

Do Livestock and Ecosystem Service Compete? A State and Transition Approach

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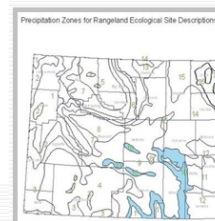
Brief Overview

- ESDs and STMs
 - What's new?
 - How are they useful?
- Applied Model
 - Livestock production
 - Comparison across other uses

Ecological Site Descriptions (ESDs)

- Similar to Range Site Descriptions
 - Beginning to be available for lots of Ecological Sites
- Available through NRCS
- Allow for understanding of ecological transformations
- Imbed a lot of useful information, especially if manager has multiple objectives

Example of ESD



ECOLOGICAL SITE CHARACTERISTICS

Site Type: Rangeland

Site Name: Loamy (L-y) 15-19" Foothills & Mountains Southeast Precipitation Zone

Site ID: R049XA122WY

Major Land Resource Area: 049-Southern Rocky Mountain Foothills

State and Transition Models (STMs)

- What is an STM?
- Generally graphical in nature
- Shows how land transitions over time in response to:
 - management (grazing management, brush control)
 - exogenous factors (drought, fire)

Why STMs?

- NRCS, USFS, BLM and others have all agreed to use this format (Get used to them)
- Historical Model of rangeland succession may not be accurate
- Data seems to show that some changes in land quality are not easily reversible
- Allows examination of trade-offs between short-term stocking rates and long-term productivity/profitability

Quick “terminology” lesson

- States are:
 - “Recognizable and Stable” complex of soil and vegetation
 - Must be distinguishable from other plant functional groups and ecosystem processes
- Thresholds are:
 - Difficult to reverse changes in primary ecological processes
 - Basically, the boundary of ‘states’
- Transitions are:
 - The suite of changes that create shifts in vegetation and site characteristics, both managerial and natural causes
 - “Crossing of a threshold”

State and Transition Models

Diagrams, text descriptions, and associated data that describe possible changes in plant communities and soils within particular ecological sites—**Conceptual models of vegetation change**

(adapted from Bestelmeyer 2003, 2009)

ESDs Provide a Lot of Info

- Describes plant communities by state
- Grazing capacity by state
- Wildlife Suitability by State
- An idea of how to get to where you want to be
- How to determine if you’re approaching a threshold – monitoring is key!

Actual STM for Loam areas of Laramie Range

BM - Brush Management (fire, chemical, mechanical, biological)
 Freq. & Severe Grazing - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
 LTFG - Long-Term Prescribed Grazing
 MCSLG - Moderate, Continuous Season-long Grazing
 NU, NF - No Fire and No Fire
 PG - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)

What we did

- Built an Economic model based on STM framework
- Determined optimal livestock management given potential long-term impacts
- Determined optimal brush control strategies
- Compared these results to those concerned with Ecosystem Services

Study Area: Elkhead Watershed, NW CO

Legend
 Elkhead Watershed
 Roads
Ecological Site
 Claypan
 Mountain Loam

Economic Model

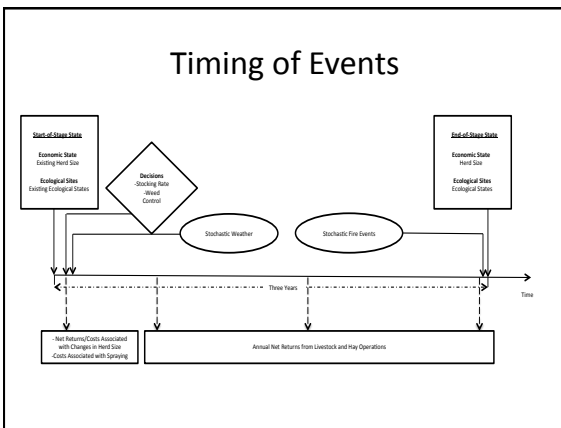
Table 2. Ranch Characteristics

Land Type	Amount
Claypan	2,392 acres
Aspen	386 acres
Mountain Loam	1,057 acres
Riparian ¹	200 acres
Hayland	800 acres
Public Land	50 AUMs
Hayland Productivity	1.25 tons/acre ²
Costs	
Cow Unit ³	\$90.67 ⁴
Hay Cost	\$40 per acre
Spray Cost	\$20 per acre (75% EQIP cost share)
Fixed Costs	\$37,350
Cost to Expand Herd	\$900 per Replacement Heifer Purchased
Returns	
Cow Unit ⁴	\$616.53
Hay	\$100 per ton
Revenues from Decreasing Herd Size	\$436.50 per Cull Cow Sold

Table 1. Description of Ecological States

Claypan	
C1	Diverse and Alkali Sage/Bluegrass Shrubland
C2	Native Grassland
C3	Eroding Alkali Sage Shrubland
C4	Alkali Sage/Western Wheatgrass Shrubland
Aspen	
A1	Forb Based
A2	Shrub Based
Mountain Loam	
L1	Mountain Big Sage Shrubland with Diverse Understory
L2	Dense Mountain Big Sagebrush Shrubland
L3	Mountain Big Sage/Western Wheatgrass Shrubland

Timing of Events



Decision Variables

- Stocking
 - Based on NRCS 'recommended' rates, +/- 20%
 - Low, Moderate, High
- Spraying
 - Brush Control
 - Have the option to Spray Claypan and Mountain Loam (Not Aspen)
 - \$5/acre, also \$20

Optimal Stocking

Existing Stocking Rate:		Moderate		
		L1	L2	L3
C1	A1	Moderate	Moderate	Moderate
	A2	Moderate	Moderate	Moderate
C2	A1	Moderate	Moderate	Moderate
	A2	Moderate	Moderate	Moderate
C3	A1	Moderate	Low	Low
	A2	Moderate	Low	Low
C4	A1	High	Moderate	Moderate
	A2	High	Moderate	Moderate

Existing Herd Impacts Optimal Stocking

Table 6. Optimal Stocking Decisions Given Ecological States and Existing Stocking Rates

Existing Stocking Rate:		Low			Moderate			High		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
C1	A1	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	A2	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
C2	A1	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate
	A2	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate
C3	A1	Low	Low	Low	Moderate	Low	Low	Moderate	Low	Low
	A2	Low	Low	Low	Moderate	Low	Low	Moderate	Low	Low
C4	A1	High	Moderate	Moderate	High	Moderate	Moderate	High	High	High
	A2	High	Moderate	Moderate	High	Moderate	Moderate	High	High	High

Optimal Brush Control

- Never spray Claypan
 - While it eliminates brush, you don't end up in a 'better' state (at least in terms of livestock productivity)
 - "Native Grassland" sounds good, but low productivity
 - "Eroding Alkali Sage Shrubland" doesn't sound good, and it isn't
- Spray 1 of 3 Loam States
 - But not all of the time, depends on grazing pressure
- Useful to help target managerial decisions

But, is livestock all we care about?

- STMs (and ESDs) also provide information regarding other ecosystem services
- Producers may also receive revenues from hunting leases
- What about potential listing of Sagegrouse as Endangered?
- What incentives are required to align private decisions with socially desired management?

Ecosystem Services in Conflict

	Deer	Elk	Grouse	Diversity	Erosion	Invasion
C1	0.35	0.52	0.36	35.5	8.5	1.2
C2	0.13	0.45	0.14	28.3	8	0.5
C3	0.2	0.33	0.25	34.7	14.7	2.8
C4	0.2	0.58	0.29	29.3	4.6	0.8
L1	0.57	0.65	0.67	38.6	6.4	0
L2	0.64	0.38	0.5	43.4	6.7	1.4
L3	0.55	0.47	0.8	41.5	7.1	0.6
A1	0.74	0.6		54	0	0
A2	0.8	0.64		50.2	0	0
Critical Value	0.33 (min)	0.66 (min)	0.33 (min)	125 (min)	7 (10) (max)	1 (max)

Example of Ranch Scale 'Weighted' Habitat Values

		L1	L2	L3
C1	A2	0.45	0.469	0.444
	A1	0.456	0.475	0.45
C2	A2	0.313	0.332	0.307
	A1	0.319	0.338	0.313
C3	A2	0.356	0.376	0.351
	A1	0.362	0.382	0.357
C4	A2	0.356	0.376	0.351
	A1	0.362	0.382	0.357

Optimal Decisions Given Constraints on Ecosystem service Levels

	Livestock	Deer	Grouse	Diversity	Erosion	Invasion
Low Stocking	19%	19%	19%	19%	25%	19%
Moderate Stocking	64%	60%	63%	53%	72%	67%
High Stocking	17%	21%	18%	28%	3%	14%
Spray Claypan	0%	0%	0%	0%	0%	0%
Don't Spray Claypan	100%	100%	100%	100%	100%	100%
Spray Loam	33%	21%	33%	8%	28%	36%
Don't Spray Loam	67%	79%	67%	92%	72%	64%

Impacts on Decisions Given Constraints on Ecosystem service Levels

	Livestock	Deer	Grouse	Diversity	Erosion	Invasion
Low Stocking	19%	94%	75%	57%	50%	19%
Moderate Stocking	64%	6%	0%	43%	25%	6%
High Stocking	17%	0%	25%	0%	25%	75%
Spray Claypan	0%	75%	75%	75%	0%	25%
Don't Spray Claypan	100%	25%	25%	25%	100%	75%
Spray Loam	33%	83%	25%	88%	25%	14%
Don't Spray Loam	67%	17%	75%	13%	75%	86%

Take Home Message

- Sometimes it's better to forego short-term profits to ensure long-term productivity
- Monitoring (and adaptation) is important – STM framework
- ESD's can help shed light on what's possible
- ESD's can help target decisions:
 - Able to show where it's best to spend time/money on improvement/prevention
- Can't have everything, need to understand trade-offs among:
 - short-term vs long-term grazing ability
 - competing ecosystem services
 - Need to understand weighting of services is important
 - Is provision of these services 'nice' or 'necessary'?

Where to get more info:

- [Local NRCS Office](#)
- <http://esis.sc.egov.usda.gov/Welcome/pgESDWelcome.aspx>
- John.Ritten@uwyo.edu
- Maria.Fernandez-Gimenez@ColoState.EDU