State and Transition Modeling
Current status of the STM Framework

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Major STM Workshops

Upland STM Concepts
August 2006

Riparian ESD & STM Concepts
August 2007
Riparian Workshop

- NRCS State Range Conservationists
- University and Agency Scientist’s
  - Fluvial Geomorphology
  - Riparian Vegetation
  - Wetland Soils

ARS Jornada Experimental Range web page
Riparian Concepts

• Stream channels: pattern, dimension & profiles
• ESD’s and Riparian Complex concepts
• Similarities and perplexing difficulties
• Riparian vegetation and stream channel pattern, dimension and profile
• Stream channels and water tables
• Water table and vegetation
Proposed ESD measurements

- Soil
- Water depth
- Vegetation
- Elevation

Greenline/shrubs

Channel dimension

- T1
- FP

Pleistocene terrace or hillslope

Ecosite boundary

Qualitative or quantitative-derived class measurements
- Valley type/stream substrate
- Channel evolution model
- Rosgen classification
Landform associated with State 1: FP=active floodplain; 1 = tufted hairgrass meadow; 2 = pleistocene terrace

CT(FP) = sedge/willow
CT (1) = tufted hairgrass

Phases potentially contain multiple CT’s.

Phase 1 to phase 2: caused by a slight incision and/or widening of the channel bed causing.

Composition (OBL’s to FACW to FAC).

Phase 2 is the at-risk phase due to the lack of bank holding plants such as sedges and willows.
Landform: State 2: FP = active floodplain; 1 = kentucky bluegrass meadow; 2 = western wheatgrass meadow; 3 = pleistocene terrace.

Dynamics: Channel incision and stabilization new terrace; disconnecting the meadow from channel processes (flooding and meadow recharge).

State 2

CT(FP) = tufted hairgrass / sedges
CT(1) = kentucky bluegrass
CT(2) = western wheatgrass

Phase 1: F-type

Channel incised and widened from
State 1: Rosgen type C to G to F.
State 2: Phase 1 reflects a stabilizing F
With the associated decoupled meadow (terrace1).
Draft general riparian channel-meadow model

Atypical disturbance

Reference conditions → Greenline degradation
Meadow degradation → Destabilized bank
Destabilized soil

High flow event → Failed bank/erosion

Long-term restoration

Loss of OBL and FACW in riparian complex

Lowered water table

Increased drainage rate from meadow

Channel evolution

Loss of resilience within state 1

Trigger

Threshold

Formation of alternative state 2

A set of general models can be adapted to MLRA-specific STMs by including species and STM formatting.
Riparian ESD & STM

*Test Case Underway*
STM’s in *Transition*

- STM Workshop @ OSU: 2006
- Scientist’s and NRCS personnel
- Problems in application
- Research needs
Positives

• **State-and-Transition** (Stringham et al. 2003)
  
  – Accommodates: Range Succession Model (Quantitative Climax Model)
  
  – Accounts for transitions, thresholds, and multiple steady states
  
  – Process based
Positives

• State-and-Transition
  – Allows for more detail in triggers and pathways of vegetation change
  – Spatial scale: Ecological Site
  – Temporal framework: Current climate
  – Used in ESD’s
Generalized STM Format

*Stringham et al. 2003*

State A

Community

Transitional community

State B

Threshold

Transition

State C
STATE

A recognizable, resistant and resilient complex of two ecosystem components, the soil base and the vegetation structure

<table>
<thead>
<tr>
<th>Vegetation Structure</th>
<th>Soil Base</th>
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<tbody>
<tr>
<td>• above ground communities of plant species assemblages</td>
<td>• developed through time from specific parent material, climate, landscape position and interaction with biota</td>
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<tr>
<td>• competitively capture and utilize the available resources</td>
<td>• determines the site’s capability</td>
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- interaction between soil and vegetation determines the functional status of the site and inherent resistance to change
The soil and vegetative components combined produce a sustained equilibrium that is expressed by a specific plant community in its various seral stages.
Transitions

A trajectory of system change away from the current stable state that is triggered by natural events, management actions, or both

Reversible Component
Occurs within a state; indicates the system is moving toward a threshold

Irreversible Component
Occurs after a threshold has been crossed

State 1
- Late Seral Sagebrush Steppe
- Native Perennial Grasses Dominate
- Depauperate Late Seral Sagebrush Steppe
- P1
- P2

State 2
- Cheatgrass and/or medusahead
Threshold

Point in space and time between any and all states such that one or more of the primary ecological processes has been irreversibly changed precluding return to the prior state.

Thresholds = state boundaries

State 1
- Late Seral Sagebrush Steppe
- Native Perennial Grasses Dominate

State 2
- Depauperate Late Seral Sagebrush Steppe
- Cheatgrass and/or medusahead
Ecological Processes

- Hydrology: capture, storage and on-site use of precipitation
- Energy Capture: conversion of sunlight to plant matter
- Nutrient Cycling: the cycling of nutrients through the physical and biotic components of the environment

Interpreting Indicators of Rangeland Health
Technical Ref. 1734-6 2000
• Ecological processes functioning within a normal range will support a suite of specific plant communities

• Maintenance of a functional site or repair of a damaged site requires management focused on:
  - soil stability
  - nutrient cycling
  - capture, storage and safe release of moisture

• Vegetation should be used as a **tool** for repair or maintenance

• Vegetation *or soil* change may be an indicator of a change in the functional capacity of the ecological processes
Generalized STM Format

Stringham et al. 2003

Issues:
- Definitions of concepts
- Application of concepts
Issues

- State-and-Transition
  - Research: Focus on identification of thresholds
  - Management: Threshold focused
  - Process based: difficulty with quantification
Issues

• State-and-Transition
  – Ecological structure ignored
  – Ecological resilience lacks detail
  – Triggers and feedback mechanisms: lack inclusion within current model
Response

- Improved definitions of model concepts
- Increase attention on: RESILIENCE MANAGEMENT vs. threshold management
- Increased emphasis on at-risk plant community phases (transitional phase)
Response

- Range Health Indicators for identification of at-risk plant community phases
- Include descriptions of triggers and feedbacks within model discussion
- Restoration Pathways: Describe activities necessary to restore the structure and function of a prior state
Outcomes

• New Manuscript:
    
    Briske D., Bestelmeyer B. and T. Stringham
  
  – SRM Symposium
Symposium

- Resilience concepts
- Up-dated model concepts
- STM Examples:
  - Oregon High Desert
  - Great Basin
  - Chihuahuan Desert
  - Northern Great Plains
  - New Mexico
  - Deep Sand Savannah

Morning

Afternoon
Symposium

• Panel Discussions: morning & afternoon
  - Research needs
  - Management application
  - ??????