The Landscape Toolbox
Tools and Methods for Effective Rangeland Management
The Landscape Toolbox

• Umbrella for guiding research and organizing results
• Scale and context matter!
  – Create a structure where it becomes possible to know when/where to use different tools, techniques, knowledge
  – Within a multi-scale, ecological site framework
• Research focused on
  – Identifying appropriate scales of analysis
  – Determining where tools/techniques work and why they fail
Selecting Appropriate Scales

A. Ikonos - image segmentation

- Correlation Coefficient vs Object/ Pixel Area (ha)
- Median Object: 5.47 ha

B. Median Object: 21.3 ha

C. Median Object: 452 ha

D. Median Object: 1030 ha
Selecting Scales – Linking to Processes

A) Shrub Residual Variogram

B) Bare Ground Residual Variogram

C) Cheatgrass Residual Variogram
NRI/CEAP \textit{Integrated Field and Remote Sensing Monitoring}

- High-res imagery (<2cm pixels) can be used for monitoring
- How to incorporate into robust monitoring programs like NRI?  
  – Training, calibration, repeatability
- What indicators can be derived reliably and where?
- Can we tell \textit{a priori} when technique will not work?
Estimating Canopy Gaps - Methods

• Data
  – High res. (3cm GSD) aerial photographs interpreted and classified
  – Field measures of canopy gap compared to image estimates

• Analysis
  – Linear relationship between field/image estimates

A. Image Interpretation (points)  
B. Train/Classify Imagery  
C. Calculate Gaps, Compare to Field
Field vs. Image Canopy Gaps

Proportion of transect in gaps > 50cm

- **Segmented, Logistic Regression**
- **Pixel-based, Logistic Regression**
- **Segmented, MLC**
- **Pixel-based, MLC**
Coefficients of Agreement

- Measure of agreement between two classifications
  - Comparison of interpreted point values and image classification
    - No field data
    - How distinct classes are?
- Strongly correlated with accuracy of canopy-gap and cover estimates
  - High agreement coefficient = easily distinguished classes = robust estimates
- Suggests coefficients of agreement can be an a priori measure of how a technique will perform
# Results by Canopy Gap Size

<table>
<thead>
<tr>
<th>Gap size</th>
<th>$r^2$ all sites</th>
<th>$r^2$ kappa &gt; 0.5</th>
<th>Coef.</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 to 50cm</td>
<td>0.607</td>
<td>0.772</td>
<td>1.721</td>
</tr>
<tr>
<td>50 to 200cm</td>
<td>0.330</td>
<td>0.845</td>
<td>1.129</td>
</tr>
<tr>
<td>&gt; 200cm</td>
<td>0.474</td>
<td>0.966</td>
<td>0.956</td>
</tr>
</tbody>
</table>

![Graphs showing results by canopy gap size](image-url)
Canopy Gap Size Estimation

- Like other indicators, canopy gaps can be estimated from VHR imagery (in many cases)
- Research suggested an a priori measure of if/when image-based estimates would succeed.
- To be used in monitoring programs, need to know more about when/where image-based techniques likely to succeed
BLM’s AIM Strategy

• Agency-wide standard suite of indicators (what to measure), methods (how to measure), and sample design (where to measure)
• Can be supplemented with additional indicators as needed
• Provide quantitative data to address cross-program management needs
• Consistent with other large-scale monitoring efforts (e.g., NRI)
BLM AIM

- Application of Jornada/ARS research & products
  - Sample design software
  - DIMA
  - Training
  - Analysis/Reporting tools

- Project design, implementation support and data analysis for > 10 demonstration projects
BLM AIM –
Research Aspects

• Integration of field and remote sensing data*
  – Qualitative vs. quantitative data for training image-based products
  – Scaling up field measures to landscape-level indicators

• Statistical sample design†
  – Integrating local-level data into national-scope monitoring
  – Making use of legacy data in a statistical sampling framework
  – Using HR aerial imagery in monitoring programs (Karl et al. 2012).

* In cooperation with BLM,
† In cooperation with Iowa State, Colorado State Universities
Building Knowledge Systems

Information Sources
- Imagery: USGS Earth Explorer
- Predictive Model: RHEM
- Veg Data: NRI, VegBank, DIMA
- SSURGO Soils
- National Climate Data Center
- National Elevation Dataset

Geo-Semantic Search
- Contextual Meaning
  - My location
  - Similar Areas

Applied Systems of Knowledge

Knowledge Sources
- JournalMap
- Ecological Site Descriptions
- NRCS Conservation Practices Database
- eXtension
- Rangeland Methods Guide

* Currently has a web service that supports integration
Building Knowledge Systems: JournalMap

- Find relevant knowledge
- Spatial & thematic context
- Support ESD development & use

In Development
- Cooperate with NAL
- Work with societies/publishers

http://www.journalmap.org
www.landscapetoolbox.org