

**Meeting Notes for the Sustainable Rangelands Roundtable (SRR)**  
**Washington D.C.– May 29-30, 2002**  
**Facilitated by Lou Romero, DeLaPorte & Associates, Inc.**

**Welcome Remarks – Tom Bartlett, Roundtable Host/Convener**

Thank you for the level of support and participation you have shown by your attendance at this and previous meetings. During this meeting we hope to refine indicators and complete 6-point framework, prepare to have indicator work reviewed by external reviewers, and determine a temporal reference point and spatial classification of indicators.

**Participant self-introductions – led by Lou Romero, Roundtable Facilitator**

Welcome to the new participants. Participants introduced themselves, answering the following questions:

- Name, organization, position?
- Participation in Roundtable Meetings?

*A list of participants can be found in Appendix A.*

*For a summary of the following talks, please refer to Appendix B.*

**Importance and Potential Benefits of Sustainability Indicators – Ted Heintz**

**Sustainability Research for Rangelands – John Mitchell**

**SRR Process and Purpose – Tom Bartlett**

**SRR Criteria and Indicator Overview – Linda Joyce**

**Future Plans and Milestones - Rod Heitschmidt**

**Questions and Comments on the briefing talks (Bartlett, Joyce, and Heitschmidt):**

Suggestions:

- Congressional groups should be interested in hearing that there is broad support for C&I framework. Traditionally opposing groups are together in this effort.
- From an operational point of view, this larger framework will help land managers view and overcome problems they face.
- This framework will increase efficiency of data collection and reporting, resulting in significant cost savings.

How will the SRR bring monitoring on rangelands to one focal point?

- This is a challenge we are working on to bring together similar efforts such as the Heintz Report, the EPA indicators, legislated indicators...

Scale: not clear what scale we are focusing on. Classification system has to cross more than one scale. One monitoring system cannot cut across all scales. Must be able to look also at regional and local units. There needs to be some aggregation. There will be some overlap

What is the definition of rangelands? Without a definition, how can we define criteria and indicators?

It is a matter of scarce resources. When presenting the SRR to agency heads, how will you argue for focusing on monitoring rather than healing damaged rangelands that we know need attention.

Rangelands are not ecosystems. It is a use dropped on ecosystems.

- No, rangelands are a type of land dominated by grasses, grass-likes, shrubs, and forbs.
- Clarify definition in future presentations.

For presentations to policy makers, the talk should clarify whether we are looking for legislation and/or changes in legislation.

**Temporal Scale Presentation – Robert Washington-Allen – See Appendix B.**

### **Reports from Working Group Leaders**

#### **Productive Capacity: Dennis Child**

Productive capacity and ecological health groups met this morning to discuss their overlap on production. There is not as much overlap as they had first thought. The productive capacity group is more interested in the area, whereas the ecological health is more interested in point based data collection. There is also collaboration with the economic and social group over recreational uses and delineating quantities and values.

#### **Ecological Health and Diversity: Linda Joyce**

- Discussed area indicator with Capacity group. Productive capacity indicator measures area in physiographic units.
- Indicators for processes: hydrology, nutrient cycling, and energy flow. Working with soil and water on lake levels and riparian areas specifically on geomorphology.
- Landscapes - Working with socioeconomic group on parcel size
- Communities - discussion about non-natives with capacity group, question of whether to use functional groups or other classifications
- Species – looking at the indicator: species that occupy a small portion of former geographic range.
- Will continue to work on overlaps with other groups and flesh out 6-point framework.

#### **Soil and Water: David Pyke**

Progress was made in between meetings in framing more indicators for soil including wind erosion, bare ground, and herbicide/insecticide (toxics indicator dropped at Denver meeting). Looking at whether C:N ratios can be used for measuring nutrient content. Still working on aggregate stability-area, extent, and variance of soil organisms. Water based indicators need some attention at this meeting.

#### **Social and Economic Indicators: Aaron Harp**

Half of the indicators on the comprehensive list are social-economic. In Denver these indicators were developed and categorized. Met with Capacity group. Quantities of goods and services will be taken by capacity; values will be incorporated in socioeconomic indicators. This meeting, we need to winnow down and flesh out our list.

**Institutional Framework:** Stan Hamilton

The group split the indicators among members of the group to verify if they should be pursued. The result is a draft to work from in this meeting. At this meeting we will decide whether we will keep all indicators. There is considerable overlap with the socioeconomic group and they need to meet more to decide how to proceed. Stan will be group leader for this meeting.

*The remainder of the afternoon was spent in Criterion Groups to refine work and continue to populate the 6-point framework.*

**Thursday, May 30, 2002**

**Discussion on Delphi Results – Helen Rowe**

Between the Tucson and Denver meetings, two topics were covered through the Delphi: the Baseline Issue and Reporting Methods. Discussion in this session resulted in consensus in the two arenas. See appendix C for group discussion notes.

- Consensus on Baseline issue: Start with earliest acceptable, compatible data. Earlier data may be included with qualifications. As technology changes in the future, data may change as well. (As long as all differences in reporting methods are well documented, data may be included.)
- Consensus on Reporting Methods issue: Use the most statistically reliable, appropriate data reporting method for each indicator; have common overlay of political boundaries (by state) for reporting purposes.

*Criterion groups continued indicator work until the following talk.*

**Status of National Sustainability Efforts – Phil Janik**

Mr. Janik introduced his theory of aggressive humility. We should be humble in our work because we cannot solve the question of sustainability independently. At the same time we can be aggressive in our individual contribution to the collective effort.

Accomplishments in sustainability predate the roundtable efforts. Sustainability has been incorporated in the forest service strategic plan, for example. The water sustainability effort is just beginning and World Summit will occur later this year. Coordination amongst the roundtables has begun through the Roundtable Network. The SRR has been successful in its involvement of grass roots organizations.

It is important to tackle the big challenges and become more than a forum for dialogue. The SRR is taking on big challenges such as attempting to define rangelands. We should study and recognize heroes of the past, but dare not forget the heroes of the present, such as those working on sustainability issues. Incorporate aggressive humility. Be patient, in an impatient way.

## **Q&A:**

What kind of reception are the RSF indicator review workshops receiving?

One workshop was held in Portland with 70 attendees and one is taking place now in DC with 140 participants. The purpose is to review the multi stakeholder document on the national report on sustainability, to be published by forest service. These stakeholder workshops have been enormously productive. The conveners have listened well.

How is the response measured?

- They hope to address the insufficiencies where additional funding is needed.
- Struggle of what should be emphasized. Not redrafting C&I because these are set.

Who will be taking over your responsibilities, after your imminent retirement?

Joel Hoeltrop will take on sustainability. Fred Kaiser, who currently works on sustainability research, is retiring this week and will be replaced by Rich Gulden. Pete Roussopoulos to co-chair with Jerry Rose on the RSF.

Do we have support from the administration?

From day one, the major question has been what difference will this make on ground. At what level can we apply these indicators? There exists a lack of understanding of these as a broad umbrella. A goal for a project would be to be able to produce a very small number of indicators that we think could be used as overall indicators.

## **Working Group Reports:**

### **Outreach (Lori Hidinger):**

We produced a 4-pager for use at the briefings and also for future outreach such as the July Cattlemen's Association Meeting. We will be holding an ESA workshop in Tucson, August 2002. Tom has submitted a symposium application for the 2002 Casper SRM annual meeting. Please give any other ideas for presentations/briefings to Lori.

### **Definitions of Rangelands and Forests: Paul Geissler**

We have good conceptual definitions and there is general agreement on typical forests and rangelands. However to compare data and estimates, we need agreement on operational definitions. The Oregon Demonstration Project found 10% to 15% difference in the areas of rangelands and forests depending on which definitions are used. There may be 40 to 60 million acres difference in the US, depending on which definition is used.

Agreement on definitions is essential to define the area to which the criteria and indicators apply. These are very long-standing and contentious issues, because allocation of some funds depends on the area of forests. Some issues include which species are trees and which are shrubs, and how many trees are needed for a forest. There are also differences on whether we are defining a land use or land cover.

The group has had three conference calls and is preparing for a face-to-face meeting to better define the issue and develop an approach for agreeing on definitions. The first step is to summarize the history of forest and rangeland definitions. This summary will allow the group to

build on experience rather than repeating past attempts. The workgroup has 18 participants representing a wide spectrum of involvement. For more information about the workgroup please visit the website at <http://www.pwrc.usgs.gov/brd/Definitions.htm>.

**Scale:** Paul Geissler

Participants: Paul Geissler, Aaron Harp, Ted Heintz, Dan McCollum, Paul Tueller, and Robert Washington-Allen

Scale is an important aspect of each of the indicators because the questions, data and interpretations change with the spatial and temporal scale. There is natural interest in the indicators at the national, regional, state and local levels. This will require aggregation, extrapolation or interpolation of the data. Selecting a baseline or reference condition sets the temporal or spatial scale.

The Scale Group will work on the following two products:

- \* Consideration of specific examples of the effects of scale. We ask the criterion groups to help us identify indicators that are particularly affected by scale issues.
- \* Development of a matrix that displays the spatial and temporal grain and extent of each indicator.

At this meeting we identified issues with the last two items of the 6-point indicator framework. The Roundtable hopes to modify these by the next meeting.

**Coordination:** Duncan Patten

Patten has been asked to head up this group; he will start defining the task of coordinating with other groups outside of the roundtables. Update on the Heintz Center: they are going to press now and it should be out in August 2002. They are currently organizing public relations and presentations. If Heintz does another round, there might be room for more close collaboration with the roundtables.

### **Criterion Groups Report**

**Socioeconomic:** Aaron Harp

We started with 58 indicators at the beginning and pared the list down to 37. Some indicators were deleted and some added. For social/community sustainability in natural resource dependent areas, the indicators we have identified relate to more than one resource; the linkages to rangelands are not known with a large degree of certainty; therefore there is some thought we should set aside the development of the indirect measures. We explore finding the set of community indicators related to all natural resources in concert with other roundtable efforts.

**Productive Capacity:** Dennis Child

- Data will be collected within the context of physiographic regions with the understanding that state boundaries will be overlaid for reporting purposes.
- Historical data will be used where practical to extend the baseline.
- Indicator #1: Percent of available rangeland that is grazed by livestock.
  - Provides information on land use patterns that may shift production from one commodity to another use.

- Provides information to interpret the baseline in a changing world.
- Indicator #2: Number of domestic livestock on rangeland. (Cattle, sheep, goats, horses, and bison)
  - A direct measure of a consumptive use of rangeland forage.
- Indicator #3: Presence and density of important obligate wildlife species.
  - A direct measure of wildlife numbers that derive a critical proportion of their food and habitat requirements from a rangeland type. (T&E species will not be selected.)
  - The presence of these obligate species will also be an indirect measure of recreational capacity.
- Indicator #4: Annual removal of: 1) landscaping and decorative plant materials and 2) edible and medicinal plants.
  - An estimate of the wide variety of other consumptive uses of rangeland.
- Indicator #5: Annual above ground biomass production.
  - A measure that integrates the biotic and abiotic factors that determine the annual production from rangeland.
  - Net primary productivity. (Like #19 but not point data.)
  - Will be monitored remotely.
- Accomplishments and future work: Five indicators have been developed.
- The next tasks:
  - To obtain buy-in of this set from the full criterion working group.
  - To rewrite paper and finish framework write-ups.
- Old indicators: #1 Total acres of rangeland within the context of physiographic regions.
  - Move to Criterion 2: Ecological Health and Diversity. (Recommend that it be combined with #'s 9 & 10)
- Old indicator: #4 Acres of invasive and noxious plants.
  - Move to Criterion 2: Ecological Health and Diversity. Recommend that it be combined with #14. However, we think that an area measure is needed as well as the proposed point cover data. Most states inventory weeds by county.
- Old indicator: #8 Capacity to provide recreation.
  - Use obligate wildlife species to provide an indirect measure; and/or give to Criterion #4 working group to consider the value of recreation; or drop.

**Soil and Water:** David Pyke

- Added a water and wind erosion indicator
- Coordinating with Health/Diversity on indicator using C/N (Area and % of soils with significantly diminished organic matter or high C/N)
- Framework completed on compaction, pesticide (checking with experts)
- Progress made on aggregate stability, soil organisms, bare ground
- Water based indicators need more work. Modifications made to aquifer indicator.

**Health and Diversity:** Linda Joyce

- Working with Soil and Water on C/N link
- Natural lake levels to be coordinated with Soil and Water group
- Fragmentation of rangeland based on Size of Parcel is to be dealt with by the Social and Economic group. Human use impacts will be dealt with by Health and Diversity group.
- Invasives overlap to be worked out with Productive Capacity group.

- Number and area of wetlands is a new indicator
- Indicators 14 and 15 were merged into: Population and Geographic Range of representative species monitored across their known geographic range
- Next tasks:
  - Review indicator text by June 14
  - Group review revisions by July 1
  - July 11 revised text

**Institutional Framework:** Stan Hamilton

- Had a complete document to review for this meeting, spent the meeting wordsmithing, but not a lot of changes were made from the RSF.
- Best management changed to application of stewardship principles.
- Each indicator has verifiers – measurements of what indicators are trying to show.

Between now and Billings: go back through draft of their “first approximation report” in accordance with work here. Flesh out with the 6-point framework. Will send completed work to Helen by end of next week.

**Briefing Report:** Tom Bartlett

The briefing this morning was a great success with presentations to Congressional Staffers, agency leadership and NGO representation, with about 45 people in attendance. The presentations went well and on time. SRR folks stayed an extra hour just responding to questions and meeting with the attendees.

**Delphi:** What should be done with Delphi between now and DC?

- Data sets
- Feedback for Steering Committee
- Input into scale question on 6-point framework

**Discussion on external reviewers – See Appendix D.**

**Discussion on identifying data sets – See Appendix E.**

**Revised 6-Point Evaluation of Indicators and discussion notes – See Appendix F.**

**Billings Draft Agenda – See Appendix G.**

## **Appendix A**

### **Washington D.C. Participants**

1. Al Abee, USDA-FS
2. Sam Albrecht, Society for Range Management
3. Tom Bartlett, Colorado State University
4. Hugh Barrett, BLM
5. Deen Boe, SRM\*
6. Mark Brunson, Utah State University
7. Larry Bryant, USDA-Forest Service
8. Larry Butler, USDA-NRCS
9. Sally Campbell, USDA-FS\*
10. Dennis Child, Colorado State University
11. Margaret Connelly, USDA-FS\*
12. Tom Davis, Bureau of Indian Affairs
13. Paul Dresler, USGS\*
14. AJ Dye, CSREES\*
15. Gary Evans, se4 consulting, inc.\*
16. Bill Fox, Texas A&M University
17. Paul Geissler, USGS
18. Ralph Giffen, USDA-FS\*
19. Andrew Gillespie, USDA-FS\*
20. Bill Haglan, USFWS
21. Stan Hamilton, National Association of State Foresters (NASF)
22. Aaron Harp, University of Idaho
23. H. Theodore Heintz, Jr., U.S. Department of the Interior
24. Rod Heitschmidt, USDA-ARS
25. Bob Hetzler, Bureau of Indian Affairs
26. Lori Hiding, Ecological Society of America
27. Phil Janik, USDA-FS
28. Leonard Jolley, SRM
29. Linda Joyce, USDA Forest Service, Rocky Mountain Research Station
30. Mike Sherm Karl, DOI-Bureau of Land Management
31. Keith Kuhlman, Western States Land Commissioners
32. Linda Langner, USDA-FS\*
33. Dick Loper, Wyoming State Grazing Board & National Public Lands Council
34. Daryl Lund, USDA-NRCS
35. Kristie Maczko, MATCOM for the USDA Forest Service
36. Mike Manfredo, Colorado State University
37. Dan McCollum, USDA-FS
38. John Mitchell, USDA Forest Service, Rocky Mountain Research Station
39. Ken Nelson, USDA-ERS
40. Duncan Patten, Montana State University
41. Janet Perry, USDA-Economic Research Service\*
42. David Pyke, USGS
43. Tom Roberts, DOI-Bureau of Land Management



44. Lou Romero, DeLaPorte and Associates
45. Helen Rowe, Colorado State University
46. John Tanaka, Eastern Oregon Agricultural Research Center
47. Doug Tedrick, Bureau of Indian Affairs
48. Allen Torell, New Mexico State University
49. Paul Tueller, University of Nevada
50. Robert Washington-Allen, Oak Ridge National Laboratory

\*Attended introductory session only.

## **Appendix B Talk Summaries**

### **Importance and potential benefits of Sustainability Indicators – Ted Heintz, DOI**

We like to believe that the better information we feed decision makers, the better decisions they will make. Unfortunately, many factors in daily life and other pressures determine their decisions, not simply the facts. Policy makers will argue about what actions will and will not promote sustainability. We need to be able to measure the impacts of these decisions within a feedback loop.

In order for these measures to be used, there needs to be wide support that the measures are appropriate to assess sustainability. “We are more likely to become what we can agree to measure—we need to measure what we agree to become”. If we can agree on indicators of sustainability, then we build common understanding.

In 1993, we embarked on developing the Sustainable Development Indicators, a national report that would organize existing governmental data into a body that could be used to assess national sustainability. This effort drew upon the work done on the Montreal Criteria. The concept of endowments substituted for maintaining capacity. Endowments were felt to be easily understood as the resources to be preserved. For future generations to be at least as well off as the present, the key is sustaining endowments. Underlying capacities must be maintained and must be increased if we are to grow. These capacities are closely linked to the capacities of systems, i.e. the capacity of rangeland to serve people’s wants and needs.

There is a common desire to boil down sustainability into one measure, one indicator. It is impossible to capture the complexity of sustainability into just one indicator. Through indicator sets, we can organize information in such a way that promotes ongoing conversations in relevant policy arenas.

### **Sustainability Research for Rangelands - John Mitchell**

Until two decades ago, perceptions of rangeland sustainability focused upon range condition in relation to livestock grazing. In recent years, the Forest Service and other organizations have started considering sustainability in terms of ecological, economic, and social measures at multiple scales. When trying to incorporate multiple scales in relation to indicators of sustainability, it is important to understand hierarchy theory. Three important scale-dependent attributes of data are grain, extent, and frequency behavior. Tradeoffs among these attributes explain, in part, why it is unfeasible to aggregate site-specific data to a national level.

A number of research forums and reports concerning the sustainable management of rangelands have been published during the past decade. The Ecological Society of America’s Sustainable Biosphere Initiative called for increases in basic research on sustainability of ecological systems to help improve the management of natural resources. Two broad scale research items in the SBI are effects of changing land use patterns on ecological processes and feedbacks between ecosystem and atmospheric processes. At least two forums on interrelations between

environmental quality and economic growth have been published. They emphasize the need to study linkages among physical, biological and socio-economic systems. The Society for Range Management outlined sustainability research goals for the next century in a 1995 report calling for more work on livestock management systems, enhancing riparian systems, providing for wildlife habitat, and understanding goals of society. Lastly, scientists at the Rocky Mountain Research Station have published evaluations of the 7 criteria and 67 indicators for sustainable development of temperate and boreal forests. Many of these indicators are also important measures of rangeland sustainability. Rangeland C&I fit within the larger R&D framework for monitoring rangelands by facilitating advances in national monitoring systems, thus promoting a feedback mechanism between monitoring and assessments.

As a final point, a forum on science and technology for sustainability has been proposed. The forum believes sustainability science to be an emerging discipline with a goal of understanding the nature of interactions between nature (ecology) and society (social and economic factors). See <http://sustsci.harvard.edu/>.

### **SRR Process, Leadership, Funding, Logistics, Timeline and Expected Product/Report - Tom Bartlett**

The Sustainable Rangelands Roundtable (SRR) is meant to be an open, positive, future focused, dynamic process that values and respects all opinions and contributions of members. Our purpose is to identify indicators for sustainable rangelands. We will publish a report on US Sustainable Rangelands in 2003. SRR gains from links with other indicator efforts, such as the Heinz Report, RSF, SMR, and others.

The Roundtable general agenda begins with an introductory session. The agenda of these meetings is meant to be flexible to fit the needs and dynamics of the group process. At the end of day two, we assess our progress, determine the topics for Delphi process, and agree on a tentative agenda for the next meeting.

SRR team:      Co-Chairs: Tom Bartlett and John Mitchell  
                    Facilitator: Lou Romero, de LaPorte & Associates, Inc.  
                    Kristie Maczko: Hotel arrangements, notes, and communications  
                    Helen Rowe: Delphi process, web page, communications, travel reimbursements  
                    Al Abee, Larry Bryant, Alison Hill, and Mike Manfredo: Idea staff and coordination

In addition to the staff, SRR has a Steering Committee and various working groups.

Time line: we hope to be done by 2003 (nine meetings - four in 2001, five in 2002). The main support is the attendance of participants. USDA-FS and CSU are matching funds; the Bureau of Land Management and USGS provide additional funding. Additional partners are needed.

## **Development and Evolution of the Criteria and Indicators – Linda Joyce**

To date, the Sustainable Rangeland Roundtable has developed 5 criteria that represent categories of conditions or processes by which sustainable management can be assessed these are:

1. Maintenance of Productive Capacity on Rangeland Ecosystems
2. Maintenance of Ecological Health and Diversity of Rangelands
3. Conservation and Maintenance of Soil and Water Resources
4. Maintenance and Enhancement of Multiple Economic and Social Benefits to Current and Future Generations
5. Legal, Institutional, and Economic Framework for Rangeland Conservation and Sustainable Management

These general criteria are characterized by a set of 115 indicators that can be monitored in space and over time. The indicators associated with each criterion are quantitative or qualitative variables that can be measured or described and which when observed periodically demonstrate trends in rangeland sustainability. These criteria and indicators will continue to evolve as the SRR advances towards an accepted set for monitoring and assessing rangeland sustainability.

Criterion Maintenance of Productive Capacity on Rangeland Ecosystems encompasses indicators that assess the capacity to provide the current and future generation with a wide variety of goods and services that will vary by society's desires at any particular time. The criterion Maintenance of Ecological Health and Diversity of Rangelands captures indicators on rangeland health where health is defined as the degree to which the integrity of the soil and the ecological processes of rangeland ecosystems are sustained. Indicators of diversity capture the dynamics of landscapes, communities, and species. The criterion Conservation and Maintenance of Soil and Water Resources encompasses indicators that describe rangeland with significant erosion, compaction, changed aggregate stability, bare ground, loss of organic matter, soil organisms diversity, and pesticide application. This criterion also captures indicators that describe water bodies with altered variation in biodiversity and biochemistry, changes in groundwater, area of wetlands, stream channel geometry changes and changes in intermittent streams. Both social and economic indicators describe the criterion Maintenance and Enhancement of Multiple Economic and Social Benefits to Current and Future Generations. In addition to the numerous social measures such as population, income, education, etc. that are available, five indicators are proposed to assess the impacts of rangeland condition and use on the social systems of rangeland-dependent communities. Economic indicators complement social measures by assessing changes resulting from adjustments in social, ecological, legal, and political systems. The last criterion Legal, Institutional, and Economic Framework for Rangeland Conservation and Sustainable Management includes indicators that assess the support for sustainability through these frameworks, such as property rights, public involvement in policy, and investment and taxation policies. Additionally indicators are included that capture the capacity to monitor change in sustainable management and the capacity in research and development aimed at improving management and delivery of goods and services.

## **Future Plans and Milestones – Rod Heitschmidt**

Short-term Goals & Objectives

- Complete development of criteria and indicators
- Expand interactive outreach activities

### Long-term Goals & Objectives

- Encourage broad based adoption of C & I by local, state, regional and federal rangeland management agencies and non-government organizations.
- Foster implementation of C & I by adopting agencies and organizations.

### Value of Effective Implementation in Developing Management Policies and Strategies

- Provides a suite of common indicators for assessing and monitoring a multi-use suite of sustainable rangeland management policies and strategies.
- Offers opportunity to improve management efficiencies as they relate to ecological, economic, and social factors.
- Provides framework for development of coordinated, multi-use, multi-level management strategies, and improved accountability.
- Provides a golden opportunity to improve our understandings of the interaction effects of ecology, economics, and social factors as they relate to the sustainability of rangeland ecosystems.

### **Temporal Framework for Monitoring Rangeland Sustainability: A Discussion: Robert A. Washington-Allen**

Many Questions are being asked between and within our groups concerning:

- What is monitoring?
- What is condition?
- What is trend?
- What is a standard or reference?
- When do you begin monitoring?
- How long do you monitor?
- How do you relate indicators?
- What about causality?

The objectives of monitoring are to:

1. Detect change in the extent and distribution of indicators.
2. Assess condition and trend.
3. Suggest causality
4. Assess the risk of future crises.

Challenges to monitoring:

- Landscapes are middle-number systems. In small number systems each component can be modeled separately and all possible interactions can be considered. In large number systems the individual components have similar behaviors, e.g., gases, thus statistical parameters such as Avogadro's number or the mean can describe and predict outcomes. However, in middle number systems it may be possible to set up experiments where all possible interactions are controlled and established predictions can be made about one or two of the variables, but allow all the variables to vary and the system becomes unpredictable (O'Neill et al. 1986). For example we know a lot about net primary productivity, but farming is still a high-risk venture (O'Neill et al. 1994).
- When indicators are re-measured some values will have changed:

- Does the change indicate a trend or normal fluctuations, i.e., what is the historical variation and relative to a standard or reference what is a significant change?
- Reliable evidence of trends requires monitoring over long periods. For rangelands, current literature suggests 15 to 20 years if you wish to capture periodic climatic events (e.g., ENSO, La Nina, and PDO) or fire return intervals.

**A General Spatio-Temporal framework** shows the relationship of biotic processes to environmental disturbance regimes, to vegetation patterns.

Illustration of Ecological Statics and Dynamics (Turner et al. 2001)

Graetz (1987) adapted this framework for rangelands. From this perspective the paradigm suggests the scales at which phenomena will act, provides an investigator with the constraints on experimental design, and suggests the tools required to detect phenomena of interest.

### **Definitions:**

**Grain and Extent:** A principle of Ecosystem science and Landscape Ecology is that before any ecosystem or landscape can be studied it must be bounded in space and time. Grain and Extent must be explicitly stated. Grain constrains the spatial and temporal scale of observation. The coarsest resolution defines the studies grain.

Example of grain: the resolution of remote sensing satellite platforms including the pixel-resolution of Ikonos, SPOT, Landsat Thematic Mapper (TM), The Indian Resource Satellite (IRS), and Landsat Multispectral Scanner (MS). Temporal grain can be considered in terms of the smallest sampling frequency required to detect a phenomena. For example, McLaughlin and (1995) found that hourly timesteps were required to show that short term changes in ozone levels had long term effects on the health of forests.

**Condition and Trend:**

- **Condition:** A one-time measure of change in an indicator relative to a standard.
- **Trend:** A temporal measure of change in an indicator. The magnitude of a trend can be measured using a significant regression coefficient of the indicator versus time.

**Standard:** The reference that provides the basis for comparison that allows determination of a significant change. Reference conditions can be subjective or objective: the average (mean, mode, or median), maximum, or minimum conditions.

### **Ways to Monitor:**

- **Experimental:** Laboratory, Lab-Field, Field
- **Adaptive resource management:** turning management interventions into guided treatments in an experimental design.
- **Retrospective Studies:** Opportunistic, but usually lack controls and replications. Studies of longer temporal scales depend upon conditions that may no longer exist, i.e., suffer from lack of analogues for contemporary comparisons.
- **Computer Simulations**

Note: Regional scale studies usually lack controls and replication and are consequently not amenable to traditional statistical designs. However, the systematic determination of a statistically significant trend (or an ecologically significant trend) may take years to determine (O'Neil et al. 1994).

For each of these ways of monitoring the levels of control differ.

### **Analytics:**

Time series analyses set the analytical domain for trend data. This includes:

- Data transformations for example:
- Log
- Moving average
- Differencing

Analytics for example:

- Autocorrelation
- Autoregression
- Non-linear time series
- Spectral/Fourier
- Cross correlation
- Intervention

### **Hypotheses of metric response to disturbances through time**

Model of contagion and growth-form composition response to high drought frequency and intense grazing pressure in a 200-year simulation by Li and Reynolds (1998).

### **How do these metrics relate to each other and through time?**

To determine how metrics relate to each other:

1. Determine initial conditions for each metric,
2. Determine the region of temporal overlap .The temporal overlap is the region of comparison.
3. The methods of comparison will involve multivariate analysis that includes a data reduction or ordination method to decorrelate metrics and then a clustering procedure.

### **Monitoring**

Examples of temporal analyses from the 88,800 ha Deseret Land & Livestock Ranch in northeastern Utah:

- The dry season soil-adjusted vegetation index (SAVI) statistical phase portrait for the sagebrush steppe portion of Deseret Land & Livestock Company ranch from 1972 to 1997.
- The dry season time series of soil-adjusted vegetation index (SAVI) images of the sagebrush steppe portion of Deseret Land & Livestock Company ranch from 1972 to 1997.
- Spatial hypothesis of temporal change in landscape pattern and structure in relation to climate change, grazing, and fire. The spatial map was adapted from West and Young (2000).

- The growth form and land cover (bare ground) time series of thematic maps of the sagebrush steppe dominated portion of Deseret Land & Livestock Co. Ranch. The maps were derived from dry season Landsat MSS and TM satellite imagery from 1972 to 1997.

### Monitoring and Causality

Monitoring can suggest, but it can seldom demonstrate causality. Monitoring can only hope to show correlations.

Examples relating monitoring data to inferred impacts:

- The seasonal wet and dry soil-adjusted vegetation index (SAVI) time series for the sagebrush steppe portion of Deseret Land & Livestock Company ranch from 1972 to 1998. The 3 management regimes and the best fit for each regime and the entire time series are curvilinear regression line are delineated. Missing years were replaced by linear interpolation.
- Mean interannual Palmer Drought Severity Index (PDSI) from 1895 to 1996 for the Northern Mountains Climatic Region 5. PDSI values from -4 or less indicate extreme drought and from 4 or greater extreme wet periods (Alley 1984). These data were acquired from the Utah Climate Center.
- The apparent spatial distribution of livestock from 1980 to 1997 at the paddock-level on Deseret Land & Livestock Company Ranch.
- Drought in the last 2000 years (Hughes and Graumlich 1996, Laird et al. 1996)
- [http://www.ngdc.noaa.gov/paleo/drought/drght\\_2000years.html](http://www.ngdc.noaa.gov/paleo/drought/drght_2000years.html)
- Fires (yellow polygons) detected on the Deseret Land & Livestock Company Ranch from 1992 to 1996 using Landsat Multispectral Scanner and Thematic Mapper (TM) satellite imagery. A 1994 Indian Resource Satellite (IRS) scene, which has been merged to a false-color TM scene, and a polygon coverage of the grazing paddocks serve as the backdrop.
- Retrospective inference of the relationship of landscape-scale metrics with extent and perimeter of fire on the eastern portion of Deseret Land & Livestock Co. Ranch from 1972 to 1997 using linear regression. For the relationship of fire perimeter with landscape-scale metrics, only the significant correlation of with contagion ( $p \leq 0.10$ ) is shown.
- The time series of seasonal soil-adjusted vegetation index (SAVI) from 1972 to 1998 (line plot) in relation to the time series of animal units (combined sheep and cattle, bar chart) from 1891 to 1998.
- A comparison between the 1972 to 1997 time series of the seasonal month of image acquisition Palmer Drought Severity Index (PDSI), the 5-year moving average of PDSI, and the seasonal soil-adjusted vegetation index (SAVI) of the Rich County-sagebrush steppe portion of Deseret Land & Livestock Company ranch.

**Vostok Ice Core:** The Vostok temperature record indicates that the earth has been colder than present for most of the past 250,000 years, including many [ice ages](#) (Jouzel et al. in press).

This implies that the warm conditions that we are studying today are unique and thus initial baselines are only relevant to this period, i.e., there are no analogous conditions in the past.



Finally, consider Robert Frost's planning horizon in his poem "Fire and Ice".

### **Literature Cited**

Graetz, R.D. 1987. Satellite remote sensing of Australian rangelands. *Remote Sens. Environ.* 23:313-331.

Hosten, P.E. 1995. Assessing the relative utility of models of vegetation dynamics for the management of sagebrush steppe rangelands. PhD. Thesis. Utah State Univ., Logan, USA.

Hughes, M. K. and L. J. Graumlich. 1996. Climatic variations and forcing mechanisms of the last 2000 years. Volume 141. Multi-millennial dendroclimatic studies from the western United States. NATO ASI Series, pp. 109-124.

Jouzel, J., C. Waelbroeck, B. Malaiz, M. Bender, J. R. Petit, N. I. Barkov, J.M. Barnola, T. King, V. M. Kotlyakov, V. Lipenkov, C. Lorius, D. Raynaud, C.Ritz and T. Sowers. In press. Climatic interpretation of the recently extended Vostok ice records, *Clim. Dynamics*

Laird, K. R., S. C. Fritz, K. A. Maasch, and B. F. Cumming. 1996. Greater drought intensity and frequency before A.D. 1200 in the Northern Great Plains, U.S.A. *Nature* 384:552-554.

Li, H. and J.F. Reynolds. 1998. Modeling effects of spatial pattern, drought, and grazing on rates of rangeland degradation: A combined Markov and cellular automaton approach, p. 211-230. *In*: D.A. Quattrochi and M.F. Goodchild (eds.), *Scale in remote sensing and GIS*. CRC Press, Lewis Publishers, Boca Raton, La.

Mclaughlin, S. and D.J. Downing. 1995. Interactive effects of ambient ozone and climate measured on growth of mature forest trees. *Nature* 374:252-254.

O'Neill, R.V., C. Hunsaker, and D. Levine. 1994. Monitoring challenges and innovative ideas. *Proc. Int. Sym. Ecological Indicators*.

## Appendix C Discussion on Baseline

### **Ecological Health/Soil Water Group**

- Third option: start with earliest acceptable, compatible data. Earlier data may be included with qualifications. As technology changes in the future, data may change as well. (As long as all differences in reporting methods are well documented, data may be included.)

### **Socioeconomic**

- Go back to the earliest possible data, but should be careful to point out differences in data collecting methods.

### **Institutional/Productive Capacity**

- Same as above.

### **General discussion:**

- Recommending future protocols that have some foundation in prior data. For each indicator
- Across indicators there may be situations in which cross comparison may be important. But we shouldn't force that on all indicators.
- Implementation issues. Be practical with limited resources.

**Consensus: Start with earliest acceptable, compatible data. Earlier data may be included with qualifications. As technology changes in the future, data may change as well. (As long as all differences in reporting methods are well documented, data may be included.) May 30, 2002.**

## Reporting methods

### **Productive capacity/institutional**

- So many ways we can report data, but that would result in chaos. Important to consider readers/common denominator.
- Report on what makes most sense for the indicator, but have common overlay of political boundaries to have a form most useable for political reporting.

### **Ecological health/soil and water**

- Collect data to allow statistically reliable reporting for ecological units as well as portions of the ecological unit within a geo-political entity, which may mean scaling up or scaling down.

### **Socioeconomic**

- Use any method, but separate by states. Use sampling within states helps understand changes.

**Consensus: Use the most statistically reliable, appropriate data reporting method for each indicator; have common overlay of political boundaries (by state) for reporting purposes. May 30, 2002**

## **Appendix D**

### **Preparation for external review**

- What do we want review to do?
- What should the review process be?
- Who should be the reviewers?
  
- What do we want completed before we do the review?
  - The Criteria as a set.
  - Philosophy of what the indicators cover?
  - Indicators with metrics.
  
- We will not have multiple reviews in the next year through the C&I and what we know about the data sets. To begin Jan/Feb 2003.
  
- ESA is a technical type of review from ecologists. In January stakeholders and the intended audience for the report will review our work.
  
- Question to ask reviewers: Is this understandable, can it be applied?
  
- The Heintz report began with internal agreement and then went out as a draft report to the general public with science background. It took about 3-4 months to incorporate all reviews within the group and give a response. Each workgroup coordinated its own review with Robin O'Malley.
  
- Did the Heintz Report use the web for review?? (Don't know)
  
- Want reviews before we send to journal. As a book or report we would need to find sufficient external review.
  
- At the ESA meeting, we will present to ecologists perhaps unfamiliar with rangelands. For other groups- will have SRM, are there other outlets?
  
- International Association for Society and Natural Resource Management is a new professional group that might provide a review.
  
- Heintz Report in two parts: Write up – why chosen, what means; and Technical – describe with maps, how maps were created.
  
- For a review we need to be ready with an almost final product that we are comfortable with. Internal review is the first step before external review. But it also must happen in time to be able to include the reviewers' comments in the 2003 report.
  
- Each active SRR participant should chose one trusted reviewer to send instructions with the full list of indicators. Do you think the C&I that we have proposed set the stage for assessment of sustainability? They could also be referred to the RSF for more information.

## **Appendix E**

### **Data Sets Discussion**

Question: How do we wish to proceed with collecting data sets?

As criterion groups write text, they should have a sense of what data sets exist. Recommendations could therefore be included for known data sets or protocols may be suggested if there is no data.

What format will be used to present the data? Use 6-point framework. How many years of data are available? Should identify grain and extent and quantitative and qualitative information about the data set.

Ultimate goal for this group is to have a report to propose the indicators and a potential matrix to use. Want to work on this phase first, rather than delving into data sets.

The timeline says data sets will be identified starting in March 2002. Indicator list will be frozen in two meetings. Start thinking about data sets now.

Evaluate indicators according to feasibility. Can add in summary information of data sets.

Question of how much information are we going for on the data sets. Is it repeatable? How much exists.

We need to point out problems with data sets that exist.

Don't want to drive whether we keep or reject data sets.

Websites have warehouses of data sets. [Sagemap.wr.usgs.gov](http://Sagemap.wr.usgs.gov) for socioeconomic group

We have done some work through the Delphi on this subject. Further discussions will combine those results with this discussion.

**Appendix F**  
**EVALUATION FRAMEWORK OF INDICATORS**

1. WHAT IS THE INDICATOR (descriptive title)?
2. WHAT DOES IT MEASURE, AND WHY IS IT IMPORTANT TO SUSTAINABILITY?
3. IS THE INDICATOR MEANINGFUL AT DIFFERENT PHYSIOGRAPHIC REGIONS?
4. CAN THE INDICATOR BE ADEQUATELY MONITORED WITH EXISTING OR OBTAINABLE DATA AND OR MODELS?
  - ARE MEASURES OF THE INDICATOR REPEATABLE, RELIABLE, AND ACCURATE?
  - CAN INDICATORS USING NOMINAL AND ORDINAL MEASUREMENT SCALES BE ADEQUATELY REPORTED OVER TIME?
  - IF ONE OR MORE OF THE ABOVE IS NOT TRUE, IS THE INDICATOR SUFFICIENTLY IMPORTANT TO MAINTAIN WITHOUT AN ADEQUATE MONITORING FRAMEWORK IN PLACE?
5. IS THE INDICATOR SENSITIVE OVER TIME FRAMES COMMENSURATE WITH ITS SCALE? ARE THE GRAIN AND EXTENT, BOTH SPATIALLY AND TEMPORALLY, OF SUPPORTING DATA KNOWN? IF SO, ARE THEY APPROPRIATE FOR THE SCALE OF THE INDICATOR?
6. IS THE INDICATOR UNDERSTOOD AND ACCEPTED BY THE GENERAL PUBLIC?

Issues raised by the roundtable:

- What is scale?
- Who is the general public?
- Do we want to include “sensitive over time frames”? Is this a separate issue from the rest of #5?

**Appendix G**  
Sustainable Rangelands Roundtable  
Preliminary Draft Agenda  
Billings, Montana  
July 30 – 31, 2002

**Objectives:**

1. Criterion Groups review indicators and completed 6-Point Framework
2. Develop framework for evaluation of data sets and data sources; consider RSF ‘killer matrix’ as part of this process.

**Special Sessions:** 8:00 – 10:15 am

1. Continued Individual and/or Joint Work Between Criterion Working Groups TBD
2. Continued Individual and/or Joint Work Between Criterion Working Groups TBD
3. Continued Individual and/or Joint Work Between Criterion Working Groups TBD

**General Session:** 8:00 – 9:45 am

SRR Overview for New Participants

- Welcome Remarks – **Tom Bartlett, Roundtable Host/Convener**
- Participant self-introductions – **led by Lou Romero**
- Importance and Potential Benefits of Sustainability Indicators – **Ted Heintz**
- Sustainability Research for Rangelands – **John Mitchell**
- SRR Process and Purpose – **Tom Bartlett**
- SRR Criteria and Indicator Overview – **Linda Joyce**
- Questions and Comments

9:45 am **Break**

10:15 am Brief Self-Introductions for Special Session Participants (see above)

10:25 am Report on Delphi Results – **Helen Rowe**

10:40 am Steering Committee Task Overview – **Tom Bartlett**

11:00 am Status of Criterion Groups by Group Leaders

11:45 pm **Lunch**

1:00 pm Small Groups Review Indicators and Completed Framework (*includes break*)

4:00 pm Discuss development of framework for data set/source evaluation

4:30 pm **Adjourn Day 1**

5:00 pm Tour of Beartooth Pass and Sunlight Basin with Dinner in Red Lodge

**July 31, 2002**

8:00 am Scale Working Group Report and Discussion

8:30 am Coordination Working Group Report and Discussion

9:00 am Criterion Groups create draft data evaluation frameworks

10:00 am **Break**

10:30 am Present, discuss and integrate draft data evaluation frameworks – **led by Lou Romero**

12:00 pm **Lunch**

1:15 pm Activity Reports:

Outreach and Definitions Working Group Reports

Salt Lake City Roundtable Network Meeting – **Tom Bartlett**

Salt Lake City Legal and Institutional Framework Interaction Session – **Stan Hamilton**

Panel Discussion at NCBA Summer Meeting – **Sam Albrecht**

2:00 pm Criterion Groups develop schedules for work to be accomplished between July 2002 and March 2003 (*includes afternoon break*)

4:00 pm Report Out by Criterion Group Leaders

4:30 pm Next Steps

5:00 pm Adjourn