Shrub Proliferation, Brush Management, and Ecosystem Services

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Introduction

- Grasslands provide a myriad of important ecosystem services.
- Over the past 150 y many grasslands have experienced a proliferation of unpalatable shrubs.



- Brush management has been widely used to reverse shrub encroachment and recover forage production, stream flow and upland game habitat.
- Results are often short-lived or sub-par and seldom economically viable solely from a livestock production standpoint (Table 1).

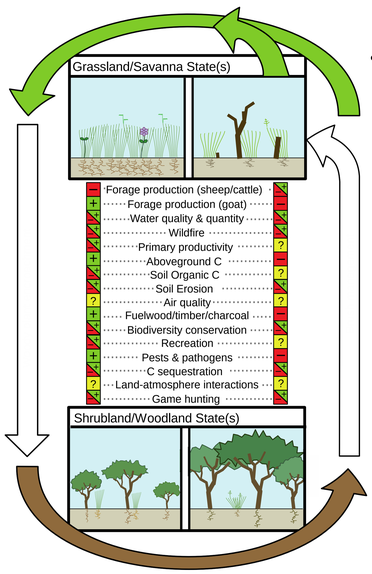
Table 1: Brush treatment on Las Cienegas National Conservation Area, 2007-2010: treatments, acreages, and costs. Data courtesy of BLM and the Nature Conservancy.

Treatment Name	Treatment Type	Acres	Cost	Cost/Acre	Completed
Airstrip	Mastication and Spray	759	$113,614	$150	2007
Airstrip Re-Spray	Foliar Spray	277	$111,473	$402	2007
Maternity	Broadcast Burn	1920	$47,296	$25	2008
Lee Tank/Prairie Dog	Mechanical	41	$8,395	$205	2008
Oak Tree	Mechanical	332	$74,858	$225	2009
Cedar	Broadcast Burn	3639	$32,095	$9	2009
Trap 1 & 2	Mechanical	482	$108,450	$225	2010
Antelope	Mechanical	199	$45,780	$230	2010
Quail	Cut Stump	196	$133,401	$680	2010

- Shrub encroachment and brush management also affect a variety of other ecosystem services (e.g. carbon sequestration, soil fertility water quality) and impact grassland-obligate plants and animals, and hence biodiversity.




- We are poorly positioned to evaluate trade-offs among these services.



- A broader understanding of how shrub proliferation and brush management interact to impact services would enable:
  - ❖ More accurate/comprehensive assessments of the validity of brush management.
  - ❖ Development of guidelines for when, where, and under what circumstances to initiate brush management.

Goals/Objectives

Goals:

- *Predict rates/patterns of shrub encroachment and recovery from brush management.*
- *Assess changes in the attending provision of a diverse portfolio of ecosystem services.*

Objectives:

1) Quantify rates/patterns of shrub cover change on sites with contrasting soils and management histories using time-series (1936-2010) aerial photography.
2) Evaluate the efficacy of past brush management actions (dating back to 1960s).
3) Quantify changes to ecosystem services occurring with shrub encroachment and following brush management.

Addressing these goals and objectives will position us to evaluate the nature and magnitude of trade-offs among contrasting, and sometimes competing, land management scenarios.

Approach

1. Develop trade-offs matrices for bundles of ecosystem services.
   - Shrub encroachment impacts ecological, social, and economic components of sustainability.
   - Accounting for the influence of shrub encroachment/brush management on multiple services and understanding trade-offs among services will enable us to more accurately and objectively assess the true costs of doing – or not doing – brush management.

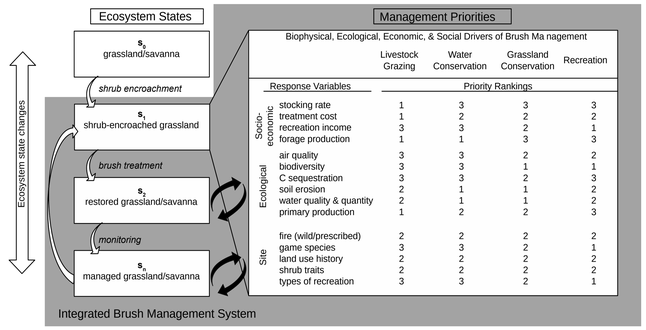


Figure 1: A conceptual framework showing ecosystem state transitions associated with shrub encroachment and subsequent brush management

2. Develop geospatial maps/layers of shrub encroachment rates and patterns and recovery from brush management.
   - Understanding spatial patterns of proliferation can be used for inference about underlying processes of encroachment.
3. Develop criteria for targeting/prioritizing diverse landscape elements for brush management actions.

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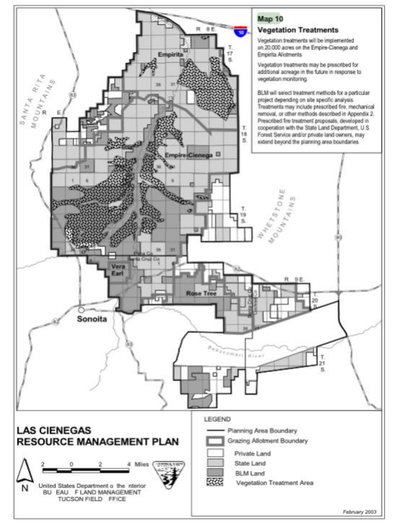
Philip Heilman - Research Leader at the Southwest Watershed Research Center USDS-ARS, Gita Bodner - Conservation Ecologist with The Nature Conservancy, and Karen Simms - Acting Assistant Field Manager of LCNCA for their support. Also, The Nature Conservancy Tucson Office for access to the LCNCA aerial imagery database.

Methods

***Study Site*: Las Cienegas National Conservation Area (LCNCA), Southern AZ**

- ~18,211 ha of state and federal lands.
- Includes five of rarest habitat types in the American Southwest.
- A "working landscape".
- Active brush management program (Tab. 1) (additional 8,055 ha targeted for treatment).



Rates and Patterns of Shrub Encroachment and Response to Brush Management:

- Utilize database of repeat aerial photos compiled by TNC (Fig. 2)
- Resampled images to a common resolution.
- Semi-manual two-step method to quantify shrub cover in GIS with landform, soil and land use overlays.

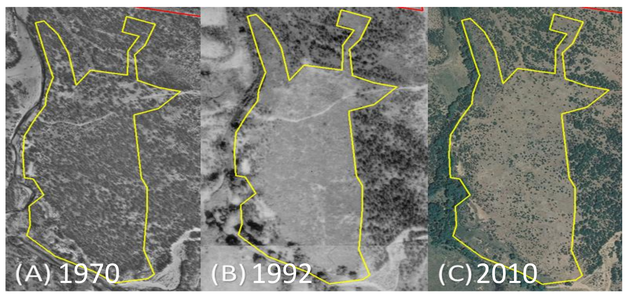


Figure 2: Time-series images of a LCNCA site that underwent brush management sometime between 1975 & 1990. (A) By 1970 site had become heavily encroached by mesquite. (B) 1992 image taken post brush treatment showing most mesquite has been cleared. (C) Site in 2010 which re-encroachment is evident. Images courtesy of The Nature Conservancy

Ecosystem Services on sites with contrasting shrub encroachment/brush management histories:

Provisioning/Supporting Services: Forage Production, Primary Production (grass + shrub) and Biodiversity:

- Point-intercept and belt transects to quantify cover by species; grass and shrub basal area at peak season converted to biomass using allometry relationships.

Regulating Service: Carbon Sequestration:

- Soil organic carbon (0-20 cm) under and between shrubs

Supporting Service: Critical Habitat:

- Habitat suitability models created using literature reviews and expert knowledge. Used to weight variables to generate spatially explicit habitat suitability scores for land cover elements in GIS.

Trade-off Matrices:

- Create trade-offs matrices for variety of ecosystem services in contrasting management scenarios (Fig. 1).