MANAGING RANGELAND TO INCREASE SOIL CARBON STORAGE

(AND PROVING IT)

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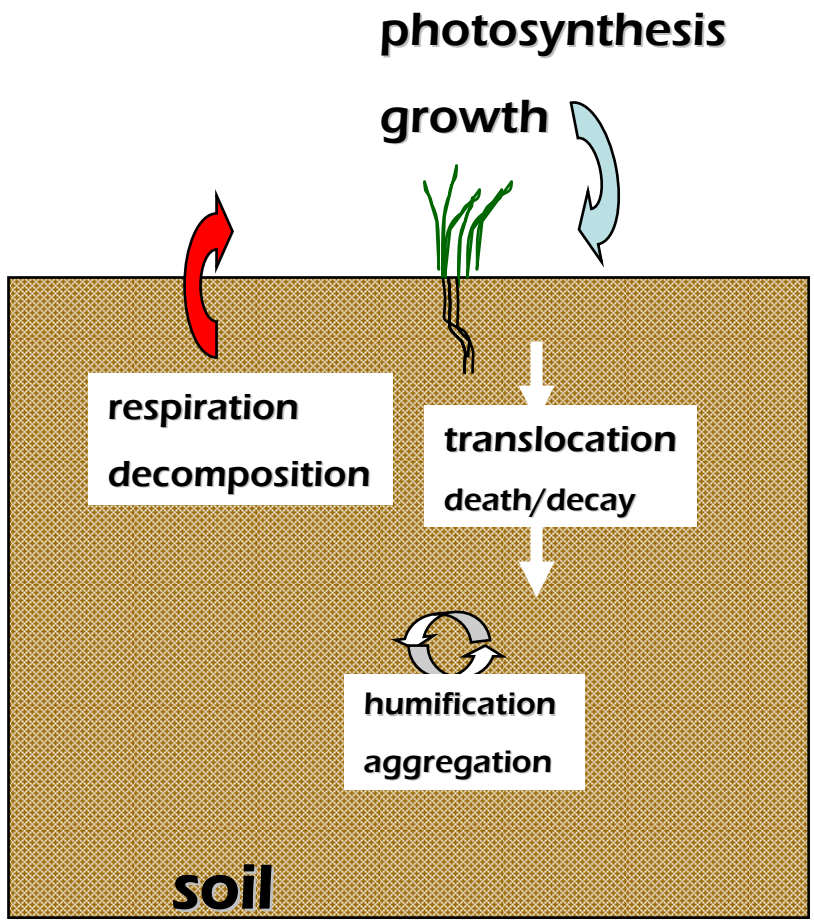
JORNADA EXPERIMENTAL RANGE

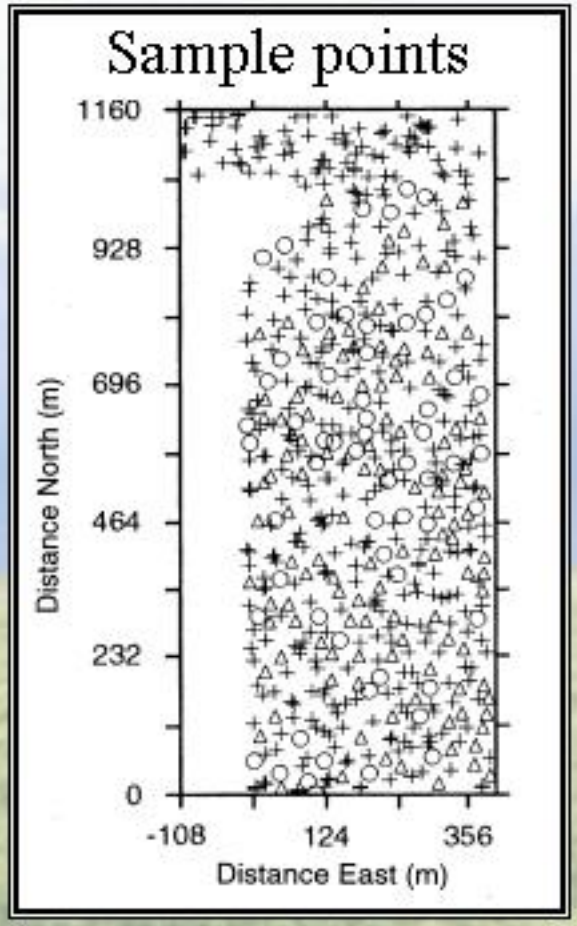
MANAGING RANGELAND TO INCREASE SOIL CARBON STORAGE (AND PROVING IT)

- **Some critical principles**
- **How can we design management systems to increase soil carbon**
- **How can we integrate those principles into a system that credibly estimates change?**

SOME BASIC PROCESSES

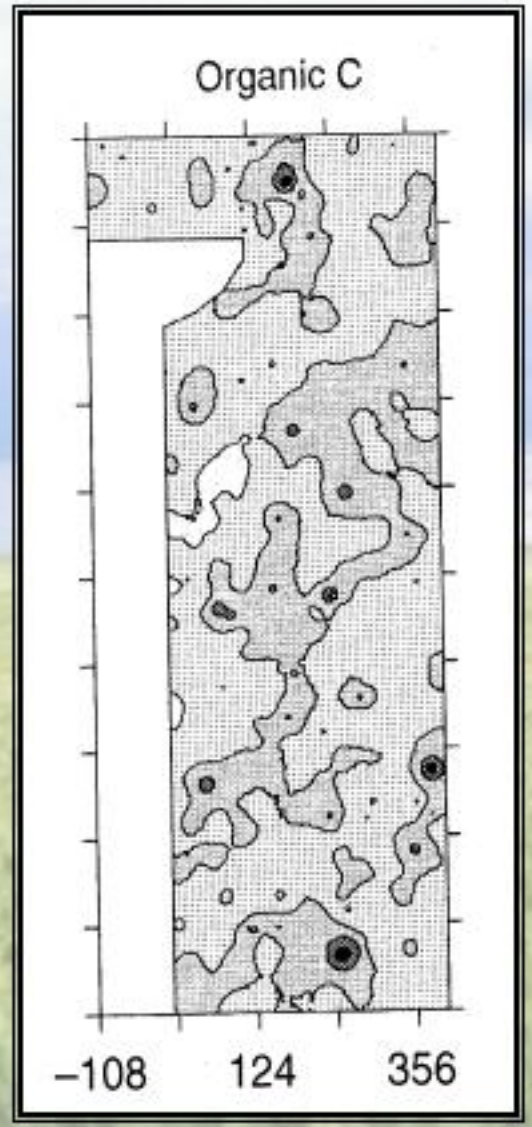
- THE LONG-TERM STORAGE OF CARBON IN THE SOIL VIA THE PROCESSES OF PHOTOSYNTHESIS, HUMIFICATION AND AGGREGATION
- EXPOSING CARBON COMPOUNDS TO THE ATMOSPHERE RELEASES CO_2
- THREE FORMS-SHORT (ANNUAL), MEDIUM (DECADES), LONG (CENTURIES TO MILLENIA) TERM

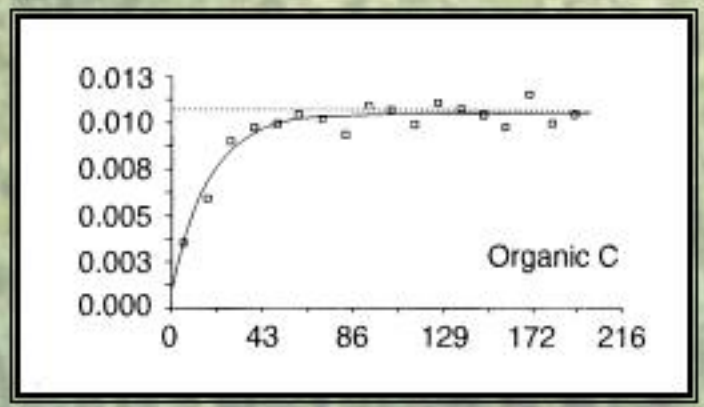




Distribution of soil organic matter in a cultivated field:

- Spatially variable in visually uniform field
- Large soil C range (0.85-1.93)
- Significant spatial structure
- Substantial fine-scale variability (2-5m)





Data from Robertson et al. (1997)

Soil carbon in an arid rangeland

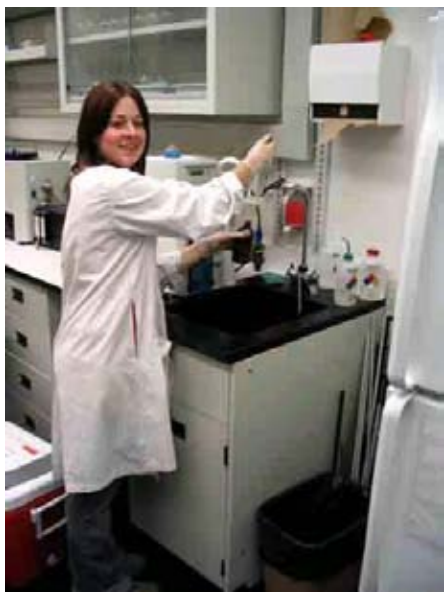
• Playa	90.5	TCO_2e/ha
• Arroyo	22.7	
• Grassland	17.2	
• Dunes	13.5	

• Under Mesquite	43.99
• Interspace	31.74

Bird et al 2000

WHAT DOES IT COST TO SAMPLE SOIL CARBON?

1.	GETTING TO SITE	VARIES
2.	EXTRACTING CORE	$2/SAMPLE
3.	PREPARATION	$2/SAMPLE
4.	CHEMICAL ANALYSIS	$10/SAMPLE
5.	STATISTICAL ANALYSIS	$1/SAMPLE
		$15/SAMPLE



HOW DO WE ESTIMATE CARBON CHANGE?

- 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)

We are not going to directly measure C!!

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

SOME BASIC PRINCIPLES OF RANGELAND CARBON FLUXES

- 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

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 RECOVERY

SOME STICKY SITUATIONS

- BURNING
  - FIRE RELEASES ABOVE GROUND CARBON, BUT LITTLE CHANGE BELOW GROUND
  - WITHIN ONE GROWING SEASON, CARBON LOSSES ARE OFFSET
- SHRUB INCREASE
  - INCREASES IN WOODY PLANTS INCREASE ABOVE GROUND CARBON
  - USUALLY ASSOCIATED WITH LOSS OF HERBACEOUS LAYER
  - INCREASES RISK OF CATASTROPHIC LOSS
  - BELOW GROUND CARBON IS APPROXIMATELY EQUAL

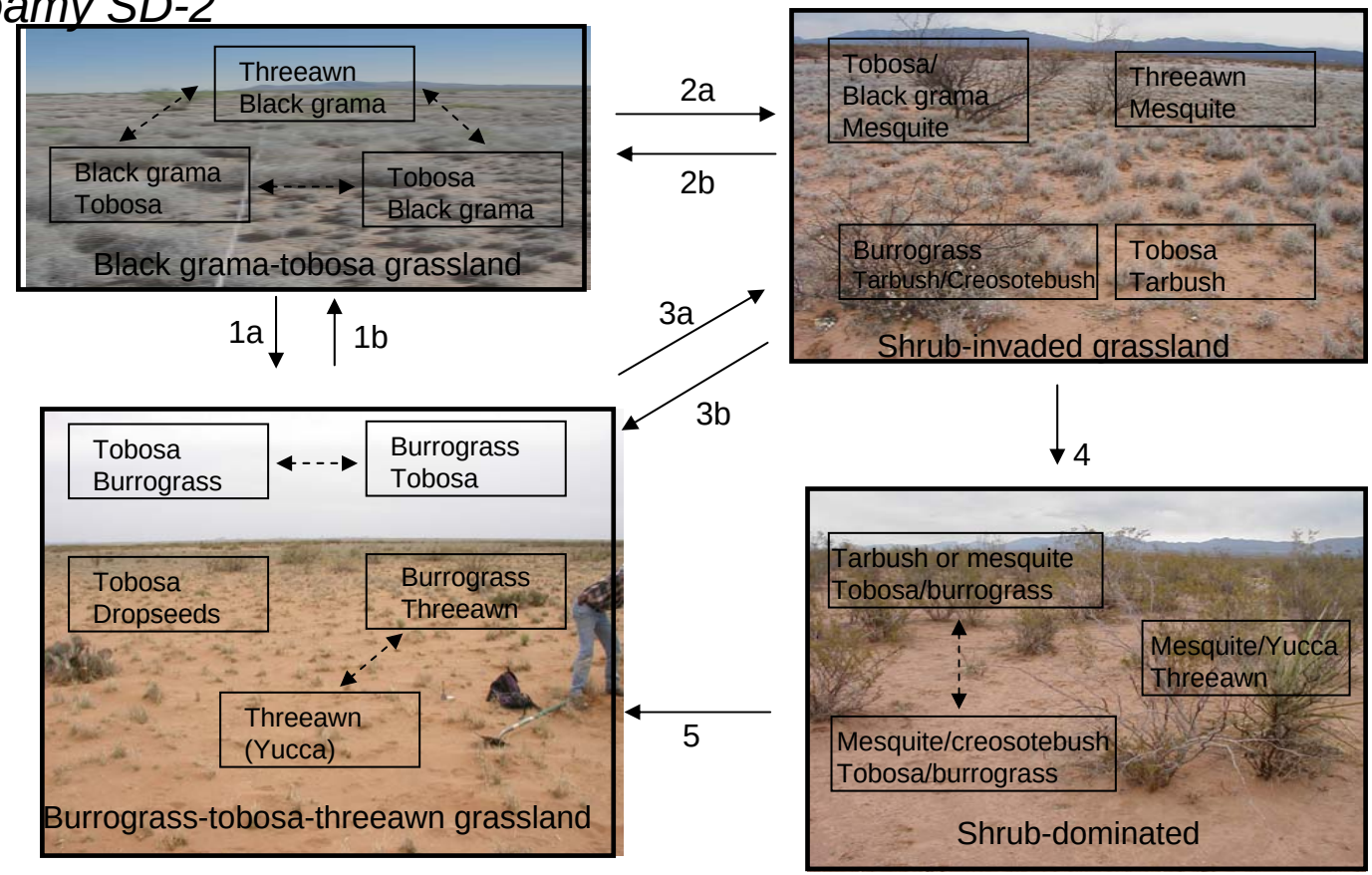
VERIFYING RANGELAND

CARBON SEQUESTRATION PROJECTS

- FORAGE SUPPLY:DEMAND BALANCE TO MAINTAIN PRODUCTIVITY
  - PLANNING
  - UTILIZATION
  - DROUGHT RESPONSE
- DISTRIBUTION
  - SPATIAL-AVOID SPOT DEGRADATION
  - TEMPORAL-MANAGE SPECIES COMPOSTION
- DROUGHT RESPONSE
  - RESPOND QUICKLY TO REDUCTIONS OF FORAGE SUPPLY

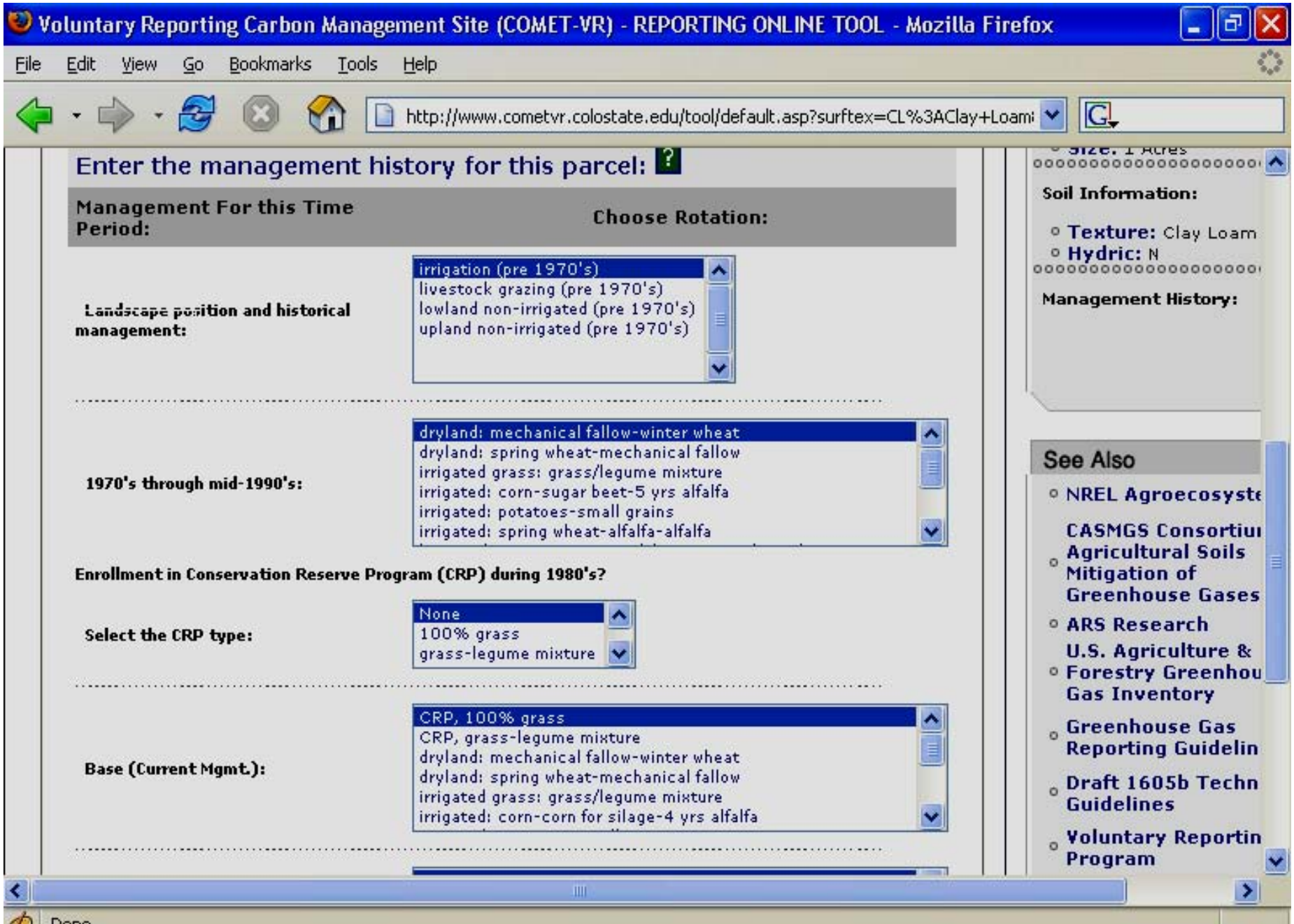
STATE AND TRANSITION MODELS AS A BASIS FOR SOIL CARBON CHANGE PREDICTIONS

Loamy SD-2

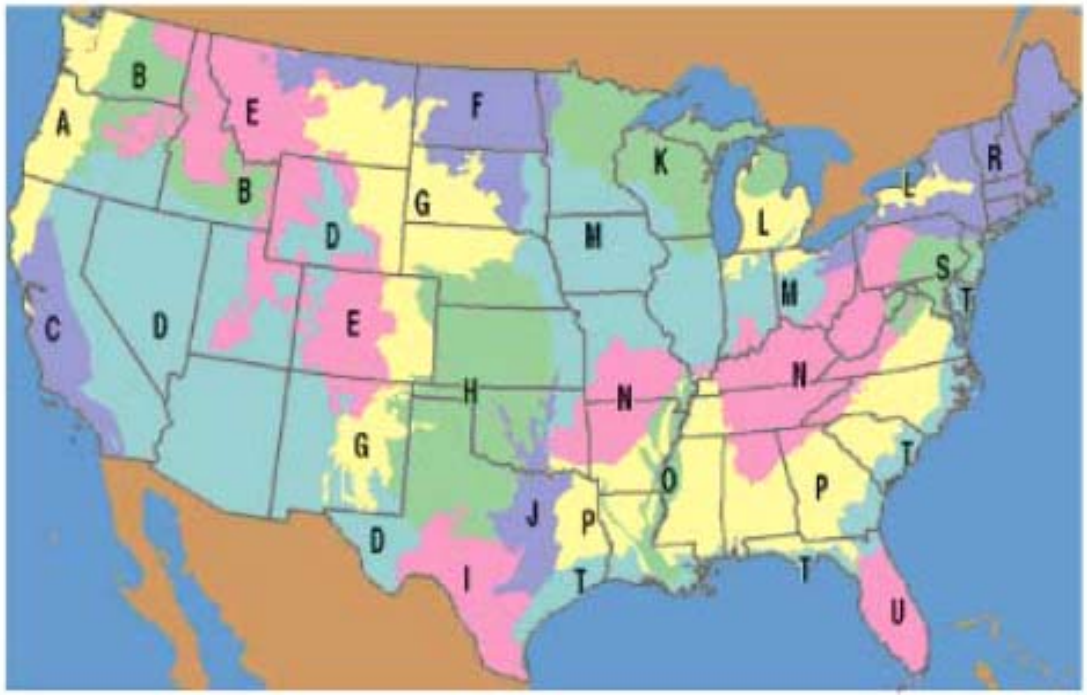


1a-Overgrazing, soil fertility loss, erosion and sand loss; 1b-Soil stabilization or modification
2a-Shrub invasion due to overgrazing and/or lack of fire; 2b-Shrub removal, restore cover
3a-Shrub invasion; 3b-Shrub removal with grass recovery
4. Persistent reduction in grasses, competition by shrubs,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

USING COMET VR TO ESTIMATE CHANGE



CHICAGO CLIMATE EXCHANGE
RANGELAND CARBON OFFSETS PROGRAM



USDA Natural Resource Conservation Service

Rangeland Rates and Eligible Regions*

Land Resource Region	Previously Degraded	Improved Manage-ment
B	0.20	0.12
C	0.16	0.16
E	0.28	0.12
F	0.24	0.12
G	0.40	0.27
H	0.52	0.20

*Additional regions may be added based on expert input.

MANAGEMENT PRACTICES-STOCKING RATE, DISTRIBUTION, DROUGHT MANAGEMENT

VERIFICATION PROTOCOLS-ANIMAL NUMBERS, RAINFALL, PASTURE MANAGEMENT

VERIFYING PERFORMANCE

- Documenting practices that affect ecological processes influencing carbon fluxes
- Local information is available and necessary
- Practices are secondary in importance to state in effects on driving ecological processes