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The use of criteria and indicator monitoring of ecosystem sustainability to assess ecosystem services on grasslands/rangelands

R. Dennis Child, Janette Kaiser, and Ralph Crawford

Introduction Ecosystem services are benefits people obtain from ecosystems. An international work program and the largest assessment of the world's ecosystems was launched by UN Secretary, General Kofi Annan, June 2001; completed March 2005. The Millennium Ecosystem Assessment (MA), as it was known, was prepared by over 1300 authors in 95 countries. The findings are contained in 15 reports. One of the main findings indicates that over 60 percent of the world's ecosystem services are in decline. Further, the report describes the critical link between ecosystem services and human well-being. The MA assessed 24 services and predicted their status; 15 of these were found to be declining. The MA highlighted that ecosystem services are natural assets for countries around the world, but without formal valuing mechanisms, they are not taken into account in measures of a country's economic progress or wealth.

Part of the problem is that these services are often considered to be "public goods" that are free and limitless. Lacking a formal market, these natural assets are traditionally absent from society's balance sheet; their critical contributions are often overlooked in public, corporate, and individual decision-making. There isn't an incentive to protect or conserve these public benefits. Recognizing rangeland ecosystems as natural assets with environmental, economic and social value can promote conservation and lead to more responsible decision-making on both public and private rangelands in the United States and the world.

Walter Reid, Institute for the Environment, Stanford University professor and the leader of the MA, identified four ways in which we might be able to prevent the degradation of ecosystem services: new business models, new technologies, new incentives and new markets. All of these changes result in changing human behavior. So what does this mean for public or federal rangelands in the US, and for rangelands around the globe?

Rangelands of the United States Rangelands, grasslands, improved grasslands and shrublands comprise approximately 70% of the earth's land surface including approximately 400 million hectares of the United States land base.

These lands are ecosystems which serve important ecological, cultural and economic roles that go well beyond the traditional "multiple uses" that usually come to mind. Healthy rangeland ecosystems provide a full suite of goods and services that are vital to human health and livelihoods, also known as ecosystem services. Many of these goods and services are traditionally viewed as free benefits to society, or public goods. These lands provide commodity, amenity, and spiritual values that are vital to the well-being of Nations, regions, and local areas. These goods and services include: food and fiber, forage for grazing animals, critical species and wildlife habitat, water storage and filtration, carbon sequestration to mitigate climate change, consumptive and non-consumptive recreation opportunities, erosion and pollution control, biofuels, cultural heritage and a way of life for grassland/rangeland dependent human communities, to name a few. Intact grassland ecosystems provide integral processes critical to functions such as pollination control, nutrient storage, climate moderation, primary productivity, and maintenance of genetic reservoirs and seed sources.

Even so, rangelands suffer from an identity crisis. A clear mental picture exists for forests, but for rangelands it's not so clear. Common characterizations of landscapes do not identify rangelands as a type of land, and often fragment rangelands into more recognizable descriptors such as forests, crop and agricultural lands which often omit those lands that are relatively undeveloped. This can be challenging, especially for management of federal rangelands. In fact, a national survey exists for all forested lands, as well as private agricultural lands. There is also a global effort to characterize forests and assess their sustainability to nations and the world which utilizes criteria and indicator monitoring protocol. Sadly, there is no national survey for rangelands in the US that includes federal rangelands, and there is no use of criteria and indicator monitoring for sustainability of rangeland resources on a global scale.

In the US, there is no data collected using the same methodology over time that allows for aggregation at the national level. That leaves interpretation to professional opinion and personal judgment. When rangelands are undervalued, as they currently are, they are increasingly susceptible to degradation, development pressures, and conversion. The highest value for rangelands in America today is development; and I suspect that is not untrue for other countries as well.

There is a need for increased recognition of the full range of ecosystem services, especially in light of increased consumption, increased demand for development, the continued need for spiritual and aesthetic values, and commitment to local community stability. The ability to identify, characterize and provide a value for these services can inform decision making and policy development on public and private rangelands.

Valuing ecosystem services on both public and private lands can make good stewardship profitable. In the US, the Forest

Service, along with other federal agencies, is exploring ways to value ecosystem services opportunities to advance markets and payments for ecosystem services on rangelands, and any application this concept may have to stimulate market-based conservation and stewardship for future sustainable use of rangeland renewable resources for current and future generations. In doing so, we can

- Provide new revenue streams for renewable resource industries
- promote conservation and sustainable land management
- support ecological restoration
- Increase appreciation and support of public lands.
- Better inform decision makers on the value and sustainable use of rangelands

Scientists predict that to stabilize carbon dioxide in the atmosphere, we need to reduce global emissions by 70 percent. Adopting certain agricultural and land management practices can reduce greenhouse gas emissions to the atmosphere and sequester additional carbon. Market based approaches to carbon sequestration, biomass utilization, and water quality exist. And other potential markets are in place or emerging. Market-based mechanisms include public payment or incentives; self-organized private payments, trading schemes, mitigation (mitigation banking; conservation banking) and investments and offsets. Market based approaches are part of the solution to the need to value and conserve important public benefits that rangeland landscapes provide.

The Sustainable Rangeland Roundtable (SRR)

There are 4 Sustainable Roundtables functioning within the US. They include:

- Sustainable Forest Roundtable
- Sustainable Rangeland Roundtable
- Sustainable Minerals Roundtable
- Sustainable Water Roundtable

The Sustainable Rangelands Roundtable is a grass-roots effort that has promoted social, ecological, and economic sustainability of U.S. rangelands. It urges associated resource assessments based upon periodic inventory and monitoring of SRR criteria and indicators. Criteria are explicit goals of sustainable management, but are too general to monitor directly. Each criterion is characterized by measurable indicators to demonstrate trends over time.

SRR's standardized monitoring and reporting framework provides a model for comprehensive national rangeland data collection. Consistent inventory and monitoring information may enable governments, agencies, and people on the land to more accurately assess effects of conservation programs, uses, and management actions which ultimately can inform decision makers on the sustainable use of rangelands. Better information can improve the delivery of effective, efficient land management actions, allocations, and conservation programs that advise and assist landowners. Comprehensive rangeland information consistently collected coast to coast and border to border, will benefit everyone. Potential outcomes include improved coordination and cooperation among agencies and organizations, improved use of scarce resources, and enhanced resource allocations for rangeland management and science. However, to be effective, SRR indicators must first be universally adopted and used to track trends in rangeland resources, economics and communities on a global scale to realize their full utility.

SRR's *First Approximation Report on Criteria and Indicators for Sustainable Rangelands* described a method for assessing rangeland sustainability and represents a milestone in collaborative development of significant rangeland metrics. While data currently is gathered for many of the indicators, it is not consistently collected, analyzed, and reported across organizations or efforts. This first approximation report offers a discussion of sustainable development in relation to rangelands and the SRR process. A subsequent Progress Report identifies 27 core indicators, and discusses data status and needs. Additional information about the Sustainable Rangelands Roundtable is available at <http://SustainableRangelands.cnr.colostate.edu>.

Core indicators

I. Conservation and maintenance of soil and water resources

Soil-based

- Area and percent of range-land soils with significantly diminished organic matter and/or high Carbon:Nitrogen (C:N) ratio.
- Area and percent of rangeland with a significant change in extent of bare ground.
- Area and percent of rangeland with accelerated soil erosion by water or wind.

Water-based

- Percent of water bodies in rangeland areas with significant changes in natural biotic assemblage composition.
- Percent of surface water on rangeland areas with significant deterioration of their chemical, physical, and biological

properties from acceptable levels .

- Changes in the frequency and duration of surface no flow periods in rangeland streams .

II . Maintenance and conservation of plant and animal resources on rangelands

- Rangeland area by plant community .
- Fragmentation of rangeland and rangeland plant communities .
- Extent and condition of riparian systems .
- Area of infestation and presence/absence of invasive and other non-native plant species of concern .
- Population status and geographic range of rangeland dependent species .

III . Maintenance of productive capacity on rangelands

- Rangeland aboveground phytomass .
- Number of domestic livestock on rangeland .

IV . Maintenance and Enhancement of Multiple Economic and Social Benefits to Current and Future Generations

- Value of forage harvested from rangeland by livestock .
- Rate of return on investment for range livestock enterprises .
- Number of conservation easements purchased .
- Index of social structure quality .
- Sources of income and level of dependence on livestock production for household income .
- Employment diversity .
- Value produced by agriculture and recreation industries as percent of total .
- Employment , unemployment , underemployment , and discouraged workers by industrial sector .
- Land tenure , land use , and ownership patterns by size classes .
- Population pyramid and population change .

V . Legal , institutional and economic framework for rangeland conservation and sustainable management

- Professional Education and Technical Assistance . Extent to which laws , regulations , and guidelines , institutions , and organizations provide for professional education and the distribution of technical information and financial .
- Land Management . Extent to which land management programs and practices support the conservation and sustainable management of rangelands .
- Measuring and Monitoring . Extent to which agencies , institutions and organizations devote resources to measuring and monitoring changes in the condition of rangelands .
- Research and Development . Nature and extent of research and development programs that affect the conservation and sustainable management of rangelands .

Sustainability-the SRR conceptual model for Ecological , Economic and Social Components Proposal for integrated Rangeland Sustainability Modeling

Integrated research and resource management offers rich opportunities for additional exploration and elucidation . The Sustainable Rangelands Roundtable (SRR) has developed a conceptual model showing information flows through the model's multiple tiers . Ecological systems and processes , including reproduction , growth , death , decomposition , succession , migration , adaptation , water cycles , nutrient cycles , carbon cycles , stage the biological interactions underlying forest and rangeland ecosystem viability . Social and economic infrastructures and processes , including demand , investment , depreciation , management , social regulation , production , consumption , social interaction , institutional processes , characterize rangeland use and management , as well as the context in which rangelands improve or decline . These systems and processes intertwine and feedback , altering natural and human capital and conditions over time . The Sustainable Rangelands Roundtable (SRR) has developed an integrated conceptual framework to capture complex relationships among ecological and natural resource processes , and intricate interactions with social and economic processes , capacities , and capitals .

Criteria and Indicator monitoring in the US (Pilot Project) The Forest Service , along with other federal agencies such as the Bureau of Land Management and the Natural Resource Conservation Service , informed by the Sustainable Rangelands Roundtable , have begun a prototype for a national survey of rangelands utilizing the SRR criteria and indicator model for assessing and monitoring sustainability of US rangelands . The Sustainable Rangeland Roundtable , a broad consortium of interests working at the grass roots level , has identified 5 criteria and 23 indicators applicable to monitor the ecological , social and economic sustainability of rangelands . Indicators are intended to provide measures of key variables that will inform and facilitate monitoring and periodic assessment of the condition and functioning of rangeland ecosystems over time . Because

human actions and influences can affect the extent and condition of rangelands, it is important to monitor human use of rangelands and the human influences on rangeland condition. Such uses and influences are, in turn, driven by underlying social and economic conditions and processes. Monitoring those driving conditions and processes will allow decision makers insight into how and why impacts on rangelands occur, and allow the possibility of proactive management to prevent or mitigate rangeland degradation or to enhance rangeland health and sustainability. It is also important to understand how changes in rangeland ecosystems affect the well being of communities that depend on them.

To date we have utilized several ecological and social economic indicators in a pilot project in Eastern Oregon in a proof of concept exercise and a prototype of future surveys. The pilot project is an important first step characterized by the following:

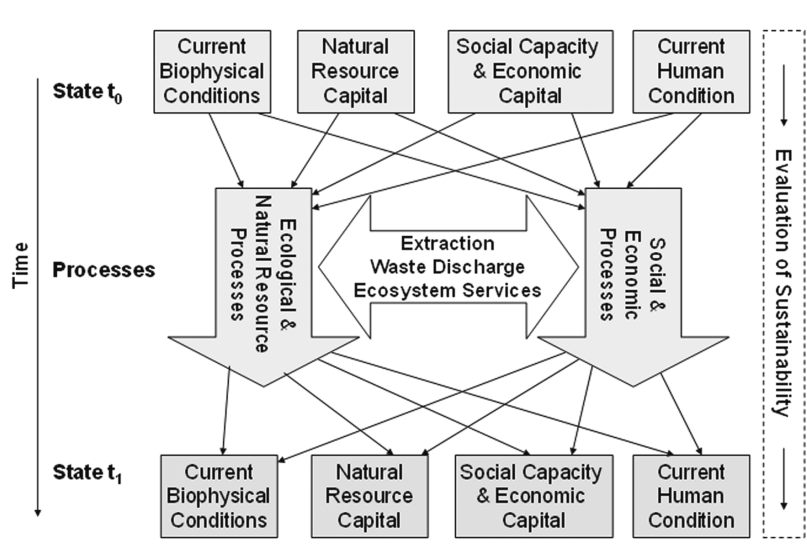


Figure 1 Tier 1 Rangeland Sustainability Evaluation Framework.

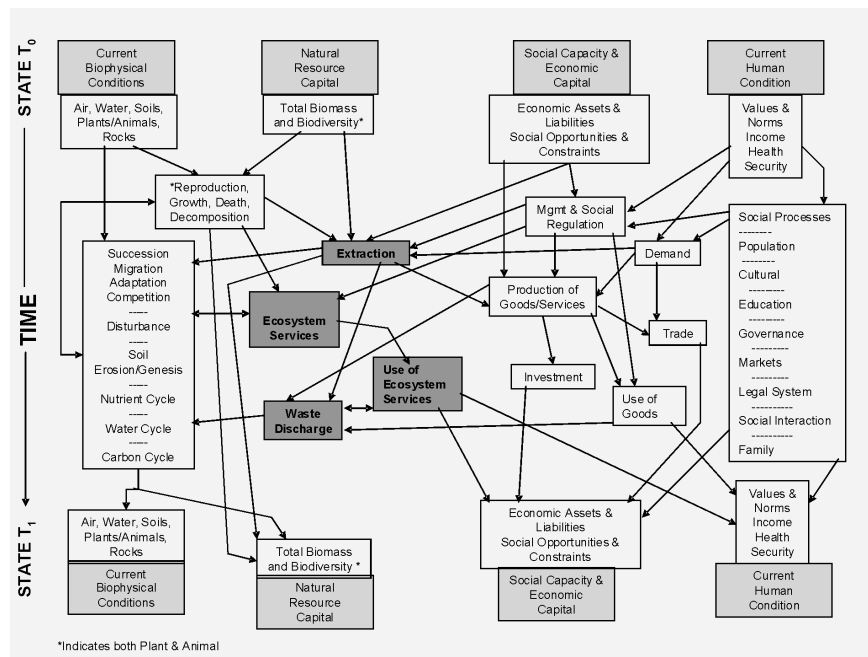


Figure 2 Tier 2 Framework-Rangeland Example.

Three federal agencies (FS, NRCS, and BLM) are collaborating to expand the FS FIA grid and the NRCS NRI grid into all rangelands utilizing criteria and indicator monitoring.

C&I from SRR informed the selection of 5 indicators: invasive spp.; bare ground; vegetation composition; change in use/condition; and fragmentation.

Simultaneously, a Land Grant University group is evaluating social and economic indicators from SRR in same area. If successful, the characterization of rangelands could be done on a national scale; providing the ability to monitor indicators of sustainability and change; putting science in a position with professional opinion and personal judgment.

Proposed Project We believe there is a critical need to establish C&I monitoring system at national and global scale. Our experience with SRR could provide a model to launch an international dialogue and the eventual development of C&I monitoring at the global scale. Some basic questions for consideration include: How to quantify, measure, and monitor ecosystem services; what is the responsiveness of indicators to track long-term changes in grassland ecosystem sustainability, and can we design a cooperative to compare the values of ecosystem services on grasslands across the globe?

This symposium, associated with the combined IRC/IGC, could lead to the adoption of a set of indicators that monitor grasslands on a global basis. This would be similar to the Montreal Protocol developed for temperate forests. It would provide a basis for stakeholder dialogue at local, regional, and national scales and expanded understanding of grassland resources and their contribution to social, economic, and ecological sustainability.

The development of international C&I monitoring would help answer some important questions about the appropriate use and potential success of sustainability monitoring linked to sustainable market based approaches in achieving our conservation goals. We anticipate that the set of key indicators of grassland ecosystem sustainability will be the same for similar grassland ecosystems in countries across the globe.

We propose a cooperative project to leverage support for grassland monitoring. Along with the modeling, assessment and valuation of indicators to determine trends in resource condition, management, and the economic and social values derived from grasslands and associated ecosystem services. What will come from the proposed project includes:

- An agreed upon framework for data collection and periodic standardized reporting to more clearly depict resource management performance and to minimize duplication in reporting standards.
- Common assessment capabilities at multiple scales among a wide range of users, permitting local, regional, and national comparisons, as well as use by the international community.
- Increased likelihood of obtaining complete coverage of key attributes to monitor due to the collaborative nature of this endeavor.
- Future research by agencies, universities, and organizations can be focused on developing methods to address data gaps and research needs associated with criteria and indicators to improve grassland management.
- Enhanced agency performance planning and prioritization of funding for at-risk grasslands and those associated with the land.
- Monitoring efforts directed to sites identified by indicators as being important.
- Identification and valuation of unique grassland goods and services for improved management and decision-making.

Conclusion Rangelands/grasslands are the largest single land type in the U.S. and on a global basis. Yet we don't have a common way to evaluate the sustainability of this important resource. We have the opportunity to change this. But, we will only find success when it is recognized that:

Social, Economic and Environmental indicators are all necessary to assess grassland sustainability.

- Ecosystem Services are central when linking environmental, social, and economic indicators.
- Common indicators exist for grassland sustainability at a global level.
- Indicators of grassland ecosystem sustainability will be responsive to long-term differences in natural resource capital, social capacity and economic capital.