Multistakeholder Development of State-and-Transition Models: A Case Study from Northwestern Colorado

Authors: Bruegger, Retta A., Fernandez-Gimenez, Maria E., Tipton, Crystal Y., Timmer, Jennifer M., and Aldridge, Cameron L.

Source: Rangelands, 38(6) : 336-341

Published By: Society for Range Management

URL: https://doi.org/10.1016/j.rala.2016.10.008

Case Study

Multistakeholder Development of State-and-Transition Models: A Case Study from Northwestern Colorado

By Retta A. Bruegger, Maria E. Fernandez-Gimenez, Crystal Y. Tipton, Jennifer M. Timmer, and Cameron L. Aldridge

On the Ground

- Engaging multiple stakeholders in building state-and-transition models (STMs) can increase the credibility and relevance they have to land managers.
- Land managers and land stewards may be more likely to use STMs that were developed in collaboration with a broad range of stakeholders.
- The quality of STMs is improved when they are repeatedly revised based on new knowledge from research, multiple interactions with local stakeholders, and ecological field data.

Keywords: collaborative research, state-and-transition models.

Rangelands 38(6):336–341
doi: 10.1016/j.rala.2016.10.008

There is often a gap when it comes to translating new scientific knowledge, products, and technologies into action. The implementation of state-and-transition models (STMs) as land management tools by ranchers is no exception. In a 2009 study, nearly 70% of surveyed ranchers did not know about STMs and only 2% used STMs in management.[1] One way to ensure that ranchers and land managers use STMs, and that STMs address the needs of ranchers and land managers, is to repeatedly engage these individuals and groups in building STMs.[2–4]

The Learning from the Land project began in 2013 with two objectives. We intended to build meaningful STMs that described ecological dynamics and included indicators for sage-grouse (***Centrocercus urophasianus***). We also piloted a STM building process that integrated multiple knowledge sources including data, research, and local and expert knowledge. Using a framework developed in previous studies,[5,6] we initiated a cycle of workshops, data collection, and analyses in several project areas to produce STMs over the course of 3 to 4 years (Fig. 1; Table 1). Participants in STM building included local ranchers, Extension agents, natural resource agency staff, and researchers. We expected that participation in STM development would lead to 1) stakeholders who are knowledgeable about STMs and likely to use them, and 2) STMs that are credible, robust, and user-friendly. Here we present a case study to illustrate how we engaged diverse experts in creating STMs. We then reflect on the challenges, benefits, and efficacy of the process in terms of awareness, credibility and application of STMs based on post-workshop surveys and team discussions.

When we started out, we wanted to know which ecological sites were most important to focus on and which were most relevant for land managers in each of the areas we worked in (we worked in 5 project areas. We feature work in one area in this article). To find out, we invited multiple stakeholders (Table 2) to a workshop at which they discussed and decided on priority ecological sites for STM development. We asked workshop participants to consider criteria such as the extent and continuity of ecological sites in their area and their importance for wildlife and grazing. We also asked what past work or research existed about these sites. We left this workshop with two priority ecological sites to focus on in the case study we present here; both dominated by Wyoming big sagebrush (***Artemisia tridentata*** subsp. ***wyomingensis***).

Developing Generalized STMs with Multiple Stakeholders

How can researchers tap into knowledge people have about landscapes? How can we use this knowledge to identify key unknowns and thus prioritize limited field sampling resources? Once participants selected focal ecological sites, we hosted another workshop locally (less than 1 hour from where

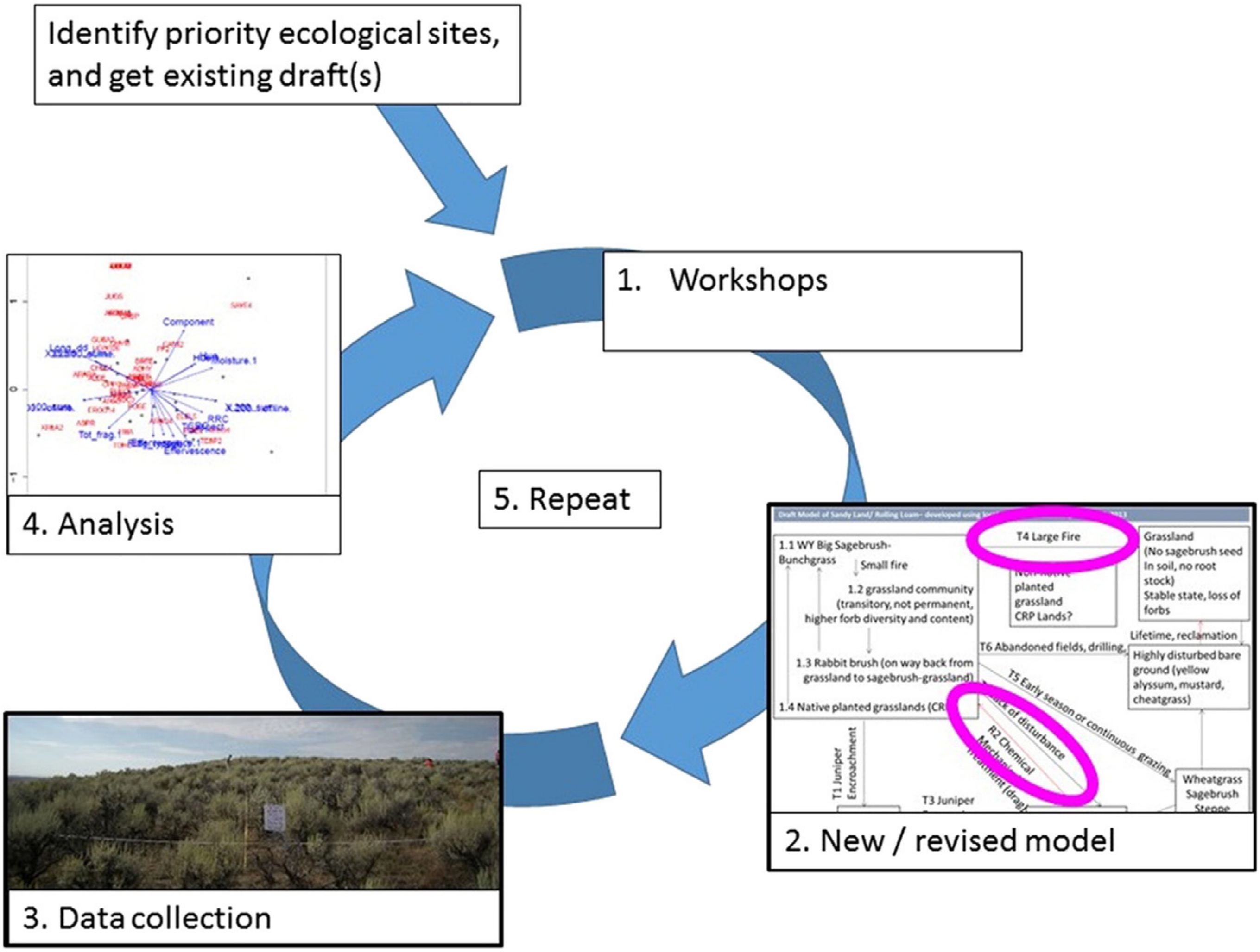

Figure 1. We used a repeated process for revising STMs over time in response to stakeholder input, literature, and data collection. This figure shows the cycles of engagement, followed by data collection, followed by subsequent workshops that we used in creating an STM. We have repeated this cycle three times, with three seasons of data collection and three (going on four) seasons of workshops.

most participants lived) in order to draft an initial STM from which future work would proceed. The attendees included representatives from groups listed in Table 2. In order to contextualize conversations about ecological dynamics on the focal ecological sites, we used STMs from nearby regions with potentially similar dynamics, or draft models based on research. The workshop followed a similar format as outlined by Knapp et al.[7] First, we presented STM concepts and terms. We then introduced draft models and broke into small groups to discuss each model (Table 3). Finally, we asked the whole

Table 1. Types and frequency of face-to-face interactions, workshops, and other outreach activities in building one STM in northwest Colorado, 2013-2016

Type of interaction	Number of events	Average no. of participants	Total no. of interactions
Field tour	6	4	24
Individual meeting	6	2	14
Interview with participant	4	2	8
Other local outreach presentation	4	23	90
STM workshop	5	17	85

Note. A final workshop is planned for December 2016.

Table 2. Examples of groups and individuals invited to and represented at workshops to build the STM in Northwest Colorado, 2013-2016

Organizations/individuals represented at workshops
Bird Conservancy of the Rockies
Bureau of Land Management
Colorado Parks and Wildlife
Conservation Colorado
County Natural Resources Representative
Colorado State University Extension
Colorado State University-based researchers
Natural Resources Conservation Service
Local ranchers
Retired agency staff
U.S. Forest Service

group to construct a single model with the help of a facilitator and based on the comments provided on the draft models (Fig. 2).

In the case study we present here, managing for sage-grouse and livestock were major concerns for local land managers. Two key questions emerged in the STM drafting process. First, participants thought that large wildfires created a disturbance cycle that would impact sage-grouse negatively due to slow post-fire recovery of sagebrush. Several wildfires had burned recently in the area. Some had been treated with seeding following the burn while others had not. Stakeholders were interested in the effects of wildfires with and without postfire seeding on vegetation and wildlife. They were also interested in the restoration potential of small-scale mechanical treatments on "depauperate" states. Participants had observed areas where, in the absence of disturbance, sagebrush became overgrown and "choked out" the grass and forb understory, creating a state that had low ecological value for livestock forage as well as sage-grouse brood-rearing habitat. They believed that small-scale mechanical treatments provided a short-term disturbance that would encourage greater forb and grass cover, but that would also be short lived (in contrast to recovery following wildfire). Based on this input, we allocated sampling resources to measure soil and vegetation characteristics in 1) areas that had been affected by large recent fires (both seeded and unseeded), and 2) past mechanical treatments on sagebrush. See Figure 2 for the STM drafted at this workshop.

Participants filled out surveys at the end of the workshop that asked "How confident are you in the accuracy of the final integrated STM developed at the workshop?", "What parts are you most/least confident about in the model?", and "What are some uncertainties that you think are the most important to address through data collection, experiments, local knowledge, etc.?" Facilitators documented the workshop using surveys, notes from small and large group discussions, and audio recordings.

Table 3. Examples of guiding questions used to elicit feedback on draft models

Example questions
Are there states you have observed that are not depicted in the draft model?
Are there communities that are not depicted in the draft model?
Have you observed all the states that are depicted in the model?
Have you seen the transitions that are in the draft model?
If yes, can you estimate how long these transitions take?
In your experience, do sites recover after experiencing a transition? How? And how long does recovery take?
Are there management actions or disturbances that influence states that are not in the draft model?

From Workshop to Testing and Refining

After deciding on key uncertainties and focal questions based on input at the workshop, we stratified sampling points by ecological site and treatment history. We used the Soil Survey Geographic Database[8] to stratify by ecological site. We gained information on the treatment history through various means. In some cases, this knowledge was available digitally; in some, we asked people to point to maps and indicate areas where treatments had occurred, and in other cases we visited ranches to document locations using a GPS. We collected and analyzed data over 3 years (2013-2015) in order to address the key uncertainties and revise the draft STM[9] (J. Timmer, 2016).

Midstream feedback from participants was essential to STM development. After each year of field data collection, we returned to the same group of participants in the project area to discuss preliminary findings before results were final and scientific conclusions drawn. At every workshop, we resummarized STM terms and concepts to reinforce learning from past workshops.

After the first year of data collection (2013), we did not yet have a final STM. We presented preliminary results from sampling on mechanically treated versus untreated areas and burned and seeded versus burned and not seeded areas. Though some researchers were initially uncomfortable presenting preliminary findings in this form, we discovered benefits to discussing "work in progress" with stakeholders. Stakeholders provided more in-depth information on landscape history that changed our interpretation of the data and informed subsequent sampling. For example, we sampled in an area that was reseeded after a wildfire in 2010. Within one burned area, we found patches of crested wheatgrass (***Agropyron cristatum***) monocultures. We assumed that

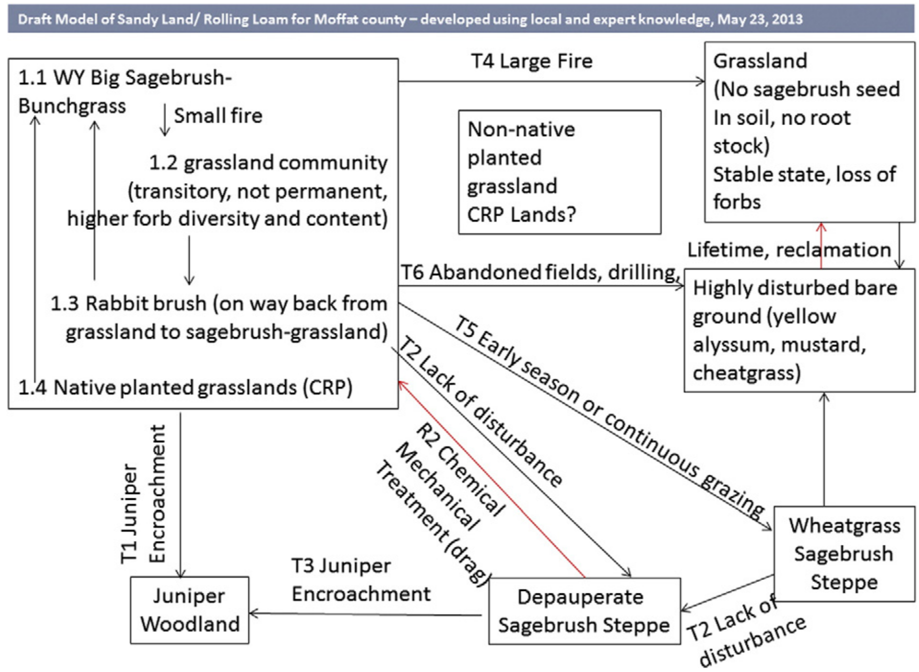

Figure 2. Draft STM made with group participation for the project area featured in this case study. Agreement and disagreement with the final draft model was assessed using an activity with multicolored dots signifying agree, disagree, and unsure. We asked participants to place these on the model components after drafting. We used uncertainties in this model to inform our research direction. Specifically, we investigated 1) recovery on burns following wildfire with seeded and non-seeded plots, and 2) grass, forb, and shrub cover following mechanical disturbance.

crested wheatgrass had been planted following the burn in 2010. When we presented this interpretation in the workshop, the landowner corrected us. The seed mix following the wildfire was comprised of native species. When we looked at a map of the area together, he identified old homesteads that were seeded in the 1950s with crested wheatgrass, which had persisted until 2013 despite the wildfire and subsequent seeding with native species. Without this opportunity to test our interpretations midstream, we would not have learned of our mistaken assumptions about landscape history. Repeated interactions between participants and researchers provide multiple chances to correct misunderstandings and refine interpretations before making conclusions.

We held two additional workshops in 2014 and 2015 to get feedback on data analyses and draft STMs, and are planning a final wrap-up meeting for December 2016. These workshops aimed to facilitate open dialog while providing structure to guide discussion and prompt thoughtful responses. One tool[10] we used was to ask participants to take a few minutes after presentations to write thoughts on notecards in response to questions such as 1) I observe that…, 2) I'm surprised by..., 3) I'm confused by…, 4) I would add…to this model, and 5) Something that is not in this model that I would expect to be is… We used small break-out groups to discuss their answers and the draft STM, followed by a report-out from each group. Quiet writing time in response to prompts gave participants the chance to gather their thoughts and helped stimulate more productive discussions. Additionally, some participants who have valuable comments may not be the most vocal, so this format provided multiple avenues for people to contribute to discussions, and ensured that everyone participated.

At the 2015 workshop, we asked participants to revisit the original draft model from 2013 (Fig. 2) and discuss some of the elements in the draft based on what they had seen on the land or learned since they drafted it. As one example, in the original workshop, participants said that cheatgrass (***Bromus tectorum***) was not a major concern in the area (or at least not ***the*** issue). Our field data, especially in 2014 and 2015, documented relatively high cheatgrass cover. We asked participants what they considered the current state of cheatgrass at a workshop after these data were presented. Many responded that they remembered thinking it was not an issue in 2013 but they have observed its increase in the past 3 years since the project began. An iterative process helped create a learning atmosphere where participants and researchers could revise their opinions over time in response to new information from field data, personal observations, or research articles.

As this project nears its conclusion, we reflect on its effectiveness in terms of the goals of collaboration and building reliable STMs. We expected that participation in STM development would lead to 1) stakeholders who are knowledgeable about STMs and likely to use them, and 2) STMs that are credible, robust, and user-friendly.

We have not yet measured if those who participated in the STM-building process are likely to apply the STM in decision-making. At minimum, they are aware of the STM developed and the STM concept. Further, the questions we addressed in the model (restoration potential of "depauperate" sites; recovery from wildfire and efficacy of seeding burned sites) came directly from concerns managers identified at the initial workshop. Despite a close relationship between information stakeholders wanted and the questions we addressed with field sampling, the STM produced[9] describes only the basic dynamics of the landscape. Rare states are not included, for example. We did not address many other stakeholder questions, such as how grazing and climate may interact to influence states. Thus, stakeholders' application of the model may be limited by the depth and complexity (or lack thereof) with which the STM currently describes landscape dynamics.

Challenges in a Collaborative Approach: Complexity, Participation, and Allocating Resources

Engaging participants in a STM building process presented challenges. When surveyed and asked "What are the challenges you've encountered in participating?" participants indicated that too few stakeholders were involved, and suggested that this might make the final STM biased. Attracting new participants proved difficult. Participants also wanted results faster than the research process allowed, and some found the project design confusing because there were many sites and multiple disciplines.

Some participants also commented that workshop presentations included too much statistical and scientific jargon. In response, the research team attended a workshop on science communication. Researchers also focused on explaining why they performed each statistical test and less on the method itself. Despite efforts to improve, learning to present technical information clearly and in compelling ways is an ongoing process that requires practice and feedback.

For the research team, it was difficult to address the number of questions that managers proposed with limited time and resources for sampling, and sometimes divergent priorities within the research team. At all iterations of the process, participants had more questions than the researchers could answer with statistical rigor given limited resources. One participant joked at the end of a workshop, "I think we need a psychologist to resolve some of these issues, not more data." Unanswered questions persist in part because of the reality that ecosystems and their processes are complex, and in part due to the quantity of questions raised thanks to engagement with multiple stakeholders. Even in a best-case scenario, building a STM is not simple. Deciding how to allocate limited resources will always be a challenge, as it is when addressing questions that are both meaningful to stakeholders and in a way that is scientifically sound.

Benefits of a Collaborative Process: Access, Credibility, and a Learning Orientation

A collaborative process also provided several benefits. First, it enabled researchers to learn about management and disturbance history that was otherwise inaccessible. We gained access to private lands, and worked with landowners to identify specific locations to sample, broadening the diversity of land and management history represented in the model.

Second, the collaborative process enhanced factors critical to successfully linking research and action, such as facilitating a learning orientation.[3,11] In a synthesis paper looking at successes in linking knowledge with action in agricultural research, Kristjanson et al.[11] recommend deliberately designing research projects to produce learning among all stakeholders. In other words, ***learning for all parties*** must be considered a product of the research process, in addition to STMs or research articles. When we asked, "What were the strengths of this workshop?" on evaluation forms, participants wrote they appreciated the range of perspectives present, the interaction between agency staff and landowners, the collaborative atmosphere, and the opportunity to learn from each other. Based on this feedback, it appears that Learning for the Land was successful at setting the stage for learning.

Third, a collaborative process helped establish credibility for the STM. For a person to act on new knowledge, they must consider that knowledge believable, trustworthy and accurate. In other words, they must consider the knowledge credible.[3] Survey results suggest that a least some of the stakeholders view the STM produced in this case study as credible. For example, in response to the survey question "What do you consider to be the benefits of this process?" one participant wrote, "(I'm) likely to implement management changes because (the) 'data' seems real." In response to "Do you believe the accuracy of the final STM?", another wrote, "I believe the data that was brought forward was accurate. We old timers were listened to." Credibility of a STM is important because stakeholders' direct experience of land is likely to be more compelling to them than an outside researcher's expertise[12] (and vice-versa—researchers may find scientific evidence more compelling than stakeholders' observations). Thus, if new knowledge conflicts with existing beliefs, whether it is grounded in personal experience or published research, it may be easy to reject that knowledge.

In this case study, there were instances in which participant hypotheses and ecological field data appeared to contradict each other. For example, analysis of field data did not reveal a "depauperate" sagebrush state, and mechanical treatments and untreated areas did not differ in understory cover 15 years after the treatments, contrary to stakeholder predictions (we did not assess what happened immediately after mechanical treatment). These unexpected findings illustrate the challenge of potentially conflicting knowledge. In Learning from the Land, however, repeated interactions and the resulting trust that developed gave researchers and participants the opportunity to engage with each other and new ideas, and to remain open to changing their beliefs based on new information. Learning from the Land demonstrates how multiple stakeholders can work in partnership with STM developers to create models that are locally relevant, scientifically sound, and credible to both researchers and local land managers.

Human Subject Exemption

This research was reviewed by the Colorado State University Institutional Review Board (IRB) protocol number 16-6986H.

Funding

This research was supported by a Conservation Innovation Grant from the Natural Resources Conservation Service, Agreement Number 69-3A75-12-213 ***Learning from the Land: Extending State-and-Transition Models for Adaptive Management of Wildlife Habitat on Western Rangelands*** and Colorado Agricultural Experiment Station project COL00698A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Natural Resources Conservation Service or the Colorado Agricultural Experiment Station.

Acknowledgments

We thank staff from the Bureau of Land Management, Colorado State University Extension, Natural Resources Conservation Service, State Land Board, and all participating ranchers who dedicated their knowledge, time, energy, and attention to this project. To all workshop attendees, without your participation, this project would not have been possible. Thank you to Kellie Clark for her editorial assistance.

References

1. Kelley, W.K. 2010. Rangeland managers' adoption of innovations, awareness of state and transition models, and management of bromus tectorum: A survey of ranchers and natural resource professionals in Wyoming and Colorado. Colorado State University [thesis] [290 p].
2. Berkes, F. 2009. Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. *J Environ Manag* 90:1692-1702.
3. McNie, E.C. 2007. Reconciling the supply of scientific information with user demands: an analysis of the problem and review of the literature. *Environ Sci Pol* 10:17-38.
4. Tanaka, J.A., K.A. Maczko, L. Hidinger, and C. Ellis. 2016. Usable science for sustainable rangelands: conclusions. *Rangelands* 38:90-95.
5. Kachergis, E.J., C.N. Knapp, M.E. Fernandez-Gimenez, J.P. Ritten, J.G. Pritchett, J. Parsons, W. Hibbs, and R. Roath. 2013. Tools for resilience management: multidisciplinary development of state-and-transition models for northwest Colorado. *Ecol Soc* 18.
6. Pritchett, J., E. Kachergis, J. Parsons, M. Fernandez-Gimenez, and J. Ritten. 2012. Home on a transitioning range: a ranch simulation game demonstrating STMs. *Rangelands* 34:53-59.
7. Knapp, C.N., M. Fernandez-Gimenez, E. Kachergis, and A. Rudeen. 2011. Using participatory workshops to integrate state-and-transition models Created with local knowledge and ecological data. *Rangel Ecol Manag* 64:158-170.
8. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available at: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. Accessed May 1, 2013.
9. Tipton, C.Y.W. 2015. Improving state-and-transition models for management of sagebrush steppe ecosystems. Colorado State University [thesis] [160 p].
10. Teacher Development Group, 2002. National Reform School Faculty, Harmony Education Center, Data Driven Dialogue. Available at: http://www.nsrfharmony.org/system/files/protocols/data_driven_dialogue_0.pdf. Accessed January 12, 2014.
11. Kristjanson, P., R.S. Reid, N. Dickson, W.C. Clark, D. Romney, R. Puskur, S. MacMillan, and D. Grace. 2009. Linking international agricultural research knowledge with action for sustainable development. *Proc Natl Acad Sci* 106:5047-5052.
12. Weber, J.R., and C. Schell Word. 2001. The communication process as evaluative context: what do nonscientists hear when scientists speak? *Bioscience* 51:487-495.