicted Change in Soil Carbon for the Parcel
Annual Change for 2005
Change in Carbon
% Uncertainty
Total Tons Carbon per year: -0.056584 8.84
Total Tons CO2 Equivalent per year: -0.207324 8.84


Grazingland Management
No Grazing and Lequme Addition
CO2 Equivalent (t/ha/yr)
-0.50 to -0.01
Not Evaluated
0.01 to 0.50
0.51 to 1.00
1.01 to 1.50
1.51 to 2.00
2.01 to 3.00
3.01 to 4.00
4.01 to 5.00
5.01 to 6.00
Uncertainty (%)
Extrapolated
Not Evaluated
0 to 20
20 to 40
40 to 60
60 to 80
80 to 100



MLRA 70
Pecos Canadian Plains and Valleys

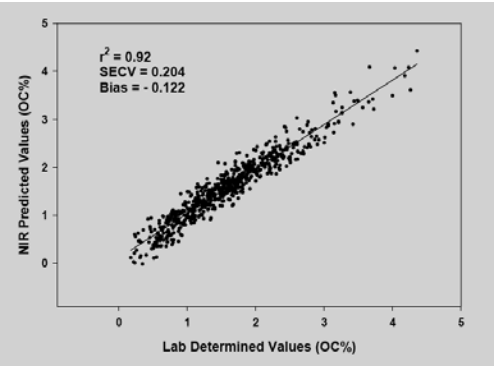
- 2, 250, 308 ha

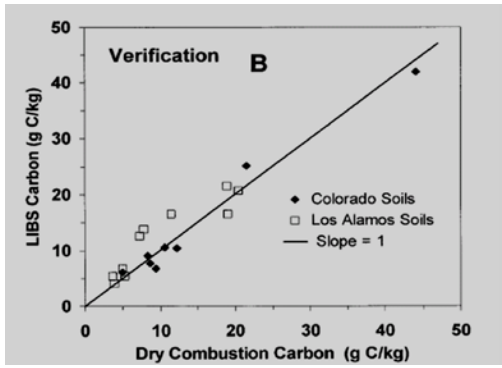
- Cropland-irr. corn to perennial grass
  8677 ha (0.6 T C/ha/y)
- Cropland-small grain to perennial grass
  3474 ha (1.1 T C/ha/y)

- No till gains little carbon

Direct Measurement

- Develop improved technologies and systems for direct measurements of soil and vegetation carbon at reference sites selected within the SW Region
  - LIBS and NIRS
  - Collect at existing long-term study sites
  - Correlation with other technologies
  - Principles for cost effective sampling





HOW DO WE ESTIMATE CARBON CHANGE?

Methodology-based vs Performance-based

METHODOLOGY BASED

- CARBON CHANGES ≤ 1 T C/y
- SOIL CARBON STOCKS VARY FROM 100 to 400 T C/ha (1m depth)
- DETECT CHANGE OF <1%/y
- 95% CONFIDENCE LEVEL

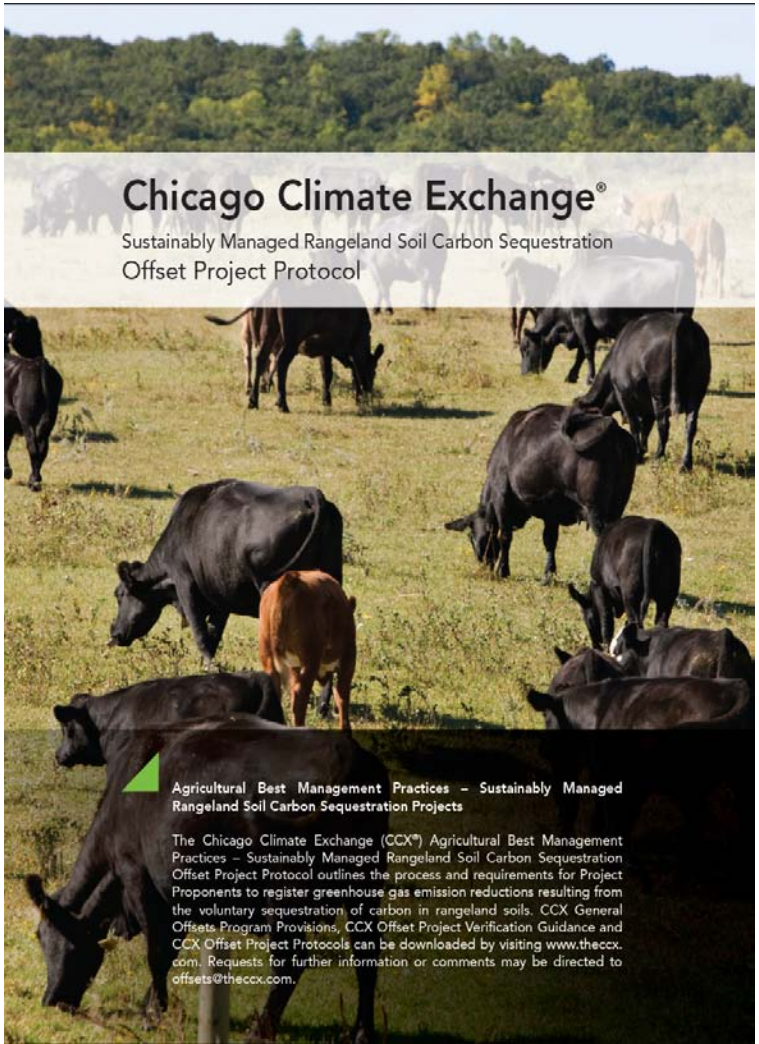
- 5 y -PRACTICALLY IMPOSSIBLE (>100 samples/field)
- 20y-20 (samples/soil series)

∴

Performance-based

How can we credibly document management practices leading to carbon change?

DEVELOPING A CARBON MARKET



Crediting rates

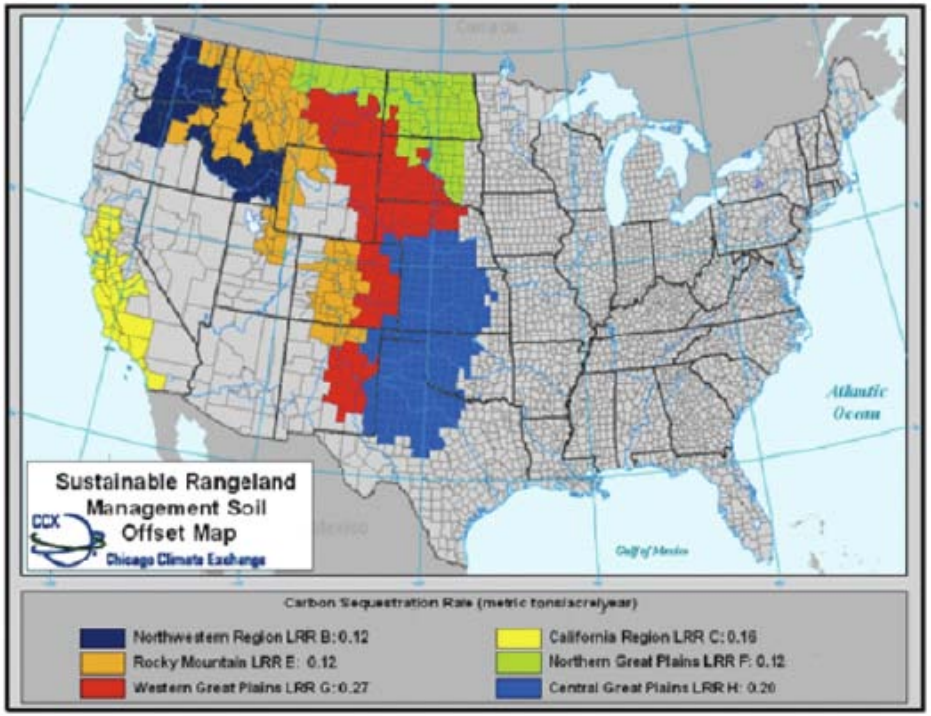
Management Protocols

Verification Protocols

DEFAULT APPROACH for CREDITING RATES

- Transparent
- Consistent
- Accuracy at regional level
- ***Uses existing information***
- Cost effective

- Lacks site specificity



Land Resource Region	Improved Manage-ment
B	0.12
C	0.16
E	0.12
F	0.12
G	0.27
H	0.20

PRINCIPLES OF RANGELAND CARBON FLUXES-PROCESS

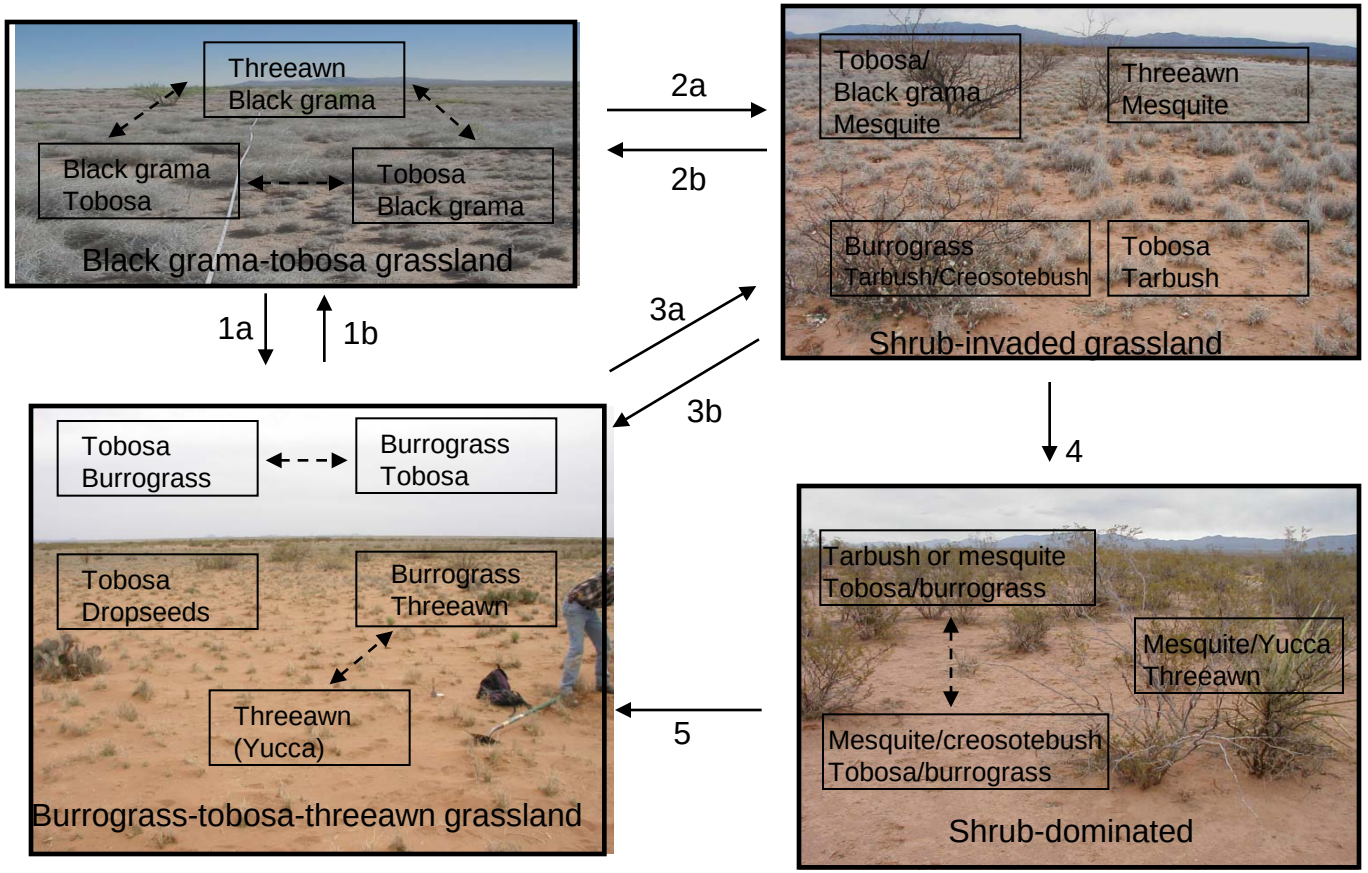
- NET PRIMARY PRODUCTION (INPUTS)
  - PRECIPITATION, INHERENT SOIL FERTILITY DETERMINE RATES
- RESPIRATION IS CONTROLLED BY TEMPERATURE AND MOISTURE
- IF THE SOIL PROFILE STAYS INTACT, LOSS IS LIMITED
- EXTREME OVERGRAZING (SOIL LOSS, DEGRADATION) RESULT IN C LOSS
  - REQUIRES SUBSTANTIAL EFFORT AND TIME TO RESTORE CAPACITY
- WEATHER CAN OVERRIDE MANAGEMENT IN DETERMINING SHORT TERM C FLUXES

WHAT PRACTICES DO WE USE?

- STOCKING RATE
  - LIGHT TO MODERATE STOCKING RATES MAINTAIN PRODUCTIVITY
- DISTRIBUTION
  - AVOID SPOT OVERGRAZING/ DEGRADATION
- SEASON OF USE
  - SPECIES COMPOSITION CHANGE
- DROUGHT RESPONSE
  - AVOID DEGRADATION AND ALLOW FOR RECOV

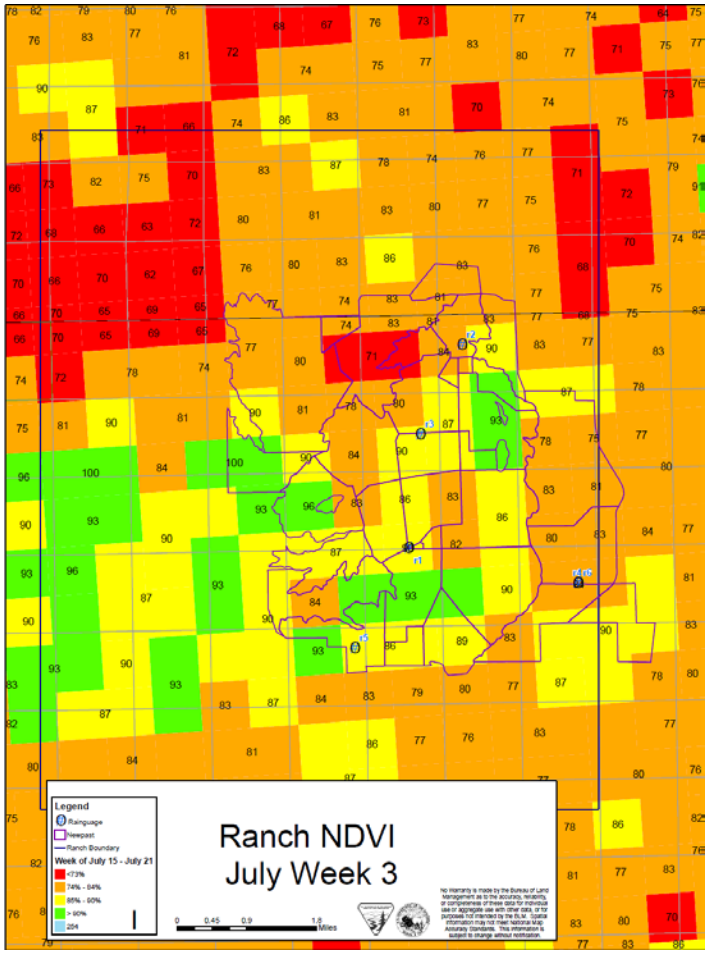
MANAGEMENT OPTIONS

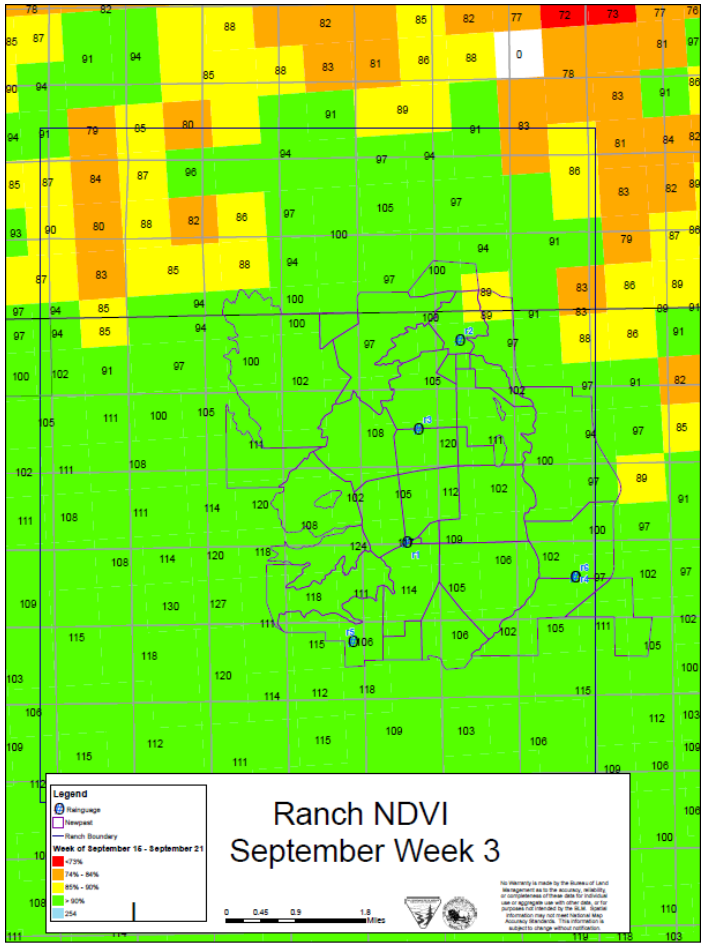
Loamy SD-2



1a-Overgrazing, soil fertility loss, erosion and sand loss; 1b-Soil stabilization or modification
2a-Shrub invasion due to overgrazing and/or lack of fire; 2b-Shrub removal, restore cover
3a-Shrub invasion; 3b-Shrub removal with grass recovery
4. Persistent reduction in grasses, competition by shrubs, erosion and soil truncation
5. Shrub removal with soil addition? (Bestelmeyer et al 2003)

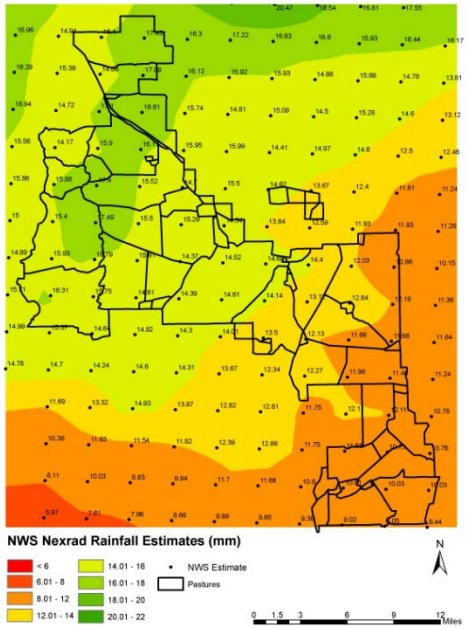
Verification Protocol Development





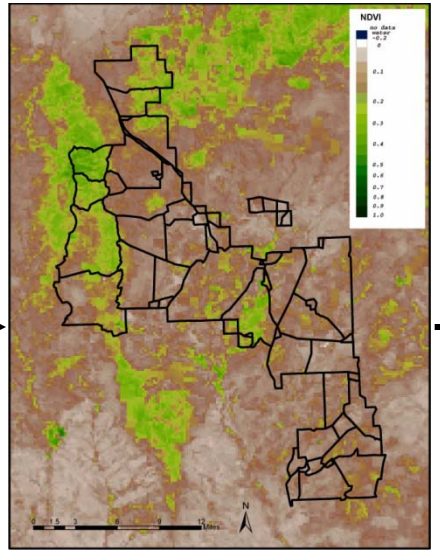
Early Warning Products

Near Real-Time Climate



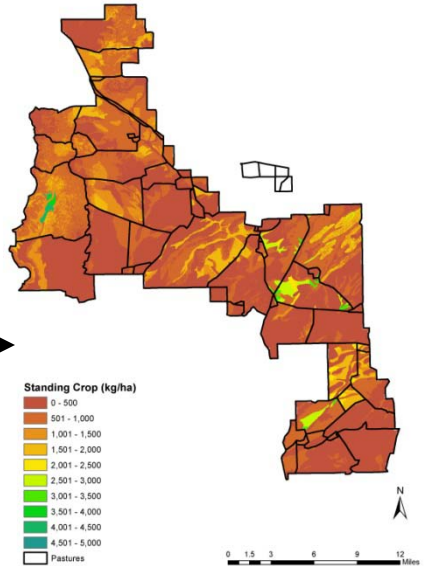
Plant Growth Models

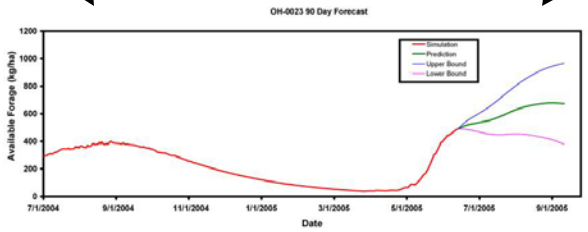
NDVI Imagery (Greenness)



Mapping and Forecasting

Standing Crop Mapping





Site Analysis

Summary

- Rangelands have a small, but significant role to play in mitigation activities
- The processes that govern carbon fluxes are relatively well understood
- The interactions of management and carbon dynamics are also relatively well understood
- Both mitigation and adaptation involve similar activities- practices and systems which have long been recognized as good range management
- The challenge lies in putting our expertise and knowledge into an organized format and communicating it to the public and markets