Data and Adaptive Management: The critical role of quality data in the successful application of adaptive management on the Valles Caldera National Preserve

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ABSTRACT – Since 2002 the Valles Caldera Trust has invested in the acquisition of "quality" data or, data collected by experts or under the supervision of experts; using specific, repeatable, protocol; and maintained with integrity (established meta-data, limited access). As a result the, the Trust can realize benefits in efficiency, reduced costs over time, increased public confidence, and ultimately learning and improved decision making - all considered benefits and rewards of adaptive management.

I. INTRODUCTION

BACKGROUND

The Valles Caldera National Preserve (Preserve) was acquired by the Federal government in 2000 with the passage of the Valles Caldera Preservation Act, Public Law 106-248(U.S.C.). The 89,000 acre Preserve (Figure 1) had been a privately owned working ranch for over a century and a half. Once acquired, it was designated as National Forest System (NFS) land. While most NFS lands fall under the jurisdiction of the USDA Forest Service (USFS), the Valles Caldera Preservation Act created the Valles Caldera Trust (Trust), a wholly owned government corporation to manage the Preserve.

Purposes for acquiring the Preserve and establishing the Trust included:

- *to protect and preserve for future generations the scientific, scenic, historic, and natural values of the Baca ranch, including rivers and ecosystems and archaeological, geological, and cultural resources;*
- "…establishing *a demonstration area for an experimental management regime adapted to this unique property which incorporates elements of public and private administration in order to promote long term financial sustainability*[1] *…;"* and
- *"…to provide for sustained yield management of the Baca ranch for timber production and domestic livestock grazing ..."*

The findings of Congress included

- "…*careful husbandry of the Baca Ranch by its current owners including selective timbering, limited grazing and hunting, and the use of prescribed fire, have preserved a mix of healthy range and timber land, with significant species diversity, thereby serving as a model for sustainable land development and use.*"

Section 108 of the Act directs that a comprehensive management program be developed that continue the management of the Preserve as a working ranch where consistent with the protection and preservation of natural and cultural resources and values, provision of access for public recreation, and maintaining the multiple use and sustained yield values of the Preserve.

The Valles Caldera Preservation Act also made clear that the Preserve was to be managed in conformity with laws pertaining to the National Forest (except the *Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 as amended by the National Forest*

[1] The Valles Caldera Preservation Act sets January 2015 as the deadline for which the management of the Preserve is to be financially self-sufficient. Financial self-sufficiency is defined in the Act as, *"management and operating expenditures equal to or less than proceeds derived from fees and other receipts for resource use and development and interest on invested funds".*

Management Act (NFMA) 1976), and identifies the Trust as an agency for the purpose of compliance with federal environmental laws.

In general, Congress foresaw management of the Preserve transitioning from private to public, mixing elements of both, in a continuum of the current "*successful*" working ranch operation.

In July 2003, the NEPA procedures of the Trust were published. They are unique to the Trust and Preserve and guide the agency not only through planning and decision making, but also through implementation, monitoring, evaluation and adjustment, or, a*daptive management*. Adaptive management is defined in the procedures as, "*…adjusting stewardship actions or strategic guidance based on knowledge gained from new information, experience, experimentation, and monitoring results, and is the preferred method for managing complex natural systems."*

Other terms defined in the NEPA procedures include:

- **Monitored Outcome -** *''… the short-, mid-, or long-term outcome selected for systematic evaluation."*
- **Objective -** ''*…the desired outcome that can be meaningfully evaluated by location and timing within the Preserve."*
- **Outcome -** *''… the result or consequence of a stewardship action that can be meaningfully evaluated by location and time of occurrence"* (For purposes of the procedures, this term has the same meaning as impact or effect).
- **Stewardship Action -** ''*… an activity or group of activities consisting of at least one goal, objective, and performance requirement proposed or implemented by the Responsible Official that may: (1) Guide or prescribe alternative uses of the Preserve upon which future implementing decisions will be based; or (2) Utilize or manage the resources of the Preserve."*

ISSUE

In the report, *Modernizing NEPA Implementation* (CEQ NEPA Task Force), the CEQ NEPA Task Force cited a variety of concerns in the incorporation of an adaptive management model into the NEPA process including:

1. Federal agencies may use adaptive management to avoid careful consideration of the potential impacts of the proposed action.
2. The potential additional expense associated with the monitoring necessary to successfully incorporate adaptive management into the NEPA process.
3. The potential for expanded judicial review due to adaptive management actions.
4. How to effectively analyze and document adaptive management when considering cumulative effects.

The concerns identified by the NEPA Task Force surfaced verbatim as the Trust began to implement adaptive management on the Preserve. While the use of scientific data will not solely

ensure successful implementation of adaptive management, the Trust has found that quality data is critical to that success.

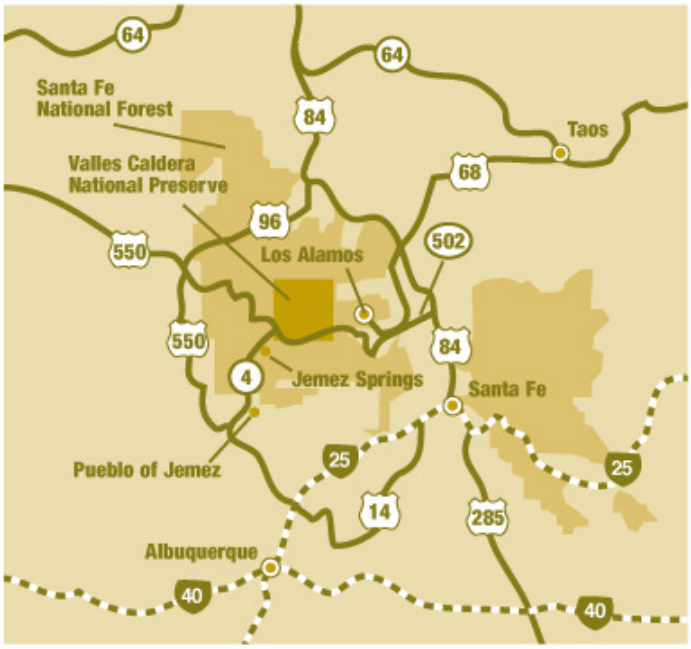


Figure 1 – Vicinity Map of the Valles Caldera National Preserve in north-central New Mexico

Figure 2 – La Jara Peak in the iconic Valle Grande, Valles Caldera National Preserve (New Mexico)

II. NEPA AND ADAPTIVE MANAGEMENT

In the 1997 study, "The National Environmental Policy Act: A Study of its Effectiveness after Twenty-five
Years", CEQ concluded that a "*major difficulty with the traditional environmental impact analysis process is that it is a one-time event; i.e., results from intensive research, modeling, and other computations or expert opinions are analyzed, the analysis of potential environmental impacts is prepared, mitigation measures are identified, and a document is released for public review."*(CEQ) The adaptive management model, by adding, "monitor and adapt," was seen as a significant improvement (CEQ NEPA Task Force).

The CEQ NEPA Task Force noted that some agencies have used the term adaptive management to describe programmatic actions that do not integrate the "monitor and adapt" components into a programmatic NEPA process. Such a programmatic NEPA process calls for research and monitoring to help understand ecosystem functions and linkages, and to then take an adaptive action. Without such research and monitoring in place, the adaptive action generally requires additional sequential NEPA review because the adaptive measures, and their effects, are not fully considered in the original programmatic NEPA analysis. This approach results in a series of NEPA analyses that incorporate the old "predict, mitigate, and implement" model.

Such an example can be found in a review of a local Land Management Plan (USDA-USFS), individual NEPA actions, and annual monitoring reports. The structure for adaptive management, which includes goals, objectives and monitored outcomes, is provided within the relationship of the Forest Plan, project level planning and monitoring report. However, without the systematic application of data to quantify and goals and objectives and relate them to the monitored outcomes, there exists no framework to articulate linkages across scales - from the scale of the individual project unit to the scales relevant for evaluating ecological responses.

This disconnect limits managers' capacity to attribute causation when variables of interest change, such as species responses to specific management actions or other environmental drivers. Furthermore, such disconnect does not contribute to a meaningful analysis of cumulative effects which requires that linkages be articulated from the project level to programmatic level and between all disciplines.

III. ACQUIRING AND MANAGING DATA FOR ADAPTIVE MANAGEMENT

SCALE AND LINKAGES

To implement adaptive management the Trust identified specific multiple scales for planning, implementing, monitoring, and evaluating the effects as well as the effectiveness of stewardship actions.

- Preserve-wide – Comprehensive planning and decision-making needed to occur Preserve-wide. The Preserve is suitable for this level of planning. All lands are contiguous with the exception of one small private in holding. The boundaries are along the fifth code USGS watershed delineation[2]. All waters within the Preserve originate within its boundaries.
- Sub-basin unit – The Trust needs a scale of management that would be more sensitive to change than the Preserve as a whole but would be large enough to measure variability and assess cumulative effects. Using GIS software, *ArcHydro*, the land within the Preserve was delineated into 28 sub-basin watersheds[2].
- 2006- Forest Stand Delineation – Polygons of vegetation were delineated based on similarities in composition and structure, from five acres to over 200 acres in size. Each stand was attributed with information on physical setting (slope, aspect, and elevation), vegetative composition (species at multiple layers), and structure (composition of size and structure at multiple layers).
- 2006 - Vegetative Map – A vegetation map was completed in 2006 to spatially identify the major plant associations on the Preserve (Muldavin E.). Plant associations are identified Preserve-wide at a 2-meter pixel resolution and summarized by 20 descriptive mapping units.
- Plot – Forests, grasslands, soils, and water are measured at a plot or transect level in the field.

QUANTIFYING THE VALLES CALDERA NATIONAL PRESERVE AT VARIOUS SCALES

The findings and vision of Congress were based on a somewhat qualitative assessment of the Preserve. Prior to Federal acquisition little data had ever been collected on the Preserve and certainly no systematic approach for quantifying the Preserve's resources or condition had ever

[2] The VCNP is almost entirely within the 5th code Jemez Watershed (USGS Hydrologic Unit Code 13020202.) The interdisciplinary team used ESRI ArcHydro to define sub-basin watersheds within the 6th code the Preserve. These sub-basins ranged from 1,600 – 12,000 acres. The landscape size and relationship within the watershed made them suitable for describing the ecological condition at the landscape scale.

been undertaken. Upon assuming management of the Preserve in 2002, the Trust needed a quantified assessment to support planning and decision-making in the context of public land management. The Trust began investing in acquiring data and investigating the land-use history of the Preserve. In the broadest sense the Trust sought to identify the reference condition[3] of the Preserve's ecosystems and habitat types, quantify the existing condition, estimate the degree of departure from the reference condition, and piece together the past actions that have influenced the ecology of the Preserve.

Over a five year period comprehensive inventory projects to delineate and map plant associations, forest composition and structure, soils, climate, and geology were undertaken(Valles Caldera Trust). Species lists for vascular plants, mammals, breeding birds, insects, reptiles, amphibians, and fish were developed. Land-use history and the history of timber harvest were investigated and published. Baselines for monitoring and adaptive management were established through forty-one permanent ecological monitoring sites, five permanent riparian exclosures, five climate stations, water quality and flow instrumentation, and two carbon flux towers.

The development of these key data sets included establishing a total of 748 field sampled plots. While field sampling was designed to describe or manage a specific resource, each sampling effort included some common measurements including percent cover by bare ground, litter, vegetation, species composition, and presence of erosive features/indicators.

ECOLOGICAL CONDITION

An interdisciplinary team with expertise in soils, hydrology, botany, wildlife, and range incorporated all the field sampled data and annual monitoring information into a single data set containing major ecological indicators of upland and riparian systems identifiable in space and time (T.E.A.M.S.). The ecological function and condition of the Preserve was evaluated using health indicators derived from site data and inventory. The assessment synthesized the abiotic (soil/site stability and hydrologic function) and biotic (vegetative cover and composition) attributes and articulated the linkages (Figure 4), (Table 1) from the plot level to the sub-basin watershed level as follows:

- Site specific field data combined at the plot level; each plot assigned an "upland" rating.
- Site specific field data combine for each stream segment; each segment assigned a "riparian" rating.
- Upland ratings synthesized within a sub-basin; each sub-basin assigned an "overall upland" rating.
- Riparian ratings synthesized within a sub-basin; each sub-basin assigned an "overall riparian" rating.

[3] Reference condition means, *"The composition of landscape vegetation and disturbance attributes that, to the best of our collective expert knowledge, can sustain current native ecological systems and reduce future hazard to native diversity"* **(USDA - USFS Rocky Mountain Research Station)**.

- Overall upland and riparian ratings synthesized within a sub-basin; each sub-basin assigned an ecological condition rating.

Ecological ratings are both descriptive and numeric attributes. Descriptive attributes are useful for a general discussion of the ecological condition of the Preserve. The numeric attributes indicate the departure from the reference condition with '1' being on a par with the reference condition and '3' being significantly departed.

By combining the data in GIS, the Trust could quantify the ecological condition of the Preserve from a two-meter pixel, to a forest stand, a sub-basin watershed (Figure 4), or Preserve-wide. In addition new data can be incorporated into the model allowing efficient update and re-evaluation of the ecological condition to occur at all scales.

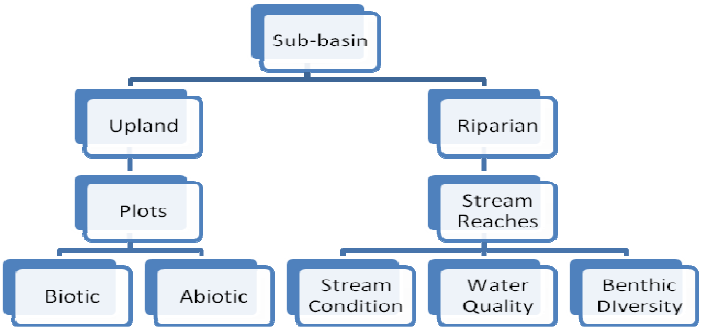


Figure 3 – Hierarchy of data synthesis

Table 1 – Sample of field data summarized at the sub-basin watershed level within the 6th code

San Antonio Creek (6th Code) 13020202020010		Upland % of Plots			Abiotic % of Plots			Biotic % of Plots				
Sub-basin	**Acres [#Plots]**	**Low**	**Med**	**High**	**Low**	**Med**	**High**	**Low**	**Med**	**High**	**Riparian[4]**	**Benthic[5]**
Headwaters – San Antonio Creek	5,385 [23]	0	56.5	43.4	0	34.7	65.3	0	52.1	47.9	PFC	SI/Mod
Lower Valle San Antonio	4,962 [10]	0	40	60	0	30	70	0	30	70	FAR	SI/MOD
North Fork San Antonio Creek	1,616 [8]	0	37.5	62.5	0	25	75	0	25	75	FAR	SI/MOD
Rito de los Indios	4,080 [6]	0	16.6	83.3	0	16.6	83.3	0	16.6	83.3	PFC	NI/MD
San Luis Creek	3,818 [7]	14.2	42.8	42.8	14.2	42.8	42.8	0	42.8	57.1	FAR	SI/MOD
Southwest Fork San Antonio Creek	2,024 [10]	10	20	70	10	20	70	0	20	80		
Upper Valle San Antonio	3,431 [35]	20	31.4	48.5	14.2	22.8	62.8	8.5	25.7	65.7	FAR, PFC	SI/MOD
Valle Santa Rosa	4,779 [81]	24.6	25.9	49.3	19.7	23.4	56.7	18.5	17.2	64.1		
Valle Toledo	4,379 [28]	7.1	57.1	35.7	7.1	42.8	50	3.5	46.4	50	PFC	SI/MOD

[4] Riparian Rating: PFC = proper functioning condition; FAR = functioning at risk; NF = nonfunctioning.

[5] Benthic Diversity: NI = non-impaired; MI = moderately impaired; SI = slightly impaired; MD = most diverse; MOD = moderately diverse; LD = Least diverse

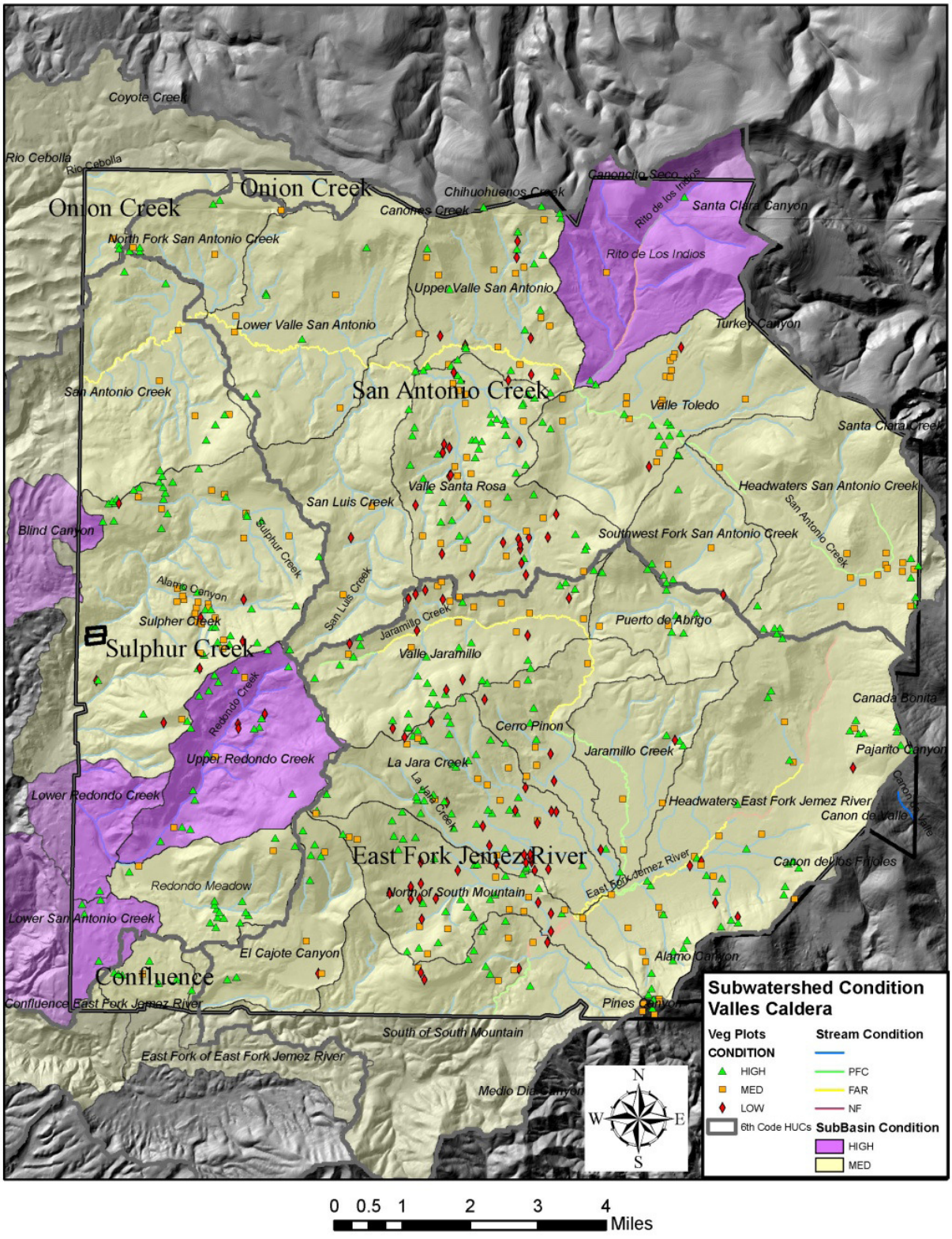


Figure 4 – Ecological Condition of the Preserve at the sub-basin and plot level.

FOREST CONDITION

The Trust used the 2006 – Vegetation Map (ecotypes and plant associations) to estimate the expected distribution of the forest by seral stage in the reference condition. The actual distribution based on the the 2006 - Forest Stand Delineation (existing vegetative structure, including size, species composition and density of all life form layers), was then compared to the expected distribution across the Preserve (Table 2). The difference was expressed as an index of 1-3, with a departure of '1' indicating that conditions are at or near characteristics typical of the reference condition, '2' indicating a moderate departure and '3' indicating that current conditions are significantly departed from the characteristic reference condition.

Table 2 - EXISTING FOREST STRUCTURE COMPARED WITH REFERENCE CONDITION

FOREST TYPE	ED	MDC	MDO	LDC	LDO
Spruce-Fir 8,207 Acres					
Existing Condition (%)	0	91	9	0	0
Reference Condition (%)	15	20	15	20	30
Departure	**3**	**3**	**3**	**3**	**3**
Mixed Conifer 37,102 Acres					
Existing Condition (%)	0	94	5	<1	<1
Reference Condition (%)	10	30	30	20	10
Departure	**3**	**3**	**3**	**3**	**3**
Aspen – 6.755 Acres					
Existing Condition (%)	0	97	2	0	1
Reference Condition (%)	60	25	4	10	1
Departure	**3**	**3**	**2**	**3**	**1**
Ponderosa Pine 2,588 Acres					
Existing Condition (%)	0	75	25	0	0
Reference Condition (%)	10	5	20	60	5
Departure	**3**	**3**	**2**	**3**	**3**

ED: Early development (seedlings <5 inches diameter);

MDC: Mid-development - closed (pole sized trees; closed canopy)

MDO: Mid-development - open (pole sized; trees open canopy)

LDC: Late development - closed (mature trees; closed canopy);

LDO: Late development - open (mature trees; open canopy)

While the overall ecological condition of the Preserve is only moderately departed from the reference condition (Figure 4), the structure of Preserve's forests as indicated in Table 2, is significantly departed from the reference condition. The structure, dominated by dense stands of small- to mid-diameter trees, affects the composition and function of Preserve ecosystems and creates specific risks of increased vulnerability to wildfire, insects and disease outbreaks, and climate change. Condition as expressed as a departure from the reference condition can be assessed Preserve-wide, at a sub-basin level, or by forest-type.

IV. IMPLEMENTING ADAPTIVE MANAGEMENT

The Trust is developing comprehensive plans for the management of the Preserve's ecosystems and the Multiple Use and Sustained Yield of its resources with a systematic and structured approach to adaptive management. Goals, objectives and monitored outcomes as well as benchmarks for evaluating management actions are linked through data. The following is a sample of a goal, objectives, and monitored outcomes currently proposed by the Trust (Valles Caldera Trust). The activities being evaluated are domestic livestock grazing, forage use by elk and other herbivores, and the management of ranch infrastructure including fences and tanks.

Goal: *The ecological condition of the Preserve would be moving towards the composition of landscape vegetation and disturbance attributes that, to the best of our collective expert knowledge, can sustain current native ecological systems and reduce future risk to native diversity* (USDA - USFS Rocky Mountain Research Station).

Objective: Upland Objectives

Objectives for upland characteristics including percent cover of bare ground, vegetation, litter, and trees are based on values predicted for the Ecological Site represented using National Resource Conservation Service (NRCS) approved ecological sites descriptions, which have been refined based on site specific field sampled data at 41 monitoring sites.

Because of the variability of data from individual plots the Trust will measure objectives in several ways.

1. *The mean value summarized by ecological site (Table 1 and Table 2).*
2. *Departure from the cumulative mean for each of 41 monitoring sites.*
3. *Departure from the cumulative mean summarized by ecological site.*

Table 3 – *Objective Upland Characteristics*

Ecological Site	*Bare Ground*	*Grass/Forbs*	*Litter*
Riparian	*<2 – 5%*	*>90%*	*>80%*
Mountain Meadow	*<3%*	*>90%*	*>80%*
Mountain Valley	*<4 – 5%*	*>90%*	*>80%*
Grazeable Woodland	*<4%*	*>70%*	*>80%*

Other objectives including, *Species Diversity* and *Riparian Function/Water Quality*, are described in similar format and detail. Monitored outcomes are listed including the location and schedule of monitoring as follows:

Production and Utilization
Production and utilization of forage will be monitored annually. Currently production and utilization are monitored using field sampled data. Other methods yielding results of equal or greater accuracy and precision may be adopted.

Ecological Condition
Changes in vegetative structure, species composition, and ecological function will be synthesized annually.

Species Composition
Species composition and diversity will be evaluated every 3-5 years using field sampling.

Water Quality
Water quality will be measured continuously during ice-free seasons and evaluated cumulatively every 3-5 years.

Noxious Weeds
Inventories for noxious weeds will be ongoing.

Proper Functioning Condition (Stream)
Proper Functioning Condition will be measured annually and evaluated cumulatively every 3-5 years.

Cumulative Effects
Monitored outcomes will be synthesized every five years to measure cumulative effects. This synthesis will be documented in the State of the Preserve. The State of the Preserve provides a concise account of the systematic review of monitored outcomes and interpretive information from, but not limited to, observations studies, public comment, research investigations, natural resources data or information summaries, and other sources to provide the technical and scientific basis for considering the cumulative effects of the past, present and reasonably foreseeable future actions of the Trust (Federal Register 2003).

The goal being proposed for adoption is quantifiable but not quantified; objectives are stated in quantifiable terms relating to the monitored outcomes. How and where monitored outcomes will be measured is defined in space and time as part of the proposed action. Using a systematic approach, stakeholders can clearly understand the goal towards which management is being directed as well as how and when progress will be evaluated.

In this example the activities being evaluated are livestock grazing, use of forage by wildlife, and the management of ranch infrastructure. Forest management activities would be guided by the same goal. Additional objectives such as the distribution of forests in seral stages (based on Table 2) would be included as well as additional monitored outcomes directly related to forest structure and composition. The long-term temporal information applied at various scales and linked between actions can increase the Trust's ability to understand the ecological relevance, or to fully interpret the magnitude of observed responses to any given management (or other experimental) action.

V. SUMMARY

ADDRESSING ISSUES IDENTIFIED BY THE NEPA TASK FORCE

The document introduction identified four issues put forward in the report, *Modernizing NEPA Implementation* (CEQ NEPA Task Force) and proposed the potential for "quality" data to be a key component in addressing these issues.

1. Federal agencies may use adaptive management to avoid careful consideration of the potential impacts of the proposed action.

Quality data collected and summarized at multiple scales is the best tool to demonstrate careful consideration of potential impacts (direct, indirect, and cumulative,) at multiple scales.

Previously, under *II NEPA and Adaptive Management,* it is noted that a clear linkage between goals, objectives, and monitored outcomes cannot be found by reviewing a local Land Management Plan (LMP), project level plans, and monitoring reports. In fact the LMP states that measureable objectives would be developed at the project level (regarding range Allotment Management Plans or AMPs)(USDA-USFS). The project level AMP (USDA-USFS) indicates that adaptive management will be used to ensure that project level implementation meets forest plan objectives. The associated 2008 Monitoring Report, states that it is, *"written to inform the Forest Supervisor and the public of information collected on the National Forest System lands and resources of the [unnamed] National Forest, as well as progress toward achieving the goals, objectives and desired future conditions as stated in the [unnamed] National Forest Plan."* (USDA-USFS)

All scales of planning identify a desired condition in qualitative terms. The quantifiable monitored outcome associated with the management action is pre- and post-grazing utilization stubble height of forage species(USDA-USFS). This information is collected annually on selected allotments. The 2008 Monitoring Report distributes much of the monitoring for the AMPs by stating that information will be collected annually on selected AMPs. Yet, no linkage between the individual AMPs is established at any scale of planning.

The 2008 Monitoring Report includes seven pages of monitoring results, none of which are quantified. The following is an example of a monitored outcome as provided in the report (page 13), "*Cattle exclosures on riparian areas have helped them move towards desired conditions (i.e., increased willow regeneration and beaver rehabilitation.)"*(USDA-USFS). This statement is not associated with any individual AMP or identified riparian area; nor is there any indication of how the movement towards the desired condition was measured. The 51-page report includes no quantified statement of any monitored outcomes[6]. Quantified measures are only provided for outputs such as acres treated, number of plans developed, or miles of fence built. The location of

[6] Plan appendices provide detailed papers published by extramural entities documenting research (including quantified monitored outcomes) on two projects implemented on the forest.

monitoring data is provided i.e. "Ranger District range files". Corporate GIS files identified in the appendices include no monitoring locations for the AMPs.

A stakeholder, concerned as to whether adaptive management is being used to *avoid careful consideration of the potential impacts of the proposed action* does cannot easily track how adaptive management is being applied without a significant investment in time and effort. If a stakeholder decided to investigate the linkages, it would undoubtedly require a significant investment of time effort by the Forest's resource staff.[7]

The Trust has increased public confidence and reduced controversy (over livestock grazing) by employing a systematic approach to monitoring and evaluation and presenting its findings annually. By using data of the appropriate scale, the Trust has created a transparent process from planning and decision making, to implementation, monitoring, evaluation, and adjustment.

Furthermore, supported by a consistent monitoring protocol, the Trust has been able to engage stakeholders in the actual monitoring in the field. The Joranada Experimental Range Station, (USDA – Agriculture Research Service) works cooperatively with the Trust to implement the annual range monitoring. The Trust and the Joranada coordinate volunteers, who work with staff (USDA-ARS) to complete annual spring and fall monitoring at 41 locations. Involving volunteers in this project provides a tremendous opportunity for the scientists to interact in the field with the public leading to improved public awareness of the Preserve's projects and data as well as increased public confidence in management. The Joranada posts data on their website, http://usda-ars.nmsu.edu/data_VCNP.htm both as raw data and summarized on colorful posters. Stakeholders then have an independent source to verify the data put forward by the Trust.

"Involving volunteers in this project provides a tremendous opportunity for the scientists to interact in the field with the public leading to improved public awareness of the Preserve's projects and data as well as increased public confidence in management."

-Joranada Website

Figure 5 - Dr. Bob Parmenter, who oversees research, inventory, and monitoring on the Preserve; works with a volunteer at one of the 41 range monitoring sites measured annually on the Preserve.

Collaborating with other agencies, universities, as well as volunteers requires a consistent monitoring protocol and timeframe. Administrative functions gain efficiencies over time. As

[7] This summary does not imply that the unnamed forest is not in compliance with NEPA, only that the linkages required for adaptive management are not easily available or apparent to stakeholders.

key personnel move, retire, etc.; the collaborative process can be easily transferred to new personnel.

2. ***The potential additional expense associated with the monitoring necessary to successfully incorporate adaptive management into the NEPA process.***

The Trust has been able to realize efficiencies in data collection by investing in permanent monitoring sites and systematic Preserve-wide data collection. The data and monitoring sites can be used for planning and decision making for all disciplines of resource management. Where adequate data is not available to address a specific issue or area, an established protocol makes additional data collection more efficient. The Trust has worked to ensure that databases provide data in formats suitable for any natural resource model currently employed by Federal land managers (lessons learned!).

In July 2008 (during the development of this paper) the Trust completed a Preserve-wide forest inventory. The 2006 Forest Stand Delineation and the 2006 - Plant Association structural data was used to stratify the forests of the Preserve for field inventory. Common Stand Exam guidance (USDA - Forest Service) recommends collecting data on 20 plots per stand for forest inventory. This intensity of inventory would have required the Trust to sample nearly 40,000 plots. By using the structural data to stratify Preserve's forests, the Trust field sampled only 600 plots while achieving the same level of statistical accuracy[8].

Systematic monitoring creates efficiencies in managing supplies and equipment, training new personnel, and planning for personnel and budget needs. Investments in data collection and management have lead to efficiencies and reduced costs in out years as previously described. In addition, by having Preserve-wide data and systematic monitoring the Trust has been able to attract outside investments in research (more data) and monitoring. In fact from 2001-2007, $7,370,229 in outside funding had been invested in research, inventory, and monitoring on the Preserve(Valles Caldera Trust). Beginning in 2003, the investments began to increase substantially based on the available data and commitment to monitoring.

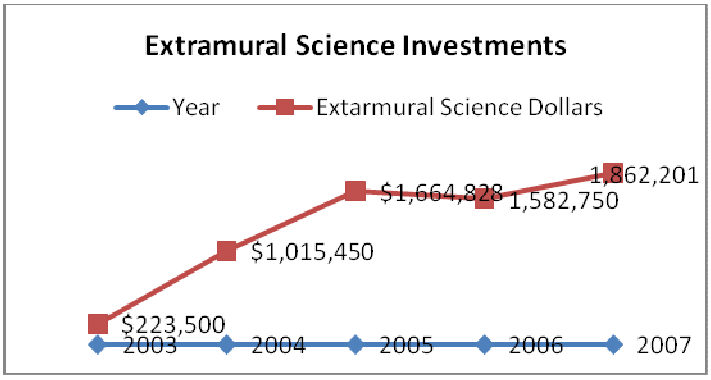


Figure 6 – Extramural investments in research, inventory, and monitoring, on the Preserve since 2003.

[8] Actual error in the field sampled data will not be available until August – 2008. Additional sampling may have to be completed within one or more strata.

An additional return on the Trust's investment into data has been "eco-tourism" opportunities. Range monitoring volunteers are now coordinated through the Sierra Club and advertised world-wide (http://www.sierraclub.org/outings/national/brochure/08343A.asp).

3. The potential for expanded judicial review due to adaptive management actions.

Quality data is an excellent tool for demonstrating compliance with management decisions, helping to avoid litigation. If litigation does occur, data provides an excellent defense.

4. How to effectively analyze and document adaptive management when considering cumulative effects.

The NEPA procedures of the Trust require that a "State of the Preserve" be completed every five years. This data oriented report is defined as, "*a concise account of the systematic review of monitored outcomes and interpretive information from, but not limited to, observations, studies, public comment, research investigations, natural resources data or information summaries, and other sources to provide the technical and scientific basis for considering the cumulative effects of the past, present, and reasonably foreseeable future actions of the Trust*"(Valles Caldera Trust) and brings adaptive management to a full circle. The State of the Preserve measures the progress towards goal attainment. A review of the State of the Preserve is required before goals, adopted by the Trust, can be adjusted or new goals adopted.

LESSONS LEARNED

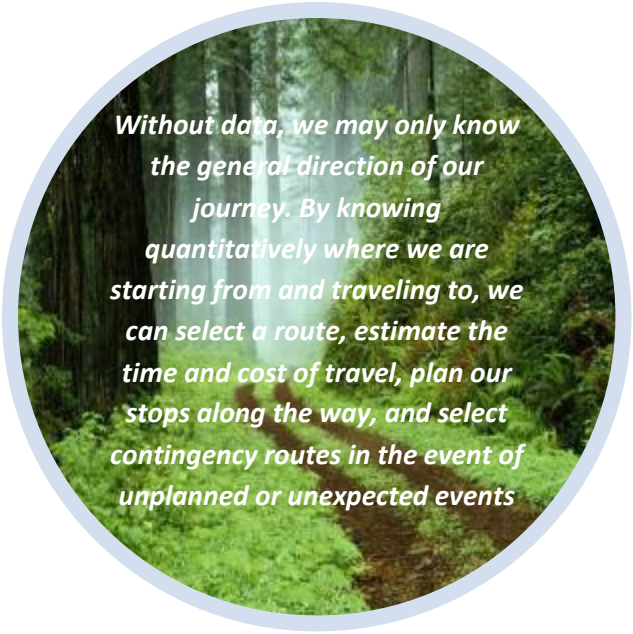
- Collaboration in the collection, review, and application of data is critical. The perception of bias can render data impotent in support of decision-making. Having a robust partnership of trained staff, other agencies, various universities, NGO's, and volunteers reduces the perception of bias. It also reduces the vulnerability of an agency to political, economic, or other special interest pressures.
- Employ the same level of expertise and planning in managing the data as in collecting it! The Trust has been investing time and money to move corporate data into an efficient data base system. Initial collection of data at permanent monitoring sites did not include a plan for the long-term storage, management, and use of the data. The current system (excel spreadsheets) has proven to be inefficient for managing long-term data sets.

  The forestry data was set up in a corporate geo-data base based on this lesson learned.
- Develop and invest in a plan to systematically communicate data and findings to stake holders. Communicating data is challenging and resource intensive. The Trust has not established an efficient system for communicating data, information, and knowledge to the public. Data alone may or may not be useful. While data must be available to ensure transparency, it needs to be presented in context to be useful to the agency and

stakeholders. The Annual Range Readiness Report [9] (Parmenter 2007) offers a good example of a comprehensive summary and presentation of data in a meaningful format.

- The most important lesson was learning about the Preserve. As noted in the introduction, Congress foresaw the Preserve transitioning from private to public ownership in a continuation of a "successful" working ranch. The Valles Caldera Preservation Act indicated that financial self-sufficiency could be supported financial self sufficiency would be supported in part, through the sustained yield management of the Preserve's range and forest resources.

  A measured, quantifiable assessment of the Preserve has found the forests and grasslands actually in need of restoration from a legacy of intensive grazing, logging and road building. . The path to financial self sufficiency is likely to better supported by the other purposes stated in the act especially, the Preserve's value for recreation, as well as learning and inspiration.



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LIST OF FIGURES AND TABLES