Collaborative Adaptive Management in Practice: 
Case Studies from Arizona and New Mexico

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ABSTRACT

Collaborative adaptive management (CAM) is a natural resource management approach in which 
a diverse group of stakeholders iteratively plan, implement, monitor, evaluate and adjust 
management actions to reduce uncertainty and improve decisions over time. In practice, few 
examples of successful CAM have been identified. This study examines three efforts in the 
southwestern United States: the Las Cienegas Adaptive Management Program and two projects 
in the Malpai Borderlands - Prescribed Fire Planning in the Peloncillo Mountains and the 
McKinney Flats Project. Three questions are addressed: 1) What does CAM look like in 
practice? 2) Are my cases actually examples of CAM? Why or why not? 3) If so, what enables 
CAM to happen in these efforts?

To be successful, CAM structures need to be able to withstand the length of time and dynamic 
nature of a CAM process. The three cases each demonstrate effective ways to design and 
implement many aspects of CAM, but, processes have faltered when key elements were absent. 
Specific tools, such as the use of a trained mediator and joint fact-finding, were introduced in the 
cases to address process deficiencies interfering with the group’s ability to collaborate or test 
management strategies. Factors such as effective long-term leadership, committed and 
enthusiastic participants, and strong organizational partnerships have also promoted the 
implementation of these programs. Recommendations for implementing a durable, flexible and 
wise CAM process are included.

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CHAPTER 1: INTRODUCTION

A hypothetical story

Imagine a group of ranchers, environmentalists, recreation enthusiasts, public agency scientists and land managers working together to manage a semiarid grassland ecosystem in southern Arizona. This group of people with multiple interests and perspectives negotiate with each other and build consensus regarding grassland management decisions. They may collectively decide, for instance, if, when and where to implement a prescribed fire. When the group feels like it needs more information, like the impact a fire will have on a specific plant species, they seek to find answers to their questions by integrating management decisions with science experiments. They might, for example, implement a few prescribed burns in a controlled and replicated fashion and collect data over the course of a decade on the impact the fires have on the species of interest. The group then incorporates this information into subsequent fire management plans and experiments.

The stories I am going to describe in this thesis are not very different from this hypothetical account. Groups of people with a broad range of interests have collaboratively tried to address natural resource management issues when it has been unclear about how to proceed, and they have made an effort to link scientifically-based hypothesis-testing with actual ecosystem management decisions. Natural resource managers and academics call the combination of such collective and experimental management processes collaborative adaptive management, or CAM.

CAM emerged as the product of two concepts coming together: adaptive management (AM) and collaborative decision-making. In this chapter I discuss 1) the development of AM, 2)
how and why collaborative decision-making became connected to this resource management approach, 3) my case-selection process, research questions and methodology, and 4) a road map of what you can expect in the rest of this document.

**What is adaptive management?**

For most of the 20th century, environmental management policies established a fixed set of actions designed for stable economic and environmental conditions (Holling 1978). Environmental assessments assumed descriptive “state of the system” surveys were a good way to evaluate environmental conditions that and that separately describing each part of an ecosystem could lead to understanding the system as a whole (Holling 1978). These approaches, however, led to inflexible, unfocused and arbitrary environmental management and assessment strategies (Holling 1978).

Adaptive management is a resource management approach that aims to address these chronic environmental management and assessment problems. In 1978, ecologist C.S. Holling and colleagues at the University of British Columbia formally introduced the term “adaptive management” as an alternative to conventional natural resource management and science. Holling drew on ideas in systems theory and argued that ecosystems are dynamic and complex, humans do not fully understand how natural systems work, how human behaviors affect natural systems, and much of what we know is wrong. Despite these uncertainties, management and policy decisions need to be made. Holling proposed bringing scientists, agency managers and policy makers together in a series of workshops to develop models of how they currently think the system of interest works. The group would then conduct experiments – some long-term and some integrated into actual management activities - to learn and adjust their models as understanding improved. By testing hypotheses about the impact of human interventions on
complex natural systems, place-based research conducted in conjunction with management actions could produce relevant information that could then be applied to improve future management decisions. This approach would permit a way to “learn by doing,” allow for large-scale experimentation as opposed to small-plot experiments, and had the potential to improve communication between decision makers and scientists. (Holling 1978)

In theory, by using an iterative approach of planning, implementing, monitoring, evaluating and adjusting management actions, we can learn about natural systems, gradually reduce uncertainty, and improve management decisions and policies over time (Figure 1) (Holling 1978, Walters 1986, Lee 1993).

Figure 1: A simple diagram of adaptive management (from DOI 2010).

Several scholars have expanded on Holling’s seminal work. Walters (1986), for example, emphasized the importance of treating management interventions as experiments to maximize learning. Walters argued that specific hypotheses could be tested through intentional probes
(active adaptive management) instead of just monitoring whatever happens to be going on in the area of interest (passive adaptive management). Repeated hypothesis-tests would provide a deliberate way to increase knowledge and decrease uncertainty through management interventions. Walters also emphasized that long-term monitoring would be needed if policies were to be designed in a way that incorporated ecological feedback. More recently, Allen and Gunderson (2011) emphasized the need to test competing hypotheses about management strategies in order to compare results and determine the best way to proceed.

What is collaborative adaptive management?

CAM theory proposes 1) that treating management interventions as experiments will help people improve their understanding of ecosystem functions and their impact on them, 2) by adjusting decisions based on what is learned, policies can change and improve in response to new information, and 3) by involving a broad range of people in an AM process, trust will improve between the various parties and the group will find a way to agree on how to proceed, despite their contending interests.

The “collaborative” in collaborative adaptive management stems from Kai Lee’s (1993) work and refers to collaboration in the sense that all stakeholders affected by a natural resource management decision should be at the planning table and involved in implementation. Lee added “social learning” to the discourse of AM. He defined social learning as a combination of adaptive management and political change and viewed multi-party negotiations and guided conflict resolution as an integral way of making social learning happen. Lee argued that social learning would develop from the knowledge within a network of organizations, conflict between organizations, and the environment itself, and that social learning was particularly important in
large ecosystems where complex systems (multiple jurisdictions, multiple uses, interdependence of people, uses and ecosystem services), contentious interests, and many people were affected.

Lee also advocated that the public should be involved in designing experimental protocol and in data collection so that 1) the community could foster and sustain learning over time, 2) experimental policies would be viewed as legitimate in the eyes of the public, and 3) the political costs of being wrong would be less than if the public were not included. A broad range of stakeholders representing the full range of interests affected by the management decisions under discussion would need to be integrated into an AM process. It would not, however, be enough for a diverse group of stakeholders to just be present at meetings; to be meaningfully involved in a public decision-making process, stakeholders would need to actively engage in seeking consensus with the other parties at the negotiation table (Lee 1993, Brandenburg 2005). By having key interests represented and engaged in collaborative problem-solving, the resulting decisions would likely be more fair (in the eyes of those affected), efficient (in terms of creating solutions with more value), stable (over time), and wise (according to the information available at the time), than would otherwise result from a less inclusive or engaging process (Susskind and Cruikshank 1987).

CAM not only requires the meaningful involvement of a diverse range of stakeholders, the collaboration also needs to withstand the length of time it takes to complete a CAM process, which can last several years or decades. Ongoing collaborative efforts typically take the form of informal or formal networks of public, private and not-for-profit organizations and/or individuals, that develop and implement management plans (Sabatier et al. 2005, Mandell 1999). To be successful, a long-term collaborative requires roles and responsibilities that are different from those used in conventional, silo-ed approaches to natural resource management (Mandell
1999, Sabatier et al. 2005). Ongoing leadership, staffing, and data collection need to be coupled with the ongoing commitment of stakeholders and their organizations (Margerum 2011). To accomplish this feat, there need to be incentives in place that encourage participants to maintain their involvement over time (Margerum 2011).

In order to assess whether CAM is taking place or not, it needs to be explicitly defined. I describe 14 key aspects of a CAM process that have emerged out of more than 30 years of theory building and attempts at implementing AM and CAM. This list has been modified from Levine (2004) and integrates ideas found in Allen and Gunderson (2011), Doremus et al. (2011), Susskind (2011) and Margerum (2011).

1. **Convene a working group that includes representatives of all key interests:** Anyone can initiate a CAM process. The working group, however, should include representatives of all key interests such that no one has been identified as missing from the group, there have been no complaints of exclusion, and anyone who could potentially block or stall implementation of agreements has been invited to join. Public agencies necessary for political action should be involved.

2. **Define problem(s):** The working group identifies specific problem(s) about what is not working, needs to change, or is unknown about the system of interest. Divergent perspectives on issues are fine (and expected).

3. **Decide if CAM is an appropriate tool:** The working group needs to decide if CAM is an appropriate approach for addressing the problem(s) of concern. CAM is appropriate if management interventions are controllable and the outcome of possible actions are unknown. If outcomes are well known, there is no need to invest in CAM; best management practices can be implemented instead. If management interventions cannot affect the main problem, such as climate change, then tools such as scenario planning may be more appropriate than CAM. CAM is also not appropriate if the proposed management strategies can cause irreparable harm, such as killing several species, or if the ecosystem function(s) of interest cannot be measured.

4. **Develop a process agreement:** If the working group decides CAM is an appropriate choice, the group needs to collectively create an agreement on how the process will work. Roles and responsibilities should be clearly defined including who is managing the process and how decisions will be made. Specific tools that will help create organizational structure need to be identified; this may include regular stakeholder meetings and a system for clear and consistent communication in between meetings (such as creating a website and email list to circulate agendas, meeting notes and other relevant information). A neutral facilitator is
another possible tool that may be used to help foster public participation, collaborative problem solving, and mediation of conflicts.

5. **Create ecologically based goals and objectives:** The working group develops unanimously supported goals and objectives that are specific enough to determine whether they have been accomplished or not. Objectives should be designed in a way to measure progress towards the identified goals and should be time-bound.

6. **Specify a conceptual model:** The working group designs a model or uses a pre-existing one that conveys the collective understanding of how the system in question functions, identifies key uncertainties regarding the system, and addresses influential variables that are outside of the system. Since the group develops the model, it should be credible in the eyes of everyone involved in the process.

7. **Develop hypotheses:** The working group develops hypotheses about the impact that possible management actions will have on the system of interest. Multiple hypotheses can be tested and not everyone will necessarily agree with each hypothesis, however, there is group agreement about what will be tested.

8. **Design management experiments/interventions to test hypotheses:** The working group develops an experimental design that includes controls of variables of interest and replication of hypothesis tests. Hypothesis tests and management activities are integrated. Unanimous agreement is sought in the experimental design.

9. **Design a monitoring plan:** The working group develops and agrees on monitoring protocol designed to detect the ecological changes of interest and measure the impact(s) of the management interventions.

10. **Implement management interventions:** The working group, a subset of the working group, or an agreed upon additional party implements management interventions according to plan. Minor hiccups can be expected, but intentional disregard or obstruction of plan implementation is unacceptable.

11. **Implement monitoring plan:** The working group, a subset of the working group, or an agreed upon additional party implements monitoring protocol according to plan. Minor hiccups can be expected, but intentional disregard or obstruction of plan implementation is unacceptable.

12. **Evaluate results of experiment:** The working group deliberates over the interpretation of the data that has been collected and its implications on management goals and objectives. Significant findings and surprising information are not ignored. Not everyone will agree on the meaning of the data or what should happen in response to it.

13. **Reassess and adjust the problem statement, goals, objectives, process, conceptual model, interventions, and monitoring plan:** The working group reevaluates all key components of the CAM process in light of new information and makes adjustments accordingly. Consensus
is sought in making these decisions.

14. Cycle is continuously repeated: The working group continues using this process until the problem has been solved or uncertainties are no longer a concern. Stakeholder group representatives consistently attend meetings over time. Funding is sufficient over time to implement the desired experiments, data analysis, and group meetings. If an individual leaves the working group, another representative of the same stakeholder group replaces him or her. If additional people or interest groups are identified as missing or would like to join the working group, they are invited to do so.

Finding cases: CAM in practice

Before embarking on this project, I was having a hard time grasping what CAM might look like in practice. How would a group of people work together over the course of several decades to do AM? Could this kind of an approach ever be implemented well? When I raised the idea of doing a project about CAM to my advisor, he essentially said, “that’s an interesting idea, good luck finding cases to study.” At the time I did not quite realize how difficult it would be to find existing CAM projects that have been going on long enough that I could research what they have done. It was also unclear what exactly should be considered CAM since few projects are explicitly labeled as such. And yet, groups of people have been resolving science intensive disputes and collaboratively managing natural resources for decades (Innes and Booher 2010, Wondolleck and Yaffee 2000, Susskind et al. 2011, Margerum 2011). There just had to be groups of people effectively collaborating with each other and integrating experimentation and monitoring into ecosystem management decisions. They may not be calling it CAM, but there were probably groups of people somewhere doing something like it.

To select the three cases used in this study, I conducted informational interviews with several academics, consultants and practitioners who study or use CAM and I asked them for examples of natural resource management efforts in which they thought a diverse range of
stakeholders were genuinely collaborating with each other and in which active scientific experimentation and/or monitoring was used to inform management decisions. After compiling a list of possible cases (see Appendix A), I looked for programs in which implementation of CAM had been ongoing for at least ten years and at least two iterations of experimentation had been completed. As I conducted cursory research into each of the cases, I found myself eliminating programs as candidates for this project either because they were obviously missing key elements of CAM, or because they were not far enough underway to study. For instance, the Platte River Recovery Implementation Program has a promising collaborative organizational structure and clear plan to implement AM, but experiments have not yet begun. The Glen Canyon Dam Adaptive Management Program has a collaborative working group and more than 15 years of data collected through water flow experiments, but, despite the data indicating that dam management should change to improve Colorado River riparian ecosystems, no adjustments to management decisions have been made and AM is not happening (Susskind et al. 2011).

My case selection process was by no means a comprehensive endeavor, but it certainly indicates the challenge of finding examples of CAM in practice. I ended up choosing two programs (and 3 specific cases within these programs) that represent different organizational structures, and, for logistical ease, are located within the same geographic region in the United States. This study examines: the Las Cienegas Adaptive Management Program, and two projects affiliated with the Malpai Borderlands Group -- Prescribed fire planning in the Peloncillo Mountains and the McKinney Flats Project (Figure 2). All three cases are located within the Sky Island region of the southwestern U.S. in which a complex of short mountain range “islands” of cooler and wetter ecosystems rise above a “sea” of grasslands and desert (read more about the area in Appendix C).
Research questions and methodology

This study aims to answer three questions: (1) What does CAM look like in practice? (2) Are my cases actually examples of CAM? Why or why not? (3) If so, what is promoting or enabling CAM to happen in these efforts?

I used semi-structured interviews with individuals involved in the implementation of the three projects. The interviews were intended to gather information about program structure, design and activities, and the opinions of participants and observers involved or affected by each natural resource management effort (see Appendix B for a copy of interview questions).

I interviewed 21 natural resource managers and scientists, public agency representatives, community members, environmental advocates and academics (see Appendices D and G). 7-14
people were interviewed about each site area. A snowball sampling technique was used to select interviewees, asking each person that I contacted for recommendations of other people with whom I should speak.

I assume that CAM has happened if all the key elements of CAM outlined earlier in this chapter have taken place (Table 1). I will fill in this grid as I discuss each case.

Table 1: Key elements of CAM. I will fill in this table as I discuss each case using the following key: ⬤ = element is consistently present, ○ = element is sometimes present, ◯ = element is absent.

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<th>Prescribed Fires</th>
<th>McKinney Flats</th>
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Road map

In chapters 2 and 3, I present my two cases. Chapter 4 analyzes my findings across all three cases and Chapter 5 discusses the implications of my findings for current and future CAM practitioners.
CHAPTER 2: COLLABORATIVE RESOURCE MANAGEMENT IN THE SONOITA VALLEY

What are the Las Cienegas National Conservation Area and the Sonoita Valley Acquisition Planning District?

The Las Cienegas National Conservation Area (NCA) is 47,279 acres of Bureau of Land Management (BLM) land in southeastern Arizona, on the outskirts of the Tucson metropolitan area (Figure 3). The Sonoita Valley Acquisition Planning District (SVAPD) is an additional 95,609 acres of state, private and BLM lands adjacent to the NCA (Figures 3 and 4). Together they make up 142,888 acres of planning area in the Sonoita Valley. The NCA and SVAPD support five of the rarest ecosystems in the American Southwest: cottonwood-willow riparian forest, cienega marshland, sacaton grass floodplain, mesquite bosque, and semi-desert grassland; are home to hundreds of species of birds, mammals, amphibians, reptiles and fish; house seven endangered species including the Gila topminnow, Mexican garter snake, and Western yellow-billed cuckoo; and have two eligible wild and scenic river segments (Figures 5 and 6). The Las Cienegas Adaptive Management Program aims to improve the ecological health of the planning area while managing it for multiple uses including livestock grazing, recreation, and cultural heritage.
Figure 3: Map of the Las Cienegas NCA and SVAPD.
Figure 4: Map of land ownership in the Sonoita Valley.
Figure 5: Images of the Sonoita Valley (clockwise from top left): semi-desert grassland (photo credit: Jenna Kay); cattle grazing in the NCA (photo credit: Jenna Kay); riparian area along Cienega Creek with the endangered Gila topminnow in forefront (photo from Bodner et al. 2007); view across the upper Cienega Creek watershed (photo from Simms et al. 2006).

Figure 6: Endangered species of the Sonoita Valley (from Pima County, in Simms et al. 2010).
Development of a CAM approach

In 1988, the BLM acquired a piece of land on the outskirts of Tucson, AZ and embarked on a conventional planning process. As a result of unclear plans, lack of public participation, and exclusion of key stakeholders, the planning process reached an impasse. In response to the conflict, the BLM convened a group of stakeholders to develop an alternative plan. Karen Simms, an ecosystem planner for the BLM Tucson field office, served as the lead for “re-doing” the land management plan using a more collaborative approach this time.

Karen led an internal BLM team that managed and prepared official documentation for the plan and she convened a large stakeholder group, called the Sonoita Valley Planning Partnership (SVPP). The SVPP was a voluntary association of about 20 federal, state and local agencies, organizations and private citizens who worked together to develop solutions regarding public land in the Sonoita Valley/upper Cienega Creek watershed. Environmental, recreation, ranching, and small-scale mining interests were represented. Agency involvement included representatives from BLM, Coronado National Forest, Natural Resource Conservation Service (NRCS), U.S. Geological Survey (USGS), Arizona Game and Fish Department (AGFD), Arizona State Land Department (ASLD), Pima and Santa Cruz Counties. A neutral facilitator initially helped the group use a consensus-based process to make decisions. Karen Simms, however, ended up facilitating most of the negotiations. The discussions were open; anyone could join and anyone could leave at any time.

After six years of monthly meetings, the SVPP came to an agreement that was adopted by the BLM as a resource management plan (RMP) for the Las Cienegas NCA and SVAPD. The RMP outlines ten broad goals for the planning area (Table 2), ecologically based objectives for
achieving each goal, and specific management actions describing how to accomplish the objectives.

Table 2: List of the goals for the Sonoita Valley, developed by the Sonoita Valley Planning Partnership and adopted as the goals for the BLM Las Cienegas Resource Management Plan. This list does not include specifics details outlined under some of the goals (BLM 2003, 4-5)

<table>
<thead>
<tr>
<th>Goals for the Sonoita Valley (Upper Cienega Creek Watershed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Maintain and improve watershed health</td>
</tr>
<tr>
<td>2. Maintain and improve native wildlife habitats and populations</td>
</tr>
<tr>
<td>3. Maintain and restore native plant diversity and abundance</td>
</tr>
<tr>
<td>4. Protect water quality</td>
</tr>
<tr>
<td>5. Protect water quantity</td>
</tr>
<tr>
<td>6. Assure sustainability and a complementary relationship of mineral resources to the protection of water quality and quantity</td>
</tr>
<tr>
<td>7. Maintain the region’s scenic beauty and open space</td>
</tr>
<tr>
<td>8. Sustain compatible traditional, current, and future use of land</td>
</tr>
<tr>
<td>9. Promote stewardship of the resources to accommodate current and future opportunities and demands</td>
</tr>
<tr>
<td>10. Manage the cultural resources in the planning area in a manner that provides for their preservation and protection and also avails selected properties for scientific, public, and sociocultural uses</td>
</tr>
</tbody>
</table>

While the SVPP stakeholders could agree on overarching goals and objectives, they could not agree on whether grazing was good or bad (more than 90% of the planning area is open to cattle grazing) and there was much discussion within the group about how to go about reaching the agreed-upon goals. Therefore, the SVPP decided to base future decisions on monitoring data rather than conflicting ideologies. The RMP states that SVPP collaboration will continue during plan implementation and that an AM approach will be used to adjust and improve management actions over time. The group also successfully petitioned Congress to designate the piece of BLM land as a National Conservation Area.
The Las Cienegas Adaptive Management Program and collaborative implementation process officially began with the approval of the RMP in 2003, and, according to Lynn Scarlett (2011), “The Las Cienegas NCA is the first major BLM-administered land area to simultaneously engage community-based planning and community-based implementation of the adopted plan through adaptive and outcome-based practices” (8).

The Las Cienegas Adaptive Management Program

Program structure

The BLM leads the collaborative and adaptive management process associated with RMP implementation and hosts two meetings each year, called biological planning meetings. These events are open to anyone who would like to participate and are largely made up of representatives of the same organizations involved in the initial planning process. Approximately 30 people typically attend. The meetings tend to have an interactive agenda in which monitoring data is shared, field trips are taken to see different parts of the planning area so everyone can “see” what the data looks like, and facilitators lead discussions on the implications of the data and how it can inform future management decisions.

Stakeholders attending biological planning meetings are not a formal federal advisory committee or legislatively enacted body. Therefore, the group has the flexibility to structure its decision-making process to meet its needs. The group’s informal status also means it cannot officially make recommendations to the BLM and the BLM is not obligated to use outcomes resulting from group meetings. Instead, the stakeholders give feedback to the BLM who then strongly considers the group’s suggestions in its official decisions.
In addition to the biannual biological planning meetings, there are four technical teams, or sub groups, within the biological planning process: the uplands team focuses on grasslands, the riparian-aquatic group focuses on those areas, the landscape team connects Sonoita Valley planning efforts to regional concerns and impacts, and the heritage team focuses on cultural and recreation resources. The four subgroups meet several times throughout the year to analyze monitoring data in more detail than is done at the larger biological planning meetings. There is also a fifth group, the coordinating team, made up of the conveners of the four working groups. The coordinating team meets periodically throughout the year and serves as a way to improve communication and coordination between the technical teams (Robertson 2012). For a diagram of the Las Cienegas Adaptive Management Framework and Biological Planning Process, see Appendix E.

Both the program structure and culture of meetings has shifted over time. A few years into plan implementation, for instance, the stakeholder group was struggling to collaborate; tension was growing between participants and within the BLM (Simms 2012). (Read more about this in Appendix F.) The group was also interested in broadening the scope of how they were using adaptive management (Simms 2012). Karen was familiar with the U.S. Institute for Environmental Conflict Resolution (USIECR) and asked the Institute for help improving collaboration within the biological planning/adaptive management process. The BLM entered into an inter-agency agreement with the USIECR, developed a scope of work, and used a competitive application process to select a mediator. Tahnee Robertson was hired by USIECR in 2009 and has been supporting the adaptive management program since then.

Tahnee was originally hired to determine potential improvements for the biological planning process, such as suggesting an appropriate framework and sideboards, clarifying the
role of stakeholders and BLM staff, and facilitating meetings. She also created and manages the group website and is in the process of conducting a stakeholder analysis. At this point, several members of the group find it hard to imagine what it would be like working without a mediator. Overall direction of the group, meeting management, tone and comfort of participants, ability to address fairly sensitive issues, and documentation of meetings has improved as a result of Tahnee’s involvement in the biological planning process (Kay 2012).

Design of management interventions and monitoring protocol

The RMP outlines goals, objectives, management actions and monitoring strategies. The SVPP based objectives on a land health standard defined for each habitat-type (based on NRCS Ecological Site Descriptions and Arizona Standards for Rangeland Health). Objectives are time-bound and specify what is trying to be accomplished. For example, one objective is to maintain or achieve <30% exposed soil surface (bare ground) in 80% or more of grassland ecological sites in the planning area by 2015 (BLM 2003). Another objective is to maintain or achieve a high similarity index (>50%, by weight) to historic climax plant communities in 80% or more of the ecological sites in the planning area by 2015 (BLM 2003).

Once the group identified the desired conditions for each habitat-type, they used state-and-transition models to highlight the major driving forces of change that impact the conditions of an ecological site (Figure 7). They also used the models to identify appropriate management strategies for moving a site with undesired conditions towards a more desired state and preventing sites already in desired states from transitioning into less desired ones.
No hypothesis-testing experiments with controls and replications were written into the RMP. Instead, CAM at Las Cienegas was based on a passive adaptive management design (Walters 1986) to test management hypotheses using descriptive monitoring techniques. A few University of Arizona researchers have designed experimental projects in the planning area. One research project tested the effects of grassland restoration efforts on birds in the NCA and another project involved examining various vegetative treatments, such as prescribed fire and manual mesquite removal, to better explain what was happening in response to certain invasive species management decisions. It seems like the Las Cienegas Adaptive Management Program could benefit from more of these types of scientific experiments, to learn about the impact of
management strategies faster than they may otherwise be able to accomplish just through monitoring. (The Audubon Society’s Appleton-Whittell Research Ranch Sanctuary, located within the planning area, has been cattle free since 1968 and is used as a comparative reference site to other parts of the planning area. More recently, several cattle exclosures have been added throughout the NCA. While these comparative sites may help distinguish between the impacts of cattle grazing and other factors such as climate, the sites have not been set up as a rigorous place-based experiment.)

Implementation of management interventions and monitoring protocol

BLM staff, grazing allotment lessees, volunteers, and additional partners implement the RMP management actions. A few hundred thousand dollars are spent each year on management interventions and this number varies depending on grants and other available funding sources. Projects completed so far include managing livestock flexibly (which is an ongoing effort); Ian Tomlinson, owner of the Vera Earl Ranch, manages approximately 1000 head of cattle on BLM land and presents and discusses his grazing plans during biological planning meetings. Several fences have been built to keep cattle out of riparian and other sensitive areas. More than 12,000 acres of vegetation have been treated to control invasive plants using chemical and mechanical brush removal techniques and prescribed fires. Black-tailed prairie dogs have been reintroduced to the planning area. Several erosion control structures have been built.

While most management interventions have been implemented according to plan, the University of Arizona invasive species experiment ran into problems during implementation when a BLM fire manager did not alter the prescribed burn plan for the year to accommodate the experiment and burned through some of the experimental plots.
More than 40 grassland-monitoring plots are located in the planning area. There are also several fish sampling locations, riparian vegetation and channel morphology measurement locations, and fire effects monitoring locations. Data collection takes place two times per year and is conducted by a few biologists, range experts and a handful of volunteers. It takes approximately 10-days of fieldwork to collect all of the desired measurements. Additional monitoring plots are set up to measure the before and after effects of specific management actions, to assess whether a vegetation treatment, for example, is actually getting the group closer towards achieving its objectives. When prescribed fires, manual brush removal, or chemical applications are used to remove invasive species, data is collected to measure how fast the undesired species returns to the area after its removal.

In 2004, the BLM signed a cost-share agreement with The Nature Conservancy (TNC) to help improve the monitoring program for Las Cienegas. The goal of this effort was to ensure that 1) the data being collected was measuring the ecologically based objectives in the RMP, 2) the sampling and measurement techniques would detect ecosystem changes resulting from management actions, and 3) a solid foundation of information was being provided to BLM managers and the stakeholder group that was useful for informing future decisions. Several changes were made as a result of TNC involvement. For instance, the RMP recognizes that shrub encroachment is a problem for grasslands habitat, but it was not being monitored. Thus, shrub coverage is now monitored in all grassland areas. TNC also recommended to increase the sampling intensity for certain measurements to better detect change (instead of collecting a few hundred data points in a sampling plot approximately 1000 measurements are now collected). The more refined data collection methods have shown changes that would not have been detected with the old system. (Bodner 2012, Simms 2012)
**Evaluation of findings**

When a stakeholder shows up to a biological planning meeting, s/he can expect to engage in discussion about the information being presented to the group. This culture of discussion, however, has not always been present. For the first few years of biological planning meetings, the group struggled to really use the gatherings as a place to deliberate over the interpretation of monitoring data and its application to management decisions. Gita Bodner of TNC explains: “stakeholders and staff would look at [the synthesized data produced by the TNC]…and say, ‘okay, thank you’” (Bodner 2012). There was little to no discussion of it. Gita continues: “And then the grazing permittee would describe his proposed grazing rotations and number of cattle for the year and everybody would say ‘yes.’” (Bodner 2012). So, there was a mechanism for looping new information into decision-making, but it was not entirely effective (Bodner 2012). Karen, Gita and a few others worked to shift the expectations of the group to be more actively involved in data interpretation and decision-making.

The Las Cienegas monitoring program is designed to measure whether conditions in the Sonoita Valley are progressing towards the management objectives or not. Data shows that some management strategies have been particularly effective at achieving RMP objectives, some strategies have not, and, some data is just hard to decipher. In 2011, the desired ground cover objectives had been met (more than 80% of sites designated as grassland communities had less than 30% of exposed soil surface). This was not a linear trajectory, however, and between 2004 and 2011, the percent of monitoring sites meeting this objective varied between 100% and 24%. During years with less rain, fewer monitoring areas met this objective, indicating that management interventions were not the only factors affecting bare ground cover. This highlights the challenge of assessing change in a dynamic system and the fundamental complexity of
assessing ecological progress. Another objective in the RMP is to have perennial grass basal cover in more than 10% of all grassland areas. In 2004, 54% of sites monitored met this objective; in 2011, 34% met the criteria. This negative trend suggests that either management activities have not led to desired ecological outcomes, or that other factors besides management activities are determining the changes in ecological conditions.

Adjustments

A handful of management interventions have been adjusted incrementally as a result of the stakeholder group reviewing and discussing data together. One example took place when the ranching lessee was surprised to find out that what he thought looked like good fodder for his cattle was not. Monitoring data showed that the perennial grasses that died over the winter were overgrown by annual plants during the summer. There was concern by a few range scientist experts that if the permittee carried out his original grazing plan, it would damage the land and his bottom line because there would not be enough food for the cows, since annual grasses would not last as long as perennial grasses. The group agreed that the permittee should not graze as many cattle on that particular allotment as he had proposed. (Kay 2012)

Another specific management change that may result from data analysis and discussion has to do with restoration of the Cienega Creek riparian area. Livestock were fenced out of a riparian area with the hopes that it would help the ecosystem regain some of its natural functions. The vegetation grew back much faster than anticipated and the population of the endangered Gila topminnow living in the stream rapidly declined in response to the increase in shade. Karen Simms reflected, “we probably would have implemented taking the cattle off in more of a
staggered way so that we had more diversity of habitats.” The RMP outlines the possibility of reintroducing beaver to riparian areas in Las Cienegas and Karen explains:

Now we're saying maybe now's a good time to talk about putting the beaver out there because they would help reduce some of that tree cover, open systems up and might benefit the native fish. On the other hand, there are people that don't agree with that because they are concerned about the beavers creating big pools that would attract bullfrogs, which is an exotic species for us and would be detrimental. If we do put the beaver out there, we will set it up with monitoring. If we see that it's causing more of a problem than a benefit, well, then we can make the decision to take the beaver back out if we want to.

By building possible options into the RMP, the group has promoted opportunities for flexible management.

While there are several instances of small management changes resulting from data collection, analysis, and group discussion, few dramatic changes have resulted from biological planning meetings (Kay 2012). One interviewee explained that it is not always clear what to do in response to the data. This raises the question: if the group is open to change but does not make adjustments, is AM happening? (Read about federal and state agency responses to this question in Appendix F).

Continuation of the CAM cycle and concerns about future implementation

The Las Cienegas Adaptive Management Program has been ongoing for nearly ten years and has greatly benefited from having an enthusiastic stakeholder group involved at meetings at least two times per year, the continuous leadership of Karen Simms, and the assistance of a neutral facilitator.

Implementation of CAM is threatened by 1) lack of CAM institutionalization in BLM, 2) stakeholder fatigue, and 3) issues such as groundwater depletion that are not well-suited to solely
be addressed with AM. Several people interviewed mentioned that the BLM is not well set up with a succession plan for Karen Simms. Interviewees also expressed their concern about some stakeholders no longer attending meetings. Others were concerned that there is currently a missing stakeholder, the Arizona State Land Department, the largest landowner in the planning area. Figuring out how to keep people coming back will be key to sustaining a long-term collaborative effort in the Sonoita Valley. Issues such as climate change, Tucson’s groundwater depletion, and water contamination from nearby mining operations are largely beyond the control of activities at Las Cienegas, but will/do severely impact ecosystem health there. The stakeholder group has decided to add a new tool into their management strategy and will use scenario planning to address climate change concerns.

Summary of Case 1

Las Cienegas has benefitted from a group of diverse stakeholders who have become committed to a long term resource management project and are open to implementing a flexible resource management plan, learning, and adjusting their management decisions over time. While the group working at Las Cienegas feel like they have muddled their way along, figuring out how to do CAM as they go, they are continuously collaborating and are open to adjusting their management strategies. Nearly all of the key elements of CAM are present in the Las Cienegas Adaptive Management Program, and yet, the three weakest aspects of Las Cienegas CAM are 1) the absence of a key stakeholder and 2) designing experiments to test specific hypotheses (Table 3).
Table 3: Key elements of CAM. ● = element is consistently present, ○ = element is sometimes present, □ = element is absent.

<table>
<thead>
<tr>
<th>Elements of CAM</th>
<th>Las Cienegas</th>
<th>Prescribed Fires</th>
<th>McKinney Flats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convene a working group that includes representatives of all key interests</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Define problem(s)</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Decide if CAM is the appropriate tool</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Develop a process agreement</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Create ecologically-based goals and objectives</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Specify a conceptual model</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Develop hypotheses</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Design management experiments/interventions to test hypotheses</td>
<td>○</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Design a monitoring plan</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Implement management interventions</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Implement monitoring plan</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Evaluate results of experiment</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Reassess and adjust the problem statement, process, goals/objectives, conceptual model, interventions, and monitoring plan</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Cycle is continuously repeated</td>
<td>●</td>
<td>●</td>
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The currently missing representative from the Arizona State Land Department has not yet caused a problem for the stakeholder group, but as the largest land owner in the planning area, with a state mandated mission to sell land for money, this missing participant could be problematic in the future and interfere with RMP goals and objectives. The group seems to have a hard time distinguishing between the different driving forces causing the changes that they see.
in their data. First, socio-ecological dynamics in Las Cienegas are complex and take several years of data collection to identify statistically significant trends. Second, since monitoring does not provide controls for certain variables such as climate, it is difficult to know why perennial grasses are not growing in a certain area – it could be a result of livestock grazing, climate, or something else. This lack of clarity makes it challenging for the group to know what to do with their data or make significant adjustments to management activities.
CHAPTER 3: COMMUNITY-BASED CONSERVATION IN THE MALPAI BORDERLANDS

What are the Malpai Borderlands?

On the border of southern Arizona and New Mexico, there are approximately 800,000 acres (1,250 square miles) of continuous open space known as the Malpai Borderlands (Figure 8). The roughly triangular area is delineated by two highways and the U.S.-Mexico border and spans the Animas Mountains along the continental divide. The area also encompasses the Peloncillo Mountains and parts of the San Bernardino, Upper San Simon and Animas valleys. Watersheds flow north into the San Simon Valley and eventually into the Gila River or south into the Río Yaqui system. Elevations range from approximately 3,800 to 8,500 feet.

Seven ecosystems converge in the Borderlands, making the area incredibly rich in biodiversity. The Sonoran and Chihuahuan Deserts, Desert Grasslands, Plains Grassland, Interior Chaparral, Madrean Evergreen Woodland, and Montane Coniferous Forest provide home to many species of reptiles, amphibians, rodents and birds (Figure 9). At least 15 threatened and six endangered species live here including the jaguar (*Panthera onca*), chiricahua leopard frog (*Rana chiricahuensis*), lesser long-nosed bat (*Leptonycteris yerbabuenae*) and New Mexico Ridge-nose rattlesnake (*Crotalus willardi obscurus*) (Figure 10).

Land ownership forms an intricate mosaic made up of 53% private land, 23% Arizona or New Mexico state land, and 17% federal land (Figure 8). Fewer than 100 human families live in the area and most privately owned lands are working ranches.
Figure 8: Map of land ownership in the Malpai Borderlands region.
What is the Malpai Borderlands Group?

In 1990, a group of ranchers started talking with each other about their concerns for their livelihood. Environmentalists were advocating to end grazing on public lands to the chant of “Cattle Free by ’93.” This was problematic for the Malpai ranchers who relied on public lands in...
order to make a living. They were also frustrated with the Forest Service fire management strategy that seemed to embrace putting out wildfires as quickly as possible. Several of the ranchers thought occasional burning of the land was good for it and fire suppression might be the cause for trees and shrub encroachment into grassland areas. Also of concern was the increasing subdivision of ranchlands that meant less open range.

After several meetings with their ranching neighbors, federal and state agency representatives, environmentalists, and science experts, in 1994, the ranchers formalized into a not-for-profit organization called the Malpai Borderlands Group (also referred to as the Malpai or Group from now on). The Group’s mission statement says:

Our goal is to restore and maintain the natural processes that create and protect a healthy, unfragmented landscape to support a diverse, flourishing community of human, plant and animal life in our Borderlands region. Together, we will accomplish this by working to encourage profitable ranching and other traditional livelihoods which will sustain the open space nature of our land for generations to come.

The Malpai’s approach is: “the group would never do anything to its neighbors, only with them at their request, and whatever actions the group did take would be driven by good science, contain a strong conservation ethic, be economically feasible, and be initiated and led by the private sector, with public agencies coming in as our partners rather than with us as their clients” (McDonald 1994 in Wolfe 2001, 11). Today there are approximately 30 ranching families involved in the Group.

By the mid-1990s, more than ten state and federal government resource and land management agencies were cooperating with the Malpai on projects aiming to preserve open space, reintroduce natural processes such as fire into the landscape, and prove that the Malpai style of ranching did not harm the land. New and unprecedented positions were created in both
the local Natural Resource Conservation Service (NRCS) and Coronado National Forest field offices in which individual agency representatives were to coordinate projects with the Malpai. The Nature Conservancy (TNC) had also become integrally involved with the Group. Additional partners included University of Arizona and New Mexico researchers.

Malpai projects cover a wide range, from funding scientific research to implementing erosion control projects, and developing fire plans with the Forest Service. The group has also developed an innovative grassbanking system, in which ranchers can use grass on someone else’s land in exchange for conservation work on their own. 77,000 acres of private land in the Borderlands are under conservation easements held by the Malpai. The Group has also been active in networking and collaborating with other groups who share similar concerns and problems as them such as the Massai.

Five part-time staff members handle the Malpai’s administrative work and serve as the Group’s nucleus. The board is made up of 12 ranchers and two retired Forest Service scientists; they meet several times throughout the year. A Scientific Advisory Committee consisting of experts in a variety of science fields meets annually and is consulted on Malpai monitoring and research projects. Agency representatives working with the Malpai on their projects all meet together each year as well. The board creates annual work plans and projects are pursued on a funding-available basis. The not-for-profit’s money largely comes from donations and grants. The organization operates out of its office at Wendy and Warner Glenn’s ranch near Douglas, AZ.
Development of the Malpai Science Program

A 10-year grant

Early on, the Malpai decided that good science would be necessary for resolving several of the uncertainties about resource management issues in the Borderlands. The Group wanted to use rigorous science as the basis for its decisions. According to rancher and Malpai Borderlands Group Executive Director, Bill McDonald: “[We] wanted the best and most credible scientists in the U.S. working with us…If the information and research is honest and unbiased, we’ll let the chips fall where they may” (from Cook 2001 in Wolf 2001).

Rather than seek out rangeland experts, the Group looked for scientists with no connections to ranching. They also decided that experimental science should take priority over observational science and that experiments should take place at a large scale so that the results would be meaningful to management decisions.

In 1994, the Forest Service Rocky Mountain Research Station received a 4 million dollar National Ecosystem Management Grant for the Southwestern Borderlands Ecosystem Management Research Project (SBEM) in which $400,000 would be annually available for ten years. Representatives from several agencies, university researchers, and the Malpai put the proposal together. SBEM’s goal was to use science to inform the development and implementation of a comprehensive ecosystem management plan for the Malpai Borderlands. The project had three objectives: 1) summarize and synthesize existing information, 2) develop a comprehensive landscape inventory and monitoring system to serve research and management needs, and 3) identify specific research studies to fill priority knowledge gaps.
Several research projects were central to filling knowledge gaps. I only examine a few of them: 1) Prescribed burns were conducted in the Peloncillo Mountains to examine the effects of fire on vegetation and wildlife species, hydrology and sedimentology, and, 2) The McKinney Flats Project attempted to understand the interactions between fire, cattle grazing, climate and wildlife.

A model on which to base experiments

The location and purpose of Malpai experiments and monitoring efforts are connected to conceptual ecological models of the Borderlands ecosystem. Dr. Jim Brown, an ecologist at the University of New Mexico and one of his former post-doctoral students, Dr. Charles Curtin, a zoologist working at the Santa Fe Institute at the time, developed a framework for thinking about the primary forces that shape existing ecosystems in the Borderlands (Figure 11). These forces, or driving variables, can be thought of as the primary drivers of change in Borderlands ecosystems. People can manipulate two of the driving variables: fire and grazing. The Malpai ranchers had already identified these as two areas that they thought were important to monitor and research in further detail, but Brown and Curtin’s analysis independently validated the rancher’s observations. (Curtin 2005)

1 The Malpai do not use CAM jargon to describe their work, rather, they describe themselves as a group of people engaged in problem solving around changing ecosystem conditions (Kay 2012). I will be ascribing CAM jargon to Malpai activities.
Figure 11: Brown and Curtin’s framework of driving variables in the Borderlands (from Curtin 2005, 240).

The framework was used to develop a model of the different Borderlands ecosystems (Figure 12, left). The model was used to identify the placement of monitoring sites within each ecosystem and along border areas between different ecosystem types. Approximately 250 monitoring sites have been set up throughout the Borderlands to track vegetation changes (Figure 12, right). These were intended to provide baseline information for ecological status and changes in the area. Professional scientists are hired to annually collect data from the monitoring sites. This has not happened in the past few years due to funding constraints. More intensive efforts would take place near ecosystem boundaries, where systems were more complex and the most responsive to change (Curtin 2005). The McKinney Flats project (discussed later in this chapter) was such an effort located on the border of grassland and shrubland systems.
Prescribed Fires in the Peloncillo Mountains

The Malpai wanted to restore a more natural fire regime to the Borderlands. To do this, the Group wanted to conduct large prescribed fires to test their assumption that fire was a key natural process to maintaining grassland health. The vision was to orchestrate a series of burns in the Peloncillo Mountains with before and after vegetation monitoring to assess the impact of burning on grass and brush species, hydrology and sedimentology. In 1993, a Memorandum of Understanding was created among the Malpai and nine federal, state, and county agencies establishing new fire management policies that would allow prescribed natural fire or wildland fire use for resource benefit. Five large prescribed fires have taken place in the Borderlands since then: Baker 1 (1995), Maverick (1997), Baker 2 (2003), Cottonwood (2007), and Thomas Tank
Burn (2008) (Figure 13). The prescribed fires have provided information that has been used to inform the construction of fire management plans throughout the region.

The prescribed fires exemplify 1) how treating a specific management action as an experiment can provide learning opportunities and help inform future management plans, and 2) through the use of a collaborative planning process made up of private stakeholders and government agencies, risky management actions were tested that would not otherwise have been possible without widespread support.

Figure 13: Map of fires in the Malpai Borderlands region as of 2005 (from Sayre 2005, 119).
Design of the prescribed burn plans

In planning for each fire, all public and private land owners or managers who might be affected by a proposed burn were involved in the planning process. The New Mexico and Arizona Game and Fish Departments and the Fish and Wildlife Service were also involved in most of the burns. Planning took eight months to more than five years for each fire. State and federal biologists would raise concerns about critical habitat area, endangered or threatened species, and, the group would then work together to figure out whether the fire should happen, and if so, how they could do it without harming the species or habitat areas of concern.

When confronted with a lack of information, the group would invite scientific experts to provide a consensus opinion on how to proceed. For instance, at one meeting regarding the Maverick burn, 23 ecologists, biologists, and agency representatives talked about the interaction between fire, agaves and nectar-feeding bats. The endangered Lesser Long-nosed Bat was of particular concern because it feeds on agave nectar and there was fear that fire would kill agaves and consequently harm the bat population. The meeting brought bat and agave specialists together who had never interacted before. They agreed that 1) there was actually little existing information on fire, agave and bat interactions, 2) the proposed fire would probably not affect enough agaves to harm the local bat population, and 3) they came up with research questions to investigate before and after the burn. Essentially, this meeting reframed the question from whether the fire should occur to how much agave should be protected and how much can burn without harming the bats. According to Peter Warren, Malpai Coordinator for TNC, “We don’t have answers to all the concerns that have been raised, but we all agreed that the only way to get the answers is to do some burning and use the opportunity to conduct monitoring and research so we can learn from it and adapt our fire program in the future” (Sayre 2005, 115).
Other joint fact-finding efforts have proved more challenging. During the Maverick burn, several species of snakes were radio-tagged in order to track how many died during the fire. While there was only one snake casualty, the fire spread beyond its prescribed boundaries and burned at a much higher intensity in a nearby canyon where there was higher fuel build up. In planning for the Baker 2 burn, biologists were concerned about the endangered New Mexico Ridge-nose Rattlesnake in areas with high fuel build up, which is good habitat for the snakes and which burns hotter than areas with less wood. The group agreed that areas with high amounts of wood would eventually burn, either naturally or with prescribed fires, and the snakes would be affected whether the group took action or not. The biologists wanted to minimize harm to the snakes, but there were so few of them and they were hard to find, so it was not possible to satisfactorily map their locations. In order to resolve disagreements within the group, they collectively decided to map snake habitat as a proxy for actual snake locations. After more than five years of planning, biological opinions, and habitat mapping, consensus was finally reached that the Baker 2 fire should take place and fuels should be kept under control in the future to limit the intensity of fires and decrease the potential harm to the New Mexico Ridge-nose Rattlesnake.

Implementation of the burns and monitoring protocol

Implementing a burn requires the coordination and cooperation of multiple parties about when it should take place and under what conditions. Decisions also need to be made while the burn is taking place that will influence the outcomes of the fire. Bill McDonald explained:

one [fire] was...the first burn on Arizona State Land in this area. And we [the McDonalds and Magoffins] had to write and get a special prescription for it and we actually held them off for a
year...we had a rain in June and I said, “y'know there's green in that grass, I don't want to burn it right now. It's not the right time.” ... And the next year, the conditions were better and we had a good burn, at least on our part. The Magoffins, I'm not sure if the country they wanted to burn was realistic...I think there was not enough contiguous fuel, and it needs some other work first before they can get it through there. They got some benefit out of it but not as much as I think they would have liked. There was a strategic or tactical decision made partway through the burn that I think hurt some of it. As they were coming off an area right next to the road which I wanted to treat and show the effects of, some of the burn started to get on the neighbor and they put a lot of resources and time into stopping that because he didn't want it. And by the time they got back to my place with it, it was nightfall, temperature dropped, humidity had risen a little bit and they didn’t really get the fire effects right that I wanted. But a lot of the stuff they burned during the day had and it’s done a lot of good. (McDonald 2012)

Burn areas are monitored like other Malpai monitoring sites. Peter Warren, who oversees the Group’s monitoring program, explained that one problem with monitoring burn areas is that fire does not burn evenly, and inevitably, plots that were set up in advance of a burn often end up in areas that do not catch fire. Some of the monitoring has been effective at demonstrating before and after effects of the fires, such as an increase in grass and decrease in woody species (Kay 2012).

*Evaluation of, adjustment to, and continuation of prescribed fires and data collection*

For more than 15 years there have been prescribed fires, data collection, discussion, and use of fire impact data in Borderlands fire plans. Joint fact-finding has been used to reach consensus and learn about the impacts from fire, though inconclusive data continues to be a source of contention. Data and visible changes in vegetation and wildlife response to fire have influenced several people in how they think about fire and its impact on Borderlands ecosystems,
and, fire management planning has taken place in response to information gathered from the
“test” fires.

Joint fact-finding on the interactions of fire, agaves and bats worked well for the
scientists, agency representatives, and Malpai ranchers. Through collaboration, the group
embraced an experimental approach for building knowledge. Studies conducted in relation to the
Maverick burn indicated that very few agaves died as a result of the fire, and that fire might
actually increase agave germination and establishment. It was also discovered that agaves are not
a limiting resource for the nectar-feeding bats. Since the Maverick burn, no one has expressed
concerns about fire’s impact on the Lesser Long-nosed Bat and the monitoring data has shifted
how several biologists think about the impact of fire on this species. Inconclusive and difficult to
measure findings such as those with the New Mexico Ridge-nose Rattlesnake have been
frustrating for the Malpai because it is not clear what to do/not to do in response to the data, and
stakeholders continue to disagree about what might or could be happening.

Both Peter and Bill have found that taking people to visit a burned area, so they can see
how the land responds to fire, is equally if not more influential than showing someone fire data.

Bill explains:

We had a situation in...one of the fires that was on the Diamond A
where they burned extremely hot in one canyon that had Ridge-
nose Rattlesnakes in it and it was basically a mistake by the New
Mexico State Forestry. And Charlie Painter...a big herpetologist,
said, “well you just wrecked that habitat for Ridge-nose.” And he
went back there expecting to document that and found more Ridge-
nose Rattlesnakes than he's ever seen anywhere. And that
population is continuing. So, they have to go back and re-think
their whole idea for what Ridge-nose Rattlesnake habitat is. I think
these animals have been in this spot for whatever reason and they
can withstand just about anything short of nuclear holocaust - that's
their home and that's what's gonna be their home. That's a layman's
view, but that was certainly borne out by that. (McDonald 2012)
Each prescribed fire presented a new series of challenges to the Malpai and their partners, which, in turn, contributed to the development of more comprehensive, pro-active planning tools. Based on information gathered from the prescribed burns and wildfires in the area, several fire plans now exist for the Borderlands region. The Bootheel Fire Management Plan was designed to provide guidance for managing fire in the Borderlands that lie in New Mexico, the Peloncillo Programmatic Fire Management Plan aims to conduct large-scale prescribed fires in the Peloncillo mountain range to better balance woody vegetation and grasses before natural fires are reintroduced into the area, and the Malpai Borderlands Regional Fire Management map identifies the preferences of private landowners in the Borderlands in regards to their preferred response option in the event of a wildland fire (consult with owner, contain and control, or suppress immediately). The Coronado National Forest is also developing fire plans for other mountain ranges in the region. The Malpai have also collaborated with FWS to develop a habitat conservation plan. The fire and species plans were developed in an attempt to make future decision-making processes more efficient and to avoid having to deal with each fire and species decision on a case-by-case basis.

Fire is risky. To conduct a prescribed burn an agency needs public support, but public safety and property damage tend to drive decision-makers away from permitting intentional burns. The Malpai enabled federal and state agencies to be more active about implementing prescribed fires. (Kay 2012)

Many questions still remain unanswered on the impact fire has on various plant and animals species in the Borderlands. Despite these questions, the Malpai are hopeful about preliminary findings. Bill explains: “I think we're finding out that everything here evolved with fire. I mean even if you burn down this brush, it comes back. I mean it's not an “ok we won and
done” deal. It's nothing like that, but it does definitely give the grass a shot in the arm, there's no doubt about it. And all the species seem to do fine” (McDonald 2012).

**Summary of Case 2**

A group of people have worked together to test fire as a land management strategy. Each burn plan was based on a combination of scientific and local knowledge developed by a range of stakeholders. Plans were made to measure various impacts of each fire; results were analyzed and then used in subsequent decisions. Most importantly, fire management and policies have changed in the Borderlands region in response to preliminary findings from the prescribed burns. Components of the prescribed fire planning and implementation processes in the Borderlands correspond with many of the key elements of CAM (Table 4).

The fires have been controversial and, in some instances, it has taken several years for all of the parties involved to agree on a fire prescription plan. There have been moments in time when consensus building has stalled, however, joint fact-finding has been effective at overcoming these challenging situations. Joint fact-finding was used through collective consultation with experts and conducting studies to gather information to fill knowledge gaps. It also served as a means for parties to reach agreement. Without widespread support for each fire, they would not have taken place. In a few instances, a few key players were not initially a part of the process and were brought in later in the conversation when it was recognized that their input was necessary in order to move forward with plan implementation. Significant deliberation took place during the initial planning process for each fire and discussions are ongoing as to the meaning and implications of fire’s effects on vegetation and wildlife. The data gathered so far has been integrated into future fire plans.
Table 4: Key elements of CAM.  ● = element is consistently present, ○ = element is sometimes present, □ = element is absent.

<table>
<thead>
<tr>
<th>Elements of CAM</th>
<th>Las Cienegas</th>
<th>Prescribed Fires</th>
<th>McKinney Flats</th>
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<tbody>
<tr>
<td>Convene a working group that includes representatives of all key interests</td>
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<tr>
<td>Define problem(s)</td>
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<td>●</td>
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<tr>
<td>Decide if CAM is the appropriate tool</td>
<td>●</td>
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<tr>
<td>Develop a process agreement</td>
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<tr>
<td>Create ecologically-based goals and objectives</td>
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<td>Specify a conceptual model</td>
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<td>Develop hypotheses</td>
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<tr>
<td>Design management experiments/interventions to test hypotheses</td>
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<tr>
<td>Design a monitoring plan</td>
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<td>Implement management interventions</td>
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<td>Implement monitoring plan</td>
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<td>Evaluate results of experiment</td>
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<tr>
<td>Reassess and adjust the problem statement, goals/objectives, conceptual model, interventions, and monitoring plan</td>
<td>●</td>
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<tr>
<td>Cycle is continuously repeated</td>
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Data collection is based on monitoring items of interest and controlled, replicated experiments are not happening in regards to the prescribed fires. Monitoring the impacts of fire has been challenging at times. Before and after monitoring is the only real way to assess the impact of large landscape-scale fires and data has not always been conclusive. Since fire does not burn evenly, it can be challenging to measure the before and after effects.
The McKinney Flats Project

McKinney Flats is an 8,800-acre site on the Diamond A Ranch in southwestern New Mexico. The 10-year, replicated landscape-level study on the interaction of fire, herbivory of both native species and cattle, and climate was supported by the Rocky Mountain Research Station, the Malpai Borderlands Group, the Animas Foundation, and several other public and private funding sources. Charles Curtin was the lead scientist for the project (Figure 14).

This case highlights 1) the value of testing assumptions through controlled and replicated experimental design, and 2) the benefits, challenges, and impact of conducting long-term, large-scale, multi-variate (complex) place-based science experiments on private land.

Figure 14: Images of a prescribed burn (left) and cattle (right) at McKinney Flats (from Curtin 2005, 249 and 250).

Design and Implementation

The McKinney Flats experimental design was based on a combination of scientific and local knowledge. Malpai ranchers were involved in designing the project, but a team of professional scientists from federal agencies, TNC, the Animas Foundation, and the Arid Lands Project largely developed the details of how the experiment would work.
The experiment was set up so that the whole site was split into four pastures. Within each pasture there were five areas, each receiving different treatments: grazed/unburned, ungrazed/unburned, grazed/burned, and ungrazed/burned, grazed/prairie dog (Figure 15). To accommodate for climate effects, the pastures spanned a 25% rainfall gradient. There were additional exclosures that excluded livestock and native species including deer, pronghorn, rabbits, javelin, and rodents – to help show the relative effects of these species on grassland vegetation composition, and the interaction of herbivory with fire.

Figure 15: Diagram of the experimental design layout for the McKinney Flats project (from Curtin 2005, 244).

Field crews made up of professional biologists, local high school students, and college interns measured the distribution and abundance of birds, grasshoppers, lizards, small rodents,
and vegetation. Diamond A cowboys moved the cattle. The cowboys were not involved in the project beyond cattle management and most of the Malpai ranchers were never involved in the data collection. Charles explains how the Malpai ranchers had ownership in the project without being directly involved in its implementation:

Some of the kids worked on the project but not a single one of them...like Bill McDonald [Executive Director of the Group] only set foot on McKinney once in a decade. And yet they [the Malpai ranchers] clearly considered it their project. By having them so engaged in the design process...it meant that they didn't have to be out there collecting data to take ownership, and that for us was very important, that they feel a sense of connection and ownership of the process. (Curtin 2012)

Sometimes the cowboys could not move the cattle when planned and they would eat more grass than was intended, or adjustments had to be made in response to wild fires and one or two pastures would be lost for a season. When things did not go exactly as intended, Charles and the others directly involved in the project’s implementation convinced themselves to embrace the bumps, play out whatever happened, and learn from the experience (Kay 2012).

Evaluation of, and adjustment to, McKinney results

McKinney Flats helped shift environmental and agency mindsets about grazing on public lands, changed scientists’ understanding of fire, herbivory and climate interactions, and contributed to the dialogue about reintroducing fire into the southwest.

McKinney Flats scientifically proved that grazing and fire are not necessarily bad in the semi-arid southwest and it highlighted the importance of climate and native grazing species in driving ecosystem processes in the Borderlands. Fires were previously thought to harm desert grasses, but burned areas at McKinney showed that is not true for most species. According to Drewa and Havstad (2001 in Curtin 2005, 249): “This is important for land managers because it
means that the fire can serve as a viable management tool in these systems, and is consistent with other recent fire experiments on desert grasslands.” The data showed that livestock grazing was not necessarily damaging to desert grasslands and wildlife. Large native grazers, such as pronghorn had more of an impact on the grasses than the cattle. Fire and grazing had more of an impact when combined with each other and with drought conditions. The additive effects could flip an ecosystem from one state to another, showing the importance of studying the interaction of processes rather than studying them in isolation (Curtin 2008).

Whenever the researchers had the chance, they shared the project’s progress and preliminary data; information was shared and discussed at Malpai science and agency meetings, there were updates in Malpai newsletters for over a decade, and both results and progress on the experiment were publicized whenever the Group had a chance.

The McKinney Flats project was designed to fill knowledge gaps. The project changed and clarified conceptual models and understanding of ecosystem driving force interactions in the Borderlands. The project added to the discourse on livestock grazing and fire management in the southwest, but specific changes resulting from the experiment are hard to identify. The research project was certainly the most rigorous scientific experiment the Malpai have been involved in and its rigor helped provide scientific backing and credibility to the Group’s claims that fire and grazing are not necessarily bad. However, since the McKinney Flats project reinforced Malpai ranchers’ assumptions about fire and grazing, it has had little effect on how they manage their land and cattle. Some ranchers learned about climate and its role as the driving force in grassland health. Bill McDonald reflected: “a lot of people were worried about what it [work on McKinney Flats] was gonna show, and it pretty much showed that climate trumps everything else.” A few
interviewees thought new ranchers in the area may have looked at McKinney results and, in a few instances, it has influenced how they do their ranching.

*McKinney’s end*

After nearly 10 continuous years of data collection, the McKinney Flats project officially ended in 2010. The project’s conclusion took place in a somewhat antagonistic manner; the Animas Foundation (an organization run out of the Diamond A Ranch) did not renew its contract with the Arid Lands Project (the organization run by Charles Curtin) and all of the fencing exclosures, materials, and cattle from the research site were removed in 2007-2008, in violation of the agreement between the two organizations. Charles returned to the site through 2010 to finish data collection despite the disruption in the research design and what he felt was a barrage of negative energy. Determined to finish his biological experiment, Curtin was also determined to finish the social experiment of conducting large-scale, community driven, place-based science on private land. (Curtin 2012)

According to Malpai-affiliated interviewees, the McKinney Flats project ended because it ran out of money and because of the strained working relationship between Charles and some of the Malpai (Kay 2012). The project’s long-term continuation is impressive, but this falling out highlights the ongoing challenge of long-term collaborative research and the necessity to maintain funding sources, sustain the relationships between the people involved, and the need for systems to resolve disputes.
Summary of Case 3

For several years, McKinney demonstrated active testing of multiple management options through a clear experimental design developed and approved by scientists, ranchers, federal agencies and environmental groups. Findings reinforced the idea that grazing and fire may be appropriate land management strategies in the region, challenging scientific and environmentalist assumptions about fire, grazing and the role of climate in the southwest. The project was collaborative in the sense that relevant stakeholders were involved in project design, hypothesis identification, and evaluation of the results. Scientists were expected to independently analyze McKinney data and interpret findings, so joint evaluation was not a part of this project, but there was consensus agreement on how evaluation would take place. These characteristics demonstrate effective examples of several of the elements of CAM (Table 5).
Table 5: Key elements of CAM.  ⬜️ = Element is consistently present, ⬜️ = element is sometimes present, ⬜️ = element is absent.

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This project used a long-term place-based approach instead of an iterative design, meaning, management interventions were not adjusted during the duration of the experiment. The system of controls and replicated long-term data collection, however, led to the most conclusive findings out of any of the cases examined.
CHAPTER 4: DISCUSSION OF RESEARCH QUESTIONS

I set out to answer three questions through my research: 1) what does CAM look like in practice? 2) Are my cases actually examples of CAM? Why or why not? 3) If so, what is promoting or enabling CAM to happen in these efforts?

Questions 1 and 2

The first question was descriptively answered in the two previous chapters and demonstrated that there are a range of possible organizational structures that can permit CAM, not just one. This variety suggests that it is important to develop a model appropriate to each particular situation. No matter what structure used, CAM efforts need to be able to withstand the test of time and embrace ecological-social system complexity and dynamics.

In regards to the second question, do any of the cases in this study fit the ideal CAM model? Each effort includes most of the key CAM elements, but, CAM does not just take place in one moment of time, it is a process that lasts, at a minimum, for several years. Therefore, CAM processes are dynamic and change, and there are a number of examples within the cases when elements are sometimes present and sometimes absent, depending on the instance in time. What becomes clear from looking at moments when key elements are absent is that the CAM process falters or stops. This is exemplified at Las Cienegas where the absence of rigorous hypothesis testing makes it difficult at times to connect data with management decisions and potentially makes CAM processes take longer than they need to. The absence of a key stakeholder at Las Cienegas also puts the process at risk for falling apart. Absence of a system to deal with conflicting interests and personalities with the Malpai prescribed fires, led to an impasse with the Malpai ranchers and some of their scientist partners and contributed to the
disintegration of the McKinney Flats project. In all three cases, absence of long-term, stable funding jeopardize monitoring and experimental projects.

Despite each case’s missing elements of CAM (or moments of missing elements), the groups of people working in the Sonoita Valley and the Malpai Borderlands have persevered and continued their CAM-like efforts for several years. I have identified three categories which explain how the cases have been able to withstand the length of time and dynamic nature of a CAM process and overcome the absence of certain CAM elements: 1) specific tools have been implemented to address and overcome missing elements of CAM, 2) effective design and implementation of CAM elements has created momentum to sustain the efforts, and 3) additional factors have enabled long-term continuation of these projects. For the remainder of this chapter, I discuss these three ideas in more detail.

**Question 3: What promotes or enables CAM to continue over time?**

Specific tools or mechanisms have helped the groups in this study address problems with their processes. For example, the Las Cienegas stakeholder group was struggling with their collaboration at their biological planning meetings, tension was developing between stakeholders, and, rather than working together, there was a tendency to think in a very silo-ed manner (Kay 2012). By bringing in a professional mediator, the group greatly improved their process by providing a more open forum for discussing concerns and working together (Kay 2012). When Malpai ranchers, agency representatives and scientists were butting heads about endangered species concerns and planning prescribed fires, a joint fact-finding process was used as a means to break through the impasse. With the Lesser Long-nosed Bat and agave situation, expert scientists talked to each other and the group and made a consensus recommendation about
how to proceed and how to gather additional missing information. With the New Mexican Ridge-nosed Rattlesnake concerns, two years were spent mapping the snake habitat in order to design a fire plan that would minimize harm to that particular species.

The three cases also provide excellent examples of several of the CAM elements, which have been effective at accomplishing their purpose. For instance, the experimental design of the McKinney Flats project was set up to test specific assumptions about fire, herbivory and climate interactions, and within a decade of data collection, including unanticipated events such as a drought, there were statistically significant results regarding the hypotheses being tested. The ecologically based objectives in the Las Cienegas RMP have made it possible for the stakeholder group to measure their progress and re-evaluate their objectives when they compare data trends and patterns with the sought-after outcomes (Kay 2012). In all three cases, there has been a tremendous integration of scientific and local knowledge that has informed problem identification, goal and objective-setting, experimental and monitoring design.

Additional factors have also been critical to sustaining momentum and supporting CAM projects over time: long-term effective leadership, enthusiasm and support by stakeholders and partner organizations, a feeling of pride, ownership and success in the approach and outcomes of the projects, and money. None of the efforts would have been possible without strong and consistent leadership from a few individuals. For the Malpai, private landowners have led the way with strong support from TNC and several agencies. In Las Cienegas, individual BLM staff members have taken the lead. Succession strategies are needed to prevent the collaborative processes from disintegrating.

Long-term commitments by stakeholders and partner organizations have also helped keep these efforts going. Those involved have stayed invested and have embraced the problem solving
and experimental approach being used to test management strategies. Forest Service, NRCS and TNC personnel have worked with the Malpai ranchers for nearly two decades. In both study areas, collaborative efforts emerged out of group discussions and have not been handed down by an agency or scientist (Kay 2012). Interviewees in both groups identified that one reason they have continued their involvement over time is because they feel like the groups have been successful at getting things done (Kay 2012). With the Malpai, their combination of small, short-term work in combination with their long-term monitoring and science projects helps keep their momentum (and investors) going (Kay 2012). At Las Cienegas, some stakeholders have identified that they feel like they can get more done in the Sonoita Valley than with their other projects, and that is one reason they have stayed involved (Kay 2012).

The groups have also managed to finance their projects for several years. The 10-year SBEM grant enabled several research projects to take place in the Borderlands, and grant-writers for this project attribute the collaboration across sectors and interests as critical to winning the grant (Gottfried and Edminster 2005). Sharing resources between organizations, a strong network of public, private and non-profit organizations, supplemented with grants and university partnerships has strengthened the financial and personnel network of the Malpai. Similarly, with Las Cienegas, the partnership, personnel and financial resources from various organizations has helped to support efforts there. At the same time, absence of consistent funding puts long-term monitoring and experimental projects at risk of ending. For the Malpai, lack of grant and donor money has halted long-term monitoring for the past few years. Loss of money also contributed to the ending of the McKinney Flats project. At Las Cienegas, removal of invasive species largely relies on grant money. These groups should be concerned with the absence of a secure long-term source of funding.
Perhaps the most important mechanism for implementing CAM has been the desire of a group of people to actually do it. The Malpai and their partners collectively wanted to make change happen in the Borderlands. At Las Cienegas, the BLM and stakeholder group wanted to try a different, collaborative approach to resource management planning and implementation. For both groups, participants have essentially said: “we don’t really understand everything there is to know about X. Let’s try something we think could work, see what happens, and then decide what to do next.” There is a group of people who are invested in using an investigatory approach and are okay (in theory at least) being proven wrong. Without this collective aspiration, it is hard to imagine that any of the cases would have implemented their management strategies, monitoring programs and experiments, or provided opportunities for better understanding how climate, fire, invasive species removal, and cattle grazing impact plant and animal species, ground cover, biodiversity, and sedimentation rates. This desire for collaboration and change, in combination with organizational structures that promote regular meetings to share data and discuss what to do next, provide the underlying umph driving the CAM processes taking place in these two places.

Summary of findings

Ecosystem management is complex. Long-term impacts of management interventions can take several years to implement. This means there is a need for someone to manage and lead such projects over long periods of time. This means there needs to be a system for including all relevant stakeholders and addressing conflicts should they arise. It means figuring out how to conduct experiments without obstructing the daily activities of those involved in management implementation. It means figuring out how to connect the disciplines of science and management
that tend to operate on different time scales and have different focus. If a CAM approach is being designed, projects also require the development of a system to support and help foster an iterative management process such as regular meetings, with facilitated discussion of data and the resolution of any conflicts. To do this, effective leadership, partnerships and the financial capacity to support long-term efforts are necessary.

The three cases in this thesis all had intensive initial collaborative planning processes which got stakeholders involved right away, gave them ownership over the resulting decisions, and contributed to making them want to continue their involvement through implementation. Clear plans with specific, measurable and time-bound objectives have facilitated implementation and provided a way to measure ecological progress. Scientific and local knowledge have been purposefully combined and used to advise the groups’ processes. The groups have also embraced the idea of trying things out, assessing how they do, and adjusting future decisions based on what they find out. They have discovered that monitoring data adds information and credibility to the decision-making process, whether it provides conclusive information or not. By incorporating new information into subsequent decisions, management has (hopefully) improved faster than would have otherwise happened. They have also identified and implemented effective tools for adjusting their processes over time to overcome obstacles.
What are the implications of these findings?

How can the analysis of three cases assist others interested in using CAM? In order to design and implement a durable, flexible, and wise CAM process in which those involved and affected by the decisions feel like they have ownership in the process, trust each other, and where outcomes are based on credible information, 1) a collective “we want to do this” attitude, 2) strong experimental design, 3) clear organizational structure, and 4) institutionalization of the CAM process are necessary.

When designing a CAM process, a group of people have to want to do it. They may not agree with each other about the problem being discussed, but they need to be willing to work with each other to test management strategies, learn from them, and incorporate their learning into future decisions. This group mindset is critical to giving the stakeholders ownership in the decisions being made and in making decisions that are legitimate in their eyes and those they represent in the process.

If it will take decades to collect enough data for results to clearly indicate anything, it would be wise to maximize the amount that can be learned during that time. When designing experiments to test specific hypotheses about how a management action will affect X, Y or Z of a particular ecosystem, experiments need to be conducted to be as meaningful as possible. This means experimental designs should include controls and replication of hypothesis-tests (Walters 1986). If several different management strategies can be tested at once, that should happen.

An organizational structure is necessary as a means for reviewing data, making decisions, and dealing with conflict. A regular system of meetings and information sharing are critical for
building transparency, trust and collaboration between stakeholders and can help stakeholders trust and believe in the process. It also provides a means to re-evaluate and improve the process over time.

CAM processes are not a short-term series of meetings (even though they may begin this way), and if they are going to last for several decades, they require long-term funding, leadership, and participation with systems for organizational capacity building and succession strategies. Therefore, the durability of a CAM process can be enhanced by stable or guaranteed investment in money, people, and time.

Recommendations for current and future CAM practitioners involved in natural resource management efforts

I suggest reviewing and following the suggestions in this section before embarking on any CAM project. This section provides a condensed review of what has been covered in this thesis and 1) clarifies what conditions are necessary if CAM has any hope of being implemented effectively, and 2) includes a list of recommendations for people currently involved or interested in pursuing CAM efforts.

Proceed with CAM as a resource management approach if the following conditions are met: 1) Uncertainties have been identified regarding the ecological impacts of specific management actions, 2) the management interventions in question can be controlled and manipulated, 3) the ecological impacts of concern can be measured, and 4) a group of stakeholders is interested in further understanding management-ecosystem interactions and adjusting subsequent decisions and is willing to commit to long-term participation. I would not pursue CAM if any of the following conditions are true: 1) it is too challenging or ecologically risky to test certain management strategies, 2) the variable(s) of interest are not controllable, 3)
the ecological impacts of interest are not measurable, 4) the management interventions’ ecological impacts are already well understood, 5) stakeholders are not really interested in the pursuit of understanding, adjusting management strategies based on new information, or are not interested in working together for a long stretch of time.

I have summarized my recommendations to potential CAM users under three headings: 1) Recommendations for all stakeholders, 2) Recommendations just for scientists, and 3) Recommendations for agency staff. I chose these three distinctions because CAM requires a group of people representing different interest groups, scientists to aid in the development and implementation of scientifically credible experiments and monitoring protocol, data collection and interpretation. Municipal, county, state and/or federal agencies also need to be involved in any CAM effort involving public land, water or other environmental resources as the official entities with decision-making authority.

Recommendations for all stakeholders

Collaborative planning processes for CAM are critical for reaching agreement on how the long-term collaborative effort will be organized and how the group will use data, make decisions, handle changes in stakeholder representation and address disputes.

- In drafting an agreement for how a collaborative adaptive management process will work, if the group decides they would like the assistance of a mediator, the group needs to decide how to select a mediator and how to pay for the neutral party’s assistance.
  
  o Mediators advertise in phone books and on roster lists, such as the U.S. Institute for Environmental Conflict Resolution mediator roster list.
  
  o In identifying a mediator who will be a good match for the proposed CAM process, the mediator should be someone who is good at facilitating multi-stakeholder conversations about complex natural resource management problems, resolving disputes in such settings, knows something about the natural resource
topic of concern, and is strong in process design (and not just facilitating conversations).

- In order for the mediator to be perceived as fair and unbiased in the eyes of the parties, the group needs to agree on who is selected to mediate, how they are selected, the scope of work the mediator is being hired to do, and how the mediator is to be paid.

- In drafting an agreement for how a CAM process will work, the group should identify any missing stakeholders who they think should be a part of the group. If any missing stakeholders are identified, they should be invited to join the group.

  - A stakeholder assessment process facilitated by a neutral party can help identify missing parties.

- In drafting an agreement for how a CAM process will work, roles and responsibilities for implementation need to be spelled out.

  - In spelling out roles and responsibilities, this should include how to handle replacement stakeholder representatives (i.e. a new person from X agency will replace the former agency representative) or what to do if a party chooses to leave the process (i.e. they should explain to the group why they are choosing to leave and the group should see if they can agree to a way to meet that party’s needs so they do not have to exit the process).

- In drafting an agreement for how a CAM process will work, a meeting schedule and structure needs to be planned.

  - Specific items that need to be agreed to by the group include: how often meetings will take place, where they will take place, what will be covered at these meetings, how agendas will be crafted and circulated, how additional agenda items will be addressed, how communication between parties will take place between meetings, and how sub-groups or working groups can/will be used.

- In drafting an agreement for how a CAM process will work, part of the agreement should include what will happen with the findings, no matter what they show. This could take the form of a contingency plan (i.e. if the data shows V, then we will do W, if the data shows X, then we will do Y, and if the data shows something we are not considering right now, then we will do Z).

  - Before signing off on such an agreement, stakeholder representatives should get approval from the group s/he is representing (their second table).

- In drafting an agreement for how a CAM process will work, a plan needs to be made for how disputes will be handled (i.e. such as using a neutral party).
• In drafting an agreement for how a CAM process will work, a plan needs to be made for revising goals, objectives, roles and responsibilities, meeting schedules and structure.

*Recommendations for scientists (as parties in a CAM group or as joint fact-finding consultants)*

Scientists may be involved in CAM in a variety of ways. Many agency representatives involved in these processes are scientists. Other stakeholders may also be scientists. The stakeholder group may bring in additional technical experts when they want specific advice or guidance in deciding how to proceed with an aspect of their project.

• A joint fact-finding process should be used as a way to combine scientific and local knowledge and to ensure that experiment or monitoring results are relevant to group goals and objectives.
  
  o In designing models that describe current understanding of the ecosystem of interest and driving variables, a collective process should be used to integrate scientific and local knowledge into informing a group vision. This same kind of collective process can be used to brainstorm possible management options and possible outcomes of proposed interventions.
  
  o If possible, models should be clear and simple for all stakeholders to understand. If models involve technical details that cannot be simplified, then the essence of this information needs to be communicated in everyday language that anyone can comprehend.

• Include stakeholders in data collection and analysis if possible to sustain engagement through citizen science. This could be accomplished through data collection days or events. Partnering with high school students or community college classes is another possible way to engage local residents in scientific activities.

• An experimental approach in which variable(s) are tested in a controlled and replicated way will likely result in more information faster, and is more likely to help determine causality than just monitoring a management action before and afterwards and trying to analyze trends. If possible, try to test multiple management options at once to compare results.

• If the experiment is intended to affect policy or future management actions, to increase the likelihood results will have an impact, link data analysis to a future planning or decision-making process in which the project’s results will feed directly into future decisions. This can be accomplished in the group’s agreement for how the CAM process will work where the plan specifies what will happen with findings (as discussed above in
the stakeholder section). One example of this might be to incorporate the experiment’s results into a future plan (i.e. the Peloncillo Programmatic Fire Plan) or in drafting a policy recommendation.

**Recommendations for agency decision-makers**

Public agency leadership and/or involvement is essential if a CAM effort is designed to affect management of public resources.

- If an agency is interested in convening some kind of CAM process, getting the right parties to the table is critical for having effective discussions. A stakeholder assessment conducted by a neutral third party is one way to identify all key stakeholders and have some explain what it would mean to participate in the collaborative process, how to engage at the negotiation table, and how to engage with the constituents at the representative’s second table. A neutral can also provide assistance to all participating parties in their preparation for negotiations.

- If a process is initiated by a public agency, then identifying an agency representative who will be a good fit for leading such a CAM effort includes:
  
  o The agency representative needs to have the ability to convene key stakeholders for the public process (get the right people to the first table) and have enough influence within his/her agency to influence changes in management decisions (make things happen at the second table).
  
  o The agency representative needs to be genuinely open to, and encouraging of, an inclusive process in which stakeholders deliberate over data and offer suggestions on subsequent decisions (in other words, the agency representative understands and wants to use a participatory process).
  
  o The agency representative needs to be able to make change happen in response to group discussions and not just talk and respond to a group of stakeholders (needs to have authority to institutionalize change).

- Since CAM processes could last from several years to several decades, agencies need a plan to accommodate for changes in leadership and/or representation in a CAM process.
  
  o Institutional capacity in an agency could be built through training staff about CAM and effective strategies for how to do it well. To find qualified trainers, consider looking for help from individuals or a group of people whom have/are involved in a CAM process.
• Having more than one representative or an observer from an agency involved in a CAM process could be another way to build internal capacity for leadership succession.

• Since public funding streams tend to target short-term projects, if possible, agencies should develop long-term project financing mechanisms.

  o Public agencies need to adjust their budgets and make long-term investments in these kinds of projects.

  o Partnerships with local, regional and national foundations and organizations can provide a way to pool resources from multiple sources.

  o Additional, but less consistent, funding can come from grants and short-term partnerships (i.e. with university researchers).

Final thoughts

At the end of this project, I have three lingering questions: 1) Is CAM a good idea?, 2) Are the cases in this study good models for others interested in pursuing CAM?, and 3) Is CAM really as elusive in practice as it seems at first glance?

In theory, CAM will reduce uncertainty and produce better ecosystem management decisions over time and there will be widespread public support behind these decisions. While I did not set out to empirically test CAM theory, at the end of this project, I find myself wondering whether CAM is an effective way to get to these predicted outcomes. Over the past two decades, the groups of people involved in my cases have learned a few things about how semiarid grasslands in the southwestern U.S. function and the impact that their decisions about livestock, fire and invasive species have on these systems. Strong partnerships have developed and lasted and there is an expanding network of collaborative natural resource management efforts in southern Arizona and New Mexico that seems, at least in part, to be in response to the enthusiasm behind already existing efforts such as the ones described in this thesis. The big
question remains: does CAM or can CAM lead to better ecosystem management decisions over time? There is some evidence in the Malpai Borderlands that fires have some ecological benefits. There is also evidence that livestock grazing can slow the impacts of climate change in semiarid grasslands. It seems like the people participating in my cases are wondering what the long-term, landscape-scale effects of their decisions have been. The Malpai have recently embarked on a new project with the Jornada Experimental Range to analyze their planning area through remote sensing techniques, to compare ecosystem conditions over the course of the past several decades to see if they can get a better sense of the impact of their activities. The Las Cienegas group is continuously reflecting on whether their management decisions are helping to achieve the group’s ecological objectives or not. This question certainly deserves more in depth analysis.

Are the cases in this thesis rare instances that would be hard to replicate with another group of people in another place? Perhaps. But this kind of logic also seems like an easy way to dismiss and not learn from the work being done in the Malpai Borderlands and the Sonoita Valley. If we cannot look to these cases as examples of long-term collaborative efforts focused on improving ecosystem management through collaborative problem solving and joint fact-finding, then, I imagine we will have a hard time assessing whether CAM is a good idea or not and when it is an appropriate tool to use.

At the start of this project, I had a hard time identifying candidate projects to study and found myself wondering whether there were any existing examples of CAM. Through the course of doing this research, I have learned of several other CAM-like projects from the people that I interviewed (See Appendix A). My suggestion to anyone interested in studying CAM further is to spend the time looking for the elusive cases – they are out there.
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APPENDIX A: CASES CONSIDERED FOR THIS PROJECT

Table 6: Cases considered for this project.

<table>
<thead>
<tr>
<th>Case</th>
<th>Why I did or did not select this case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malpai Borderlands Group</td>
<td>Possibility, passive and active AM</td>
</tr>
<tr>
<td>Las Cienegas National Conservation Area Adaptive Management Program</td>
<td>Possibility, passive AM</td>
</tr>
<tr>
<td>Trinity River Restoration Program</td>
<td>Possibility, passive and active AM</td>
</tr>
<tr>
<td>Suwannee River Partnership</td>
<td>Possibility, passive AM</td>
</tr>
<tr>
<td>Platte River Recovery Implementation Program</td>
<td>Too new to evaluate</td>
</tr>
<tr>
<td>CALFED Bay-Delta Program</td>
<td>Lack of collaboration</td>
</tr>
<tr>
<td>Oregon dry forest ecosystem restoration strategies</td>
<td>Too new to evaluate</td>
</tr>
<tr>
<td>Missouri Department of Conservation Forest Management for Oak Regeneration</td>
<td>Few stakeholders beyond scientists and managers</td>
</tr>
<tr>
<td>Glen Canyon Dam Adaptive Management Program</td>
<td>Data not connected to subsequent decisions</td>
</tr>
<tr>
<td>Adaptive Harvest Management</td>
<td>Few stakeholders beyond scientists and managers</td>
</tr>
<tr>
<td>Comprehensive Everglades Restoration Plan Adaptive Management Program</td>
<td>Lack of collaboration</td>
</tr>
<tr>
<td>Kissimmee River Restoration</td>
<td>Few stakeholders beyond scientists and managers</td>
</tr>
<tr>
<td>Upper Mississippi River Navigation and Ecosystem Sustainability Program</td>
<td>Too new to evaluate</td>
</tr>
<tr>
<td>Klamath Basin Adaptive Management Plan</td>
<td>Too new to evaluate</td>
</tr>
<tr>
<td>Chesapeake Bay Program Adaptive Management</td>
<td>Too new to evaluate</td>
</tr>
<tr>
<td>Northwest Forest Plan</td>
<td>Several challenges and barriers to implementation</td>
</tr>
<tr>
<td>Massachusetts Marine Spatial Planning</td>
<td>Too new to evaluate</td>
</tr>
</tbody>
</table>

Through the process of conducting this research I have been made aware of additional programs that seem to be doing CAM-like activities (Table 7).

Table 7: More possible CAM efforts.

<table>
<thead>
<tr>
<th>Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative Sagebrush Initiative</td>
</tr>
<tr>
<td>Altar Valley Conservation Alliance</td>
</tr>
<tr>
<td>Agua Fria National Monument</td>
</tr>
<tr>
<td>Wallowa Resources</td>
</tr>
</tbody>
</table>
APPENDIX B: INTERVIEW QUESTIONS

I used two sets of questions, the first were for in-depth, hour-long interviews with key people involved in each case. The second set of questions were used in brief 15-minute interviews with additional people involved in the efforts.

Long interview questions

Participant Information
1. Can you tell me a little bit about yourself and your role in name of organization?

Connection between science and management decisions
2. What are the most important management goals of the organization?
3. Have you/has the organization done anything to find out more about name key management issue(s)?
   If yes:
   a.) Can you give an example?
   b.) How did you/the organization do it?
      i.) How did you/the organization decide what information/data to collect?
      ii.) How was the information collected?
      iii.) Who was involved in the collection?
   c.) Were there any surprises in what you/others found out?
      If yes:
      i.) Can you give an example?
      ii.) How did you/the group respond to this information?
   d.) How did you/the organization sort through/discuss the information collected?
      i.) Who was involved in discussing/interpreting the findings?
   e.) Did what you find out have any effect on your management decisions, the group’s efforts?
      If yes:
      i.) Can you explain how?
4. How often do you/the organization do experiments/data collection such as the one we just discussed?
   a.) Has the way the organization has collected, discussed, and/or responded to information changed over time?
      If so:
      i.) In what way?

Sustaining the collaborative
5. How long have you been involved in the organization’s efforts?
6. How did you get involved in the organization?
7. Why do you continue your involvement?
8. Have there been major obstacles that the organization has dealt with in the past X years?
   If yes:
   a.) Can you provide an example about what happened and how the group
handled the situation?

9. Has there been an instance in which individuals within the group could not come to agreement about something?
   If yes:
   a.) Can you explain what happened and how the situation was handled?
   b.) Is this typical of how other challenges have been addressed in this group?
   If no:
   i.) Can you explain?

10. If you could give advice to another group who wants to pursue similar management goals such as this organization, what would be your main suggestions/warnings to them about connecting information gathering with management decisions and sustaining a collaborative effort over time?

Closing

11. Is there anything else you feel like I should know about the organization?

12. Can you recommend three people who you think is really really important that I talk to?

13. Can I use your name and let them know that you recommended I speak with them?

14. In the coming months, if I discover that I have follow-up questions that I would like to ask you, would it be all right if we set up a time to speak over the phone?

Additional questions if time

15. Can you describe a typical day/meeting?

16. Who is invited and who typically shows up to meetings?

17. Is there anyone who you wish were a part of this group who is not?
   If yes:
   a.) Who and why?

18. Is it possible for someone to join the group?
   If yes:
   a.) How would someone go about joining?
   b.) How would s/he find out about the group?

Short interview questions

1) Can you explain your involvement or role with the Las Cienegas Adaptive Management Program/Biological Planning Process?

2) Do you think the group is engaged in collaborative and adaptive management? Why or why not?

3) Can you give examples of things your agency is doing or has done that were modified in some way through the collaborative process?

4) What problems or concerns do you have about the collaborative and adaptive approach being used at Las Cienegas?

5) What would you say is the attitude of XX towards the approach being taken at Las Cienegas?
APPENDIX C: RESOURCE MANAGEMENT IN THE SKY ISLAND REGION

The Madrean archipelago or “sky islands” are a 70,000 square mile complex of 40 short mountain ranges located in southeastern Arizona, southwestern New Mexico and northern Mexico (Figure 16). The mountain ranges provide a range of altitudinal climatic zones, supporting different habitat and species at different elevations. At progressively higher elevations of each mountain range, oak woodland, pine-oak forest and coniferous forests thrive. Towards the bottom of each mountain range are desert scrub and grassland ecosystems. Elevations range from 1250 to 6750 feet. The mountains are like islands of cooler and wetter ecosystems supporting flora and fauna not found in the surrounding sea of grasslands and desert.

Figure 16: Relief map of the Madrean Sky Islands of North America and location of the two planning areas.
In order to more fully understand the natural resource management conflicts and questions that the groups in my cases are trying to address through collaborative adaptive management, it is helpful to understand how humans have used and impacted land and water resources in the region and what their concerns are today. In this appendix, I discuss the main resource and environmental management issues central to my cases: 1) loss of biodiversity, 2) livestock management, 3) fire suppression, 4) groundwater depletion, and 5) climate change.

**Loss of biodiversity**

In addition to supporting different species at various elevations, the whole Sky Island complex spans subtropical to temperate climates, promoting an outstanding degree of flora and fauna. A variety of soil types in the mountains also provide a multitude of niches for species. Furthermore, the separation of the mountain ranges means that some species have not been able to cross from one mountain island to another and evolution has happened in a relatively isolated manner. There is debate over what exact driving forces or combination of forces and events have lead to the rich biodiversity in the Madrean sky islands, but, whatever the evolutionary explanation, this region is a biodiversity hot spot. (Bodner et al. 2005)

While the area is ecologically thriving, it is also increasingly at risk for loss of biodiversity and resilience due to high erosion rates, over-pumping of groundwater, habitat fragmentation, suppression of fires and introduction of exotic species. In the past 20 years, there has been increasing concern about the population viability of several of the species living in the region. Many insects, fish, amphibians, reptiles, birds and mammals are species of concern. Several animals that used to live in the area are thought to have been extirpated including grizzly bears, ocelot, and the gray wolf. The increasing number of endangered and threatened species
serves as an indicator that better ecosystem management is needed if the region’s spectacular biodiversity is to remain intact (Warshall). Both groups are working to address all of these issues.

*Livestock management*

Livestock grazing caused severe ecosystem degradation in southern Arizona and New Mexico during the latter part of the 19th century, in a time known as the “cattle boom.” In 1870 in New Mexico, there were approximately 41,000 cattle and 619,000 sheep. In 1885, there were 800,000 cattle and 5 million sheep. There was a similar pattern in livestock ownership in Arizona. (Curtin et al. 2002)

Homesteading laws limited the amount of land a family could claim. This meant that most settlers relied on nearby, unregulated public land to graze livestock and the influx of animals lead to a tragedy of the commons of heavily overgrazed land. Formerly vegetated ground became bare, erosion and sedimentation rates increased around water channels that were made up of unconsolidated material not secured by vegetation, and arroyos formed. A vicious feedback cycle developed of eroded and bare landscapes becoming vulnerable to further erosion. (Curtin et al. 2002, Baker et al. 1994)

In 1905, in response to the highly degraded range conditions (and the near collapse of the cattle industry) in the southwest, President Theodore Roosevelt created the Public Lands Commission. The Commission recommended a system of grazing allotments and permits on national forest land. A few decades later, the Taylor Grazing Act extended a similar allotment and permitting system to the rest of the federal lands in the West, which would eventually fall
under the jurisdiction of the Bureau of Land Management. Today, a system of fixed stocking rates are still associated with grazing permits for leased public land allotments. (Sayre 2005)

In general, land conditions have improved over the past century, but they are still degraded compared to pre-cattle-boom conditions (Curtin et al. 2002). It is also generally agreed by ecologists and rangeland scientists that heavy livestock grazing can have severe ecological impacts but that simply removing livestock will not automatically lead to restored ecosystems (McPherson and Weltzin 2000).

Environmental activists have pushed to end livestock grazing on public lands. Ranchers who rely on public lands have been concerned that their livelihood was at risk if public grazing were to be banned or reduced in some way. Some ranchers (such as the Malpai) are convinced that they ranch in a sustainable way and are not causing harm to the landscape by lightly grazing cattle on it and adapting their management based on land and water conditions. In the Sonoita Valley, there are pro- and anti-grazing stakeholders who have agreed to use science to test their various theories. In both areas, collaboration between people with different perspectives and interests is enabling research to take place to better understand the impact of light livestock management on semiarid grassland ecosystems and how to effectively restore degraded lands.

Fire management

Studies of tree rings in the southwestern U.S. show a pattern of wildfires burning through grassland areas every four to eight years (Kaib et al. 1996). In southwestern grassland systems, when fires burn, grass plants are barely harmed because they grow close to the ground, below the most intense heat. Woody shrubs like mesquite, which grow from their branches higher off the ground, often die in forest fires. Without fires, these woody species encroach into the grasslands
For most of the 20th century, the U.S. Forest Service promoted fire suppression as the appropriate response to forest fires. While it is now generally agreed that fire suppression can increase the degradation of grasslands and watersheds, the details on how often fires should burn and how intensely remains unclear (Sayre 2005). There is also little known about how specific animal and plant species are impacted by fire or what the long-term consequences of large wildfires in the region would be like (DeBano and Ffolliott 2004).

In the 1990s, collaborative efforts of ranchers, forest service personnel and environmentalists in the Malpai Borderlands pushed to test the idea that fire might benefit the ecological health of the Sky Island region. With more than 15 years of vegetation and wildlife monitoring in conjunction with prescribed fires, there has been a gradual increase in understanding of how fires impact certain species (read more about this in Chapter 3).

**Groundwater pumping**

At lower elevations in the Madrean Archipelago, the climate is arid and the average annual precipitation is less than 100 mm. At higher elevations the climate is semiarid and annual precipitation can be more than 800 mm. The majority of precipitation falls during the summer in the form of short-duration, high-intensity storms. This water mainly flows through washes (empty river beds or arroyos), which otherwise lie dry for most of the year (Figure 17). Soils and vegetation that absorb some of the water are prone to high rates of evaporation and evapotranspiration due to the summer heat. With little perennial surface water in the region, most
people and industries rely on groundwater to supply water for drinking, irrigation and industrial purposes.

Figure 17: A typical water cycle in a semi-arid region (from Arizona Soils 2012).

During the 20th century, the Tucson metropolitan area began pumping groundwater at a rate faster than it was replenished. In 1980, Arizona’s Groundwater Management Act designated the Tucson region as an Active Management Area (AMA) with the goal to recharge the aquifer over which it lies by the year 2025. Despite this ambitious objective, Tucson’s population has risen from 518,438 people in 1980 to 853,423 people in 2000, meaning, municipal water demand has increased while mining operations continue as the largest users of aquifer water (Barker 2009). The Central Arizona Project (CAP), a canal that conveys water from the Colorado River to Tucson and other cities in central and southern Arizona, has helped to reduce some of the groundwater pumping, as have other water conservation measures, but, the Tucson metropolitan region still has a ways to go to recharge its aquifer (Barker 2009).
How does Tucson’s water use affect my case study areas? Excessive groundwater pumping from the aquifer underlying the greater Tucson metropolitan region has led to reduced stream flows in the Cienega Creek in the Sonoita Valley (Bodner 2012) (see Chapter 2). This, in turn, has harmed riparian habitat vegetation that relies on these surface waters (Bodner 2012). Other noted impacts from over-pumping groundwater include subsidence and deterioration of water quality (Baker et al. 1994). Water levels have dropped up to several hundred feet in areas throughout the Sky Island region (Baker et al. 1994). The stakeholder group working to manage Las Cienegas is struggling to distinguish the impact of their riparian area management decisions from the impact of regional groundwater depletion.

Climate change

Climate change predictions for the southwestern U.S. indicate that there will likely be more severe droughts and rain storm events in the future. This is of concern to many residents and public officials since plant growth, seeding rates and regeneration cycles are increasingly uncertain and unpredictable (Brown et al. 1997). An increase in species mortality is also of concern, such as what has been happening with piñon and ponderosa pine trees in Arizona and New Mexico, where native bark beetles, that typically only attack weakened or diseased trees, have killed millions of trees that have become vulnerable to the beetles as drought has stressed and weakened them (US Forest Service 2012). Climate change predictions for the southwestern U.S. also suggest that the frequency and severity of fires could increase due to changes in climate circulation (Heilman et al. 1998). Increased fire risk poses a threat to public safety if fires get out of control or intersect areas where people live.
The McKinney Flats project indicated that climate is the most powerful driving force in the Borderlands (Chapter 3). At Las Cienegas, changes in plant flowering times have been noted and the stakeholder group has decided to pursue scenario planning as an additional resource management tool (Chapter 2). While CAM may not be sufficient to address climate change concerns on its own, interviewees suggested that having a group of people who are used to problem solving together could be useful for addressing different and uncertain future conditions (Kay 2012).

**Combinations of ecosystem variables**

Livestock management, the role of fire, groundwater levels, and climate all impact ecosystems, but, limited research has been conducted on the combined effects of these variables or on their interaction with each other (until the McKinney Flats project discussed in Chapter 3). Understanding complex interactions between driving forces in the Sky Islands seems critical to better understanding the ecosystems of concern. Shrub encroachment into grasslands, for instance, is one visible change of ecosystem states throughout the Sky Islands. Comparisons between today and historical surveyor records, repeat photography and long-term data sets show that woody vegetation (i.e. mesquite) has spread into grasslands during the 20th century. When grasses are removed from a grass-dominated ecosystem in the southwest (such as what happens with extensive livestock grazing), there is less water loss due to a lower rate of evapotranspiration (Brown 1982). Woody plants with an extensive root system have more water available when there is less grass, and thus, shrub encroachment into grassland areas takes place. If grassland areas do not recover their grasses, then the likelihood of fires declines and woody plant encroachment expands (Brown 1982). According to Brown et al. (1997), shrub
encroachment has also been promoted by a shift in climate; when higher levels of winter rain are coupled with dry summers, shrub growth is favored over grass growth.

Research in the Borderlands and Sonoita Valley has and continues to provide insight into the interactions of different variables and driving forces and their impact on vegetation and wildlife species. Hopefully, work by the Malpai Borderlands Group and the Las Cienegas Biological Planning team will lead to more robust and adaptable restoration and resource management decisions in the future.
APPENDIX D: PARTIES INVOLVED IN LAS CIENEGAS ADAPTIVE MANAGEMENT

The following list includes parties involved in Las Cienegas collaborative planning and/or adaptive management efforts. * indicates that I interviewed a person from the specified organization or category.

US Government: State, federal and county agencies
- Bureau of Land Management (Tucson Field Office)**
- Coronado National Forest (U.S.D.A. National Forest Service)*
- U.S.D.A. Natural Resources Conservation Service*
- U.S.D.A. Agricultural Research Service*
- U.S. Fish and Wildlife Service*
- U.S. Geological Survey
- Arizona Game and Fish Department
- Arizona State Land Department*
- Pima County
- Santa Cruz County

Researchers/Scientists
- University of Arizona*

Non-government organizations
- The Nature Conservancy*
- Sky Island Alliance
- Sonoran Institute
- Arizona Zoological Society – Phoenix Zoo*
- Empire Ranch Foundation
- Audubon Appleton-Whittell Research Ranch

Organized groups representing conservation organizations, grazing and mining interests, hiking, bird-dog, mountain biking and off-highway vehicle clubs
Several individuals/residents/land owners/businesses*
- Vera Earl Ranch*

Other
- Southwest Decision Resources*
- U.S. Institute for Environmental Conflict Resolution*
APPENDIX E: LAS CIENEGAS ADAPTIVE MANAGEMENT FRAMEWORK AND BIOLOGICAL PLANNING PROCESS DIAGRAMS

Figure 18: A diagram of the Las Cienegas Adaptive Management Framework and who is involved at each stage (from Las Cienegas Adaptive Management Program 2012).
Figure 19: A diagram of the Las Cienegas Biological Planning Process and how it intersects with BLM management strategies (from Las Cienegas Adaptive Management Program 2012).
APPENDIX F: FEDERAL AND STATE AGENCY ATTITUDES ABOUT THE LAS CIENEGAS ADAPTIVE MANAGEMENT PROGRAM

Eight people interviewed about Las Cienegas work for state or federal agencies. I asked each of them to explain whether or not they thought CAM was happening at Las Cienegas. Everyone interviewed seemed to be in agreement that the process was collaborative, inclusive and stakeholders felt like they had ownership in the RMP. Discussions were considered to be useful and the group consistently reached consensus on whether past decisions were good or bad and what should happen next. Representatives from various agencies felt like they learned from others and had an opportunity to teach by being involved in biological planning meetings.

There was a mixture of responses, however, as to whether what is happening at Las Cienegas should be considered adaptive management. Everyone agreed that the data was analyzed by the group, but few interviewees could identify dramatic changes resulting the biological planning meetings. Interviewees could identify incremental changes that have taken place, such as adjustments to decisions about whether a parcel of land should be rested or burned. One interviewee explained that it is not always clear what to do in response to the data. Another interviewee was unclear if there was a formal BLM procedure for adjusting actions based on discussions in the group and thought the term “adaptive management” might be used too loosely to describe what is happening at Las Cienegas. Another interviewee said the amount of adaptive management seemed to depend on the availability of funding for projects.

I also asked agency representatives if anything their agency does (or has done) has been modified in some way through their involvement in the Las Cienegas collaborative process. A few individuals said they have been convinced that the approach being used at Las Cienegas is useful even if it takes a lot of time and energy to implement. Some interviewees said there have been no changes in what or how their agency does what it does. The person
interviewed from FWS acknowledged that FWS did not have to be involved in the biological planning process, but they chose to be because their involvement helped them keep track of species of concern and have input on what was decided about them. (According to Jeff Williamson, a CWP representative, it has been easier to keep agencies like FWS involved than neighboring land management agencies such as the state trust lands and forest managers. The Coronado National Forest lies outside the scope of the planning area. The State Land Department’s mandate is to sell state lands to the highest bidder to fund education. There is concern about the ecological consequences (especially to the riparian corridor) if state lands within the SVAPD are sold.)

The most visible impact Las Cienegas has had on agency activities seems to be within the BLM itself. Other BLM land managed out of the Tucson Field Office are incorporating elements of collaboration and adaptive management into planning and implementation processes. Karen and a few other people involved at Las Cienegas are helping a collaborative and adaptive process get started at Agua Fria National Monument. While the approach being used at Las Cienegas seems to be slowly spreading its influence, Karen is the go-to person for making it happen.

When interviewees were asked about problems or concerns they have with the collaborative and adaptive approach used to manage Las Cienegas, two main themes emerged: fatigue and confusion about the process. Several people mentioned the amount of time it takes to prepare and participate in biological planning meetings. There is also concern that the collaborative process cannot go on indefinitely. One interviewee noted that it seemed like some stakeholders have dropped out over time because attending no longer seemed relevant to them. Other concerns identified by those interviewed included the increase in recreation to the area potentially causing problems to management decisions and that adaptive management would not
be particularly effective to address the impacts from climate change such as changes in surface water levels.

Most confusion about the Las Cienegas CAM process has been within the BLM itself. Some BLM staff used to feel like the stakeholder group was making decisions. Also, when staffing for two BLM areas merged, several of the BLM staff members suddenly responsible for management activities in Las Cienegas were not familiar with the idea of adaptive management. After several conversations over the past few years, however, BLM staff working in the Tucson Field Office seem to understand that the stakeholder group is holding the BLM accountable through asking questions and offering feedback, but they are not making decisions. The BLM Tucson Field Office Manager attends biological planning meetings when he can and clarifies any lingering confusion about what the group can and cannot offer suggestions about.

There are a handful of BLM staff who attend biological planning meetings, but according to one interviewee: “it still needs to go further, because they're not all totally embracing it. So I don't know if they just don't see the value or sometimes they just want to do their thing and not be bothered. But meanwhile, at the higher levels of BLM, Las Cienegas was one of the Department of Interior adaptive management examples, it's almost like they don't even realize it” (Kay 2012). The instance of the fire manager interfering with the vegetation treatment experiment exemplifies some of the internal issues: if a “person internally doesn't respect the process so they just ignore it and do their thing. That can be a problem” (Kay 2012).

Lack of money is also of concern to one interviewee: “it takes money and we're working with agencies by and large that have traditionally been under-resourced and that are gonna be further under-resourced. They didn't have the money to do the jobs that they were tasked to do when they had resources and those resources are drying up” (Kay 2012).
APPENDIX G: MALPAI BORDERLANDS GROUP & PARTNERS

The following list includes parties involved in Malpai Borderlands projects (and has been adapted from Malpai Borderlands Group 2012). * indicates that I interviewed a person from the specified organization or category.

Malpai Borderlands Group staff***

_Private sector_
Cooperating ranchers in Arizona, New Mexico, and Mexico*

_Public sector_
U.S. Department of Agriculture:
  - Forest Service, Coronado National Forest
  - Forest Service, Rocky Mountain Forest and Range Experiment Station
  - Natural Resources Conservation Service, Arizona and New Mexico*
  - Hidalgo Soil and Water Conservation District
  - Whitewater Draw Natural Resource Conservation District
U.S. Department of Interior:
  - Bureau of Land Management, Las Cruces and Gila Districts
  - Fish and Wildlife Service
U.S. Department of Homeland Security:
  - Border Patrol/Customs
Arizona State Land Department
University of Arizona’s Desert Laboratory
University of New Mexico
Arizona State University
New Mexico State University
New Mexico Department of Game and Fish
Arizona Game and Fish Department

Nonprofit organizations
The Animas Foundation
The Nature Conservancy*
Fundación San Bernardino

Additional scientists*