Tejon Group Project Proposal

Development of conceptual models and ecological baselines to support the creation of an adaptive management plan for Tejon Ranch, California

2010 Group Project Proposal

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ABSTRACT

In June 2008, 178,000 acres of ecologically significant land on Tejon Ranch were dedicated to permanent conservation through the Tejon Ranch Conservation and Land Use Agreement. The Agreement was signed by the Tejon Ranch Company and a consortium of natural resource groups, and fostered the creation of the non-profit, Tejon Ranch Conservancy. A thorough understanding of the environmental drivers, stressors, and processes that are impacting Tejon Ranch is necessary to successfully develop an adaptive management plan. The purpose of this project is to assist the Conservancy in the development of a Ranch-Wide Management Plan (RWMP) by establishing baseline conditions and creating conceptual models for the development of conservation priorities.
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**EXECUTIVE SUMMARY**

Encompassing 270,000 acres, Tejon Ranch is the largest contiguous privately-owned property in California. Tejon Ranch is a hotspot of biological diversity lying at the confluence of four major ecological regions: the western Mojave Desert, foothill oak woodlands and mixed coniferous forests of the Tehachapi Mountains, San Joaquin Valley grasslands, and southwestern California coastal ranges. These diverse vegetation communities provide essential habitat for rare and endemic species, ancient oak trees, endangered California condors, and intact watersheds and streams — all near Los Angeles, the largest metropolitan area in California. Tejon Ranch also serves as a vital wildlife corridor between publicly-owned wilderness areas, parks, and monuments.

In June 2008 the Tejon Ranch Company and a consortium of natural resource organizations signed the historic “Tejon Ranch Conservation and Land Use Agreement” (the Agreement), which dedicated 178,000 acres of Tejon Ranch for permanent conservation, and provided an option for purchasing conservation easements for another 62,000 acres. The Tejon Ranch Conservancy (the Conservancy) was created as an independent, non-profit organization to “preserve, enhance and restore the native biodiversity and ecosystem values of the Tejon Ranch and the Tehachapi Range for the benefit of California’s future generations” (Tejon Ranch Company 2009a). Pursuant to the Agreement, three major land uses (grazing, hunting, and filming operations) will be permitted to continue on the Ranch.

According to the Agreement, one of the first obligations of the Conservancy is the creation and adoption of a Ranch-Wide Management Plan (RWMP) for the conserved lands. A critical step in this process is formally conceptualizing conservation values, restoration opportunities, and establishing baseline conditions. During an initial five-year period, the RWMP will focus on the preservation of existing conservation values by maintaining baseline conditions. After the initial period, the RWMP will implement a program for “restoring and enhancing the natural values of the conserved lands” (Adaptive Management Standard; Tejon Ranch Company 2009b, p. 4).

An adaptive management and monitoring program, as specified in the RWMP, is necessary to ensure the conservation and enhancement of the natural heritage and biodiversity of Tejon Ranch in perpetuity. Adaptive management and monitoring promotes long-term, science-based stewardship by generating feedback to inform and refine future management decisions. An initial understanding of the environmental drivers that are impacting environmental resources on Tejon Ranch is necessary to develop an adaptive management plan.

Our client, the Tejon Ranch Conservancy, has requested that we compile data and information on baseline conditions, generate conceptual models of ecosystem processes on Tejon Ranch to inform the development of the RWMP, and suggest a monitoring framework to track changes of natural resources. One goal of this project is to assist in the collection and analysis of select baseline data and historic information on Tejon Ranch. This analysis will focus on the natural resources of Tejon Ranch, as well as current and historic land uses, in order to better understand current ecological conditions and trends. Additionally, the project will involve the development of conceptual models which will be used in the development of the RWMP. The purpose of developing conceptual models is to identify the drivers, stressors, and performance measures of environmental changes to inform management decisions.
INTRODUCTION

Encompassing 270,000 acres, Tejon Ranch is the largest contiguous privately-owned property in California (Exhibit 1). Tejon Ranch is an invaluable part of California’s natural heritage — a hotspot of biological diversity lying at the confluence of four major ecological regions: the western Mojave Desert, the foothill oak woodlands and mixed coniferous forests of the Tehachapi Mountains, the San Joaquin Valley grasslands, and the southwestern California coast ranges. These diverse vegetation communities include essential habitats for rare and endemic species, old growth oak woodlands, endangered California condors, rare vegetation communities, and intact watersheds and streams — all near California’s largest metropolitan area, Los Angeles. Tejon Ranch also serves as a vital wildlife corridor between publicly-owned wilderness areas, parks, and monuments.

In June 2008 the Tejon Ranch Company and a consortium of natural resource organizations signed the historic “Tejon Ranch Conservation and Land Use Agreement” (the Agreement), dedicating 178,000 acres of the Ranch to permanent conservation while allowing development on 30,000 acres. Resource conservation organizations have the option of purchasing the remaining 62,000 acres, and are currently seeking funds to do so. As part of the agreement, the Tejon Ranch Conservancy (the Conservancy) was created as an independent, non-profit organization to “preserve, enhance and restore the native biodiversity and ecosystem values of the Tejon Ranch and the Tehachapi Range for the benefit of California’s future generations” (Tejon Ranch Company 2009a, p. 1). By any standard, the Agreement represents one of the most significant and forward looking conservation achievements in California. Current land-use practices on Tejon Ranch include grazing, hunting, and filming operations. Within the agreement, these historic uses are stated to continue. The goal of our group project is to produce baseline ecological information and conceptual models of ecosystem processes to inform the Conservancy’s development of a Ranch-Wide Management Plan (RWMP), according to an adaptive management standard.

SIGNIFICANCE

According to the Agreement, one of the first obligations of the Conservancy is the creation and adoption of a RWMP for the conserved lands. A critical step in this process is formally conceptualizing conservation values, identifying restoration opportunities, and establishing baseline conditions. During an initial five-year period, the RWMP will focus on the preservation of existing conservation values by maintaining baseline conditions. After the initial period, the RWMP will implement a program for “restoring and enhancing the natural values of the conserved lands” (Adaptive Management Standard; Tejon Ranch Company 2009b, p. 4). One goal of our group project is to produce a subset of these conceptual models to help refine and articulate conservation goals, as well as contribute to the establishment of baseline conditions to be used in the RWMP.

As specified in the RWMP, an adaptive management and monitoring program is necessary to ensure the conservation and enhancement of the native biodiversity and natural heritage of Tejon Ranch in perpetuity. Adaptive management and monitoring promotes long-term, science-based stewardship by generating feedback to inform and refine future management decisions. These decisions are based on the rigorous experimental design of management actions and the systematic monitoring of ecosystem responses to different management treatments. An adaptive management plan will allow for flexibility in the face of changing climate conditions, shifting land use, improved ecological knowledge, and other unforeseen changes. An initial understanding of the environmental drivers that are impacting the natural resources on Tejon Ranch is necessary to develop an adaptive management plan. The purpose of developing conceptual models is to identify the drivers, stressors, processes, relationships, and measures of environmental change that will inform management decisions. Additionally, the establishment of baseline conditions will allow future environmental changes to be assessed, such as changes in land use practices, grazing, or various climate change scenarios.
**PROJECT OBJECTIVES**

Our overall objective is to assist in the gathering of select baseline data and historical information on Tejon Ranch’s natural resources and land use, and to develop conceptual models for management objectives in support of the development of the RWMP. Conceptual models are diagrams that communicate the processes and relationships within a system. We also plan to assist in articulating and refining conservation goals, as well as identifying spatial and temporal considerations regarding the monitoring of conservation objectives.

Constraints to our project include the absence of complete historical information about Tejon Ranch, the short time-line of the project with only one major season for fieldwork, and practical considerations such as accounting for existing lease agreements that may confound our ability to make changes. Elements of the RWMP our research team will address include:

- Using existing scientific literature, we will compile what is known about the ecology on Tejon Ranch, particularly with regard to the status and ecology of sensitive species. This may include the development of an annotated bibliography including summaries of reports concerning these sensitive species.

- Establishing how Tejon Ranch looked in the past (through historical research) and present (through fieldwork and photo comparisons), and developing a statement of those trends through time while identifying potential drivers of change.

- Comparing land use changes and resource conditions within Tejon Ranch to surrounding, comparable landscapes outside Tejon Ranch (e.g., Tehachapi Mountains and Antelope Valley).

- In collaboration with the Tejon Ranch Conservancy, articulating and refining conservation goals and objectives based on historical and current conditions.

- Developing conceptual models of ecological subsystems based on stated conservation goals and objectives through an understanding of the drivers, stressors, and processes that impact Tejon Ranch, identifying data gaps and uncertainties in these relationships, and identifying performance measures.

- Establishing a monitoring framework that includes options to identify protection, enhancement, and restoration opportunities on Tejon Ranch.

Achieving the project objectives (stated above) will assist in the creation of an adaptive management plan for Tejon Ranch through the following processes:

1. Identifying and articulating conservation goals and objectives for Tejon Ranch.

2. Selecting and identifying specific management objectives for the adaptive management of ecosystem processes on the ranch.

3. Conducting a review of historical land use to identify detectable changes or trends in ecological systems on Tejon Ranch while developing an understanding of existing baseline conditions. Through this review we will also attempt to summarize reports on the status and distribution of sensitive species on Tejon Ranch.

4. Development of conceptual models of selected ecological systems to help inform management decision making. Potential modeling interests may include grassland diversity, landscape connectivity, oak regeneration, and the extent of wetlands and riparian corridors.
5. Identifying and addressing gaps in baseline data and management uncertainty related to environmental systems, through fieldwork and research.

6. Establishing a monitoring framework that includes options to identify protection, enhancement, and restoration opportunities on Tejon Ranch.

BACKGROUND INFORMATION

Adaptive management is an appropriate and effective tool for conservation planning

Environmental management involves decision-making at varying levels of uncertainty, due to gaps in data or a lack of understanding of the ecosystems being managed. Adaptive management attempts to systematically reduce this uncertainty by evaluating management actions through experimentation (Murray and Marmorek 2004). Adaptive management is often referred to as “learning-by-doing”, placing an emphasis on monitoring the outcomes of management in order to learn about their effectiveness (Holling 1978; McCarthy and Possingham 2007; Walters 1986). The integration of design, management, and monitoring through a combination of research and action allows adaptive managers to test hypotheses and adapt management actions (Cottingham et al. 2001; Salafsky et al. 2001). Adaptive management should be used to improve environmental management and to understand the impact of incomplete knowledge (Schreiber et al. 2004).

The key starting point in adaptive management is the definition of specific conservation goals and the objectives of the overall project (Margoluis and Salafsky 1998). Adaptive management is dependent on the clear articulation of goals (such as conservation of biodiversity or maintenance of oak regeneration potential) to focus management objectives. Flexible goals, as well as a long-term commitment to detailed monitoring, are important in adaptive management in order to adjust and build knowledge (Murray and Marmorek 2004; Pastorok et al. 1997). Well-defined project objectives lay out a “road map” for the project (Pastorok et al. 1997). These desired outcomes, and the uncertainty about how to achieve these outcomes, drive the adaptive management process (Murray and Marmorek 2004).

Once management objectives have been defined and ecosystems identified, such as foothill oak woodlands, existing information for each ecosystem to be managed should be compiled through biological surveys, literature reviews, and an analysis of historical photographs and maps. The compiled information presents a baseline to monitor changes in the ecosystem, as well as to identify constraints and driving processes within the ecosystem (Haney and Power 1996). Existing knowledge should be described through conceptual models to promote a consensus, while identifying uncertainties in the system (Salafsky et al. 2002). The aim of conceptual models is to create a simplification of the relationships within an ecosystem in order to understand the pressures and efficiently improve the ecosystem through an adaptive management approach (Haney and Power 1996; Sainsbury et al. 2000; Salafsky et al. 2002).

Following the implementation of management practices, an adaptive management process includes the monitoring and evaluation of an ecosystem (Murray and Marmorek 2004). Effective monitoring must include measurements in order to learn from failures and work efficiently towards conservation objectives (Redford and Taber 2000; Salafsky et al. 2002). For learning to occur, the information collected must be within the parameters identified in conceptual models of the system, in relation to the conservation goals (Schreiber et al. 2004). Monitoring data is used to validate or adjust components of the model (Haney and Power 1996). The evaluation and use of the results to modify future actions is the “closing of the loop” aspect of adaptive management (Murray and Marmorek 2004).

As a scientific process, adaptive management is vulnerable to failure. Poor planning and design, limited data, insufficient understanding of the system processes, and inadequate monitoring and evaluation can all contribute to the failure of the implementation of adaptive management (Schreiber et al. 2004). An
understanding of these weaknesses can help evaluate whether adaptive management is possible for a given problem. Incorporating scientific methodology through the evaluation of ecological processes in comparisons of management strategies is attractive to both scientists and managers (Carpenter 1990; Cottingham et al. 2001). Adaptive management is a process aimed at reducing the uncertainty in management decisions, as well as improving the chances of reaching specified conservation objectives (Murray and Marmorek 2004).

Conservation goals, management objectives, and performance measures direct conservation planning and adaptive management

In order for adaptive management to be effective, clear and explicit conservation goals and objectives need to be formulated. Conservation goals are broad overarching statements that are brief, visionary, and inspire more specific objective setting (Tear et al. 2005). An example of a conservation goal could be the maintenance of biodiversity through time. Conservation objectives are more specific and are associated with a quantifiable metric, while conservation goals are more conceptual (Tear et al. 2005). Objectives target specific systems or outcomes and lead to the selection of a performance measure. An example of a management objective could be the maintenance of oak woodland regeneration. Performance measures are a quantifiable gauge of the condition of specified management objectives. An example of a performance measure would be oak seedling densities, when the objective is maintaining oak regeneration.

Emphasis should be placed on the conservation of representative ecosystems upon which sensitive species depend, rather than focusing solely on the recovery of endangered species themselves. This enables the conservation of non-target, but still valuable species and communities (Tear et al. 2005). Conservation planners must define performance measures that can be assessed over a specified space and time. We will ensure that our monitoring framework reflects the species or ecosystems identified in our goals. Appropriate monitoring of the correct measures is critical to the success of adaptive management. Objective setting will employ the concepts of adaptive management in expectation of changes as scientific knowledge increases (Tear et al. 2005).

Science-based standards should also be applied to objective setting in order for conservation planning to be successful (Tear et al. 2005). Although goal selection and objective setting should be evidence-based and independent of feasibility considerations, objective setting should strive to identify multiple measurable alternatives for evaluation in order to enable an analysis of trade-offs (Tear et al. 2005). Objectives should be chosen for both short and long term planning horizons. Additionally, objectives should be tailored to the specific biological system of concern; therefore, a variety of objectives may be needed depending on the diversity and complexity of the systems or species involved. The existence of error and uncertainty in scientific understanding of biologic processes and relationships will be acknowledged and described (Tear et al. 2005).

Conceptual models are an important tool to use within an adaptive management framework, and provide the foundation for decision making through the identification of drivers, stressors, endpoints, and performance measures

Conceptual models are visual interpretations of the current understanding of entities and relationships within a system, and are an important form of communication to an array of audiences. Conceptual models are the most important product of an environmental problem formulation exercise, and a critical component of risk assessment, management, and recovery processes (Gentile et al. 2001). When environmental managers are attempting to deal with a complex system, they must first describe it in a simple conceptual model so that they can both understand and efficiently change the system in order to solve the ecological problem (Parrish et al. 2003; Salafsky et al. 2002). Conceptual models will be used to illustrate the connections between societal actions, environmental stressors, and ecological effects, while providing the basis for developing and testing causal hypotheses (Gentile et al. 2001).
The drivers and stressors controlling ecosystem structure and function, and the interactions among and between them, are identified through conceptual modeling. Drivers are large, over-arching factors that cause measurable changes in the properties of biological communities. Examples of drivers include environmental factors such as rainfall variability and available soil nitrogen, as well as management factors such as livestock grazing practices and prescribed burning (Havstad and Brown 2003). Stressors are the physical, chemical, and biological changes that result from natural and anthropogenic drivers affecting other changes in ecosystem structure and function. Relevant drivers and stressors, and their interactions are modeled based on current knowledge and scientific understanding (Gentile et al. 2001).

Drivers can be considered first-order influences, and stressors can be considered second-order influences in chains of cause and effect, where there are several links before the final effects on model endpoints (Henderson and O’Neil 2004). Stressors have associated time dimensions and can usually be measured quantitatively (e.g. nutrient loading rates). Stressors may affect a single resource component or may act on multiple ecosystem components simultaneously. As a result, stressor effects may be limited or widespread. Conceptual models can define relationships between drivers, stressors and ecosystem change.

To create an integrated assessment, conceptual models are used within an ecosystem management framework (Gentile et al. 2001). One role of conceptual models in the management process is to identify objectives and performance measures (Gentile et al. 2001). These models are developed by identifying drivers, stressors, objectives, and performance measures, and can be used to formulate hypotheses to explain the current conditions of an ecosystem (Gentile et al. 2001). Information from site-specific surveys or case studies provide the basis for developing conceptual models of ecosystems (Pastorok et al. 1997; Schreiber et al. 2004). Through the development of conceptual models for management objectives, a limited number of biological characteristics, ecological processes, and interactions with the physical environment will be identified, along with linkages (Maddox et al. 2001). Objectives typically have ecological importance, are susceptible to a stressor or environmental concern, and should have attributes that allow for the characterization of the state, health, or change in a system (Gentile et al. 2001). Performance measures are a quantifiable gauge selected to assess a system’s response to management. These performance measures serve as a tool to measure the degree to which specified conservation goals and management objectives have been achieved. Conceptual models representing existing knowledge of a given system are crucial to identifying uncertainties, but collaboration is also essential to ensure realistic bounding of management problems, constraints on possible actions, and identification of realistic outcomes (Schreiber et al. 2004).

As a conservation management tool, conceptual models can be incorporated into all types of assessments and planning activities to describe the causal relationships among land uses, stressors, valued ecological resources, and their associated objectives and indicators (Gentile et al. 2001). Conceptual models can also be used to structure management scenarios to predict the magnitude of system recovery, and are used in the initial development of performance criteria (Gentile et al. 2001). Conceptual models show the relationships among objectives for species or communities, performance measures, and key ecological parameters, while forming the basis for developing hypotheses describing causal mechanisms leading to changes in the community (Pastorok et al. 1997).

Conceptual models are not meant to be final or complete; rather they are to be used as a flexible framework that should evolve and change as understanding increases (Maddox et al. 2001). It is important to focus on drivers and stressors which impact a specific environmental objective of interest. Understanding of similar or related systems can be used to hypothesize relationships or stressors as additional knowledge or data is collected. Through the development of conceptual models, simplifications of reality are created that are useful to an adaptive management program (Sainsbury et al. 2000). Simple conceptual models are generally regarded as more appropriate than more complex, realistic models because complex models may be vulnerable to misspecification. Simple models require less data, are quicker to develop, and are easier to compare (Sainsbury et al. 2000; Schreiber et al. 2004).
Conceptual models must be constructed correctly to be a viable means of communicating and leading discussions with scientists and the public.

Conceptual models are developed to effectively illustrate a variety of activities and stressor-response relationships (Suter 1999a,b). If a conceptual model is properly developed, it captures the scientific understanding of an ecosystem and its response to natural and anthropogenic stressors (Gentile et al. 2001). A well-presented graphical representation of a conceptual model can express linkages and identify stressors clearly to an audience (Gentile et al. 2001). Conceptual models illustrate current linkages while providing a common language that people from different perspectives can understand (Salafsky et al. 2002). The appropriate levels of detail, resolution, and aggregation in conceptual models are necessary to fully communicate causal linkages for the setting, and are important for communicating with the public (Gentile et al. 2001).

Conceptual models are an extremely useful management tool for thinking through the potential efficacy of management options and can be an effective tool for communicating to both the public and environmental managers who are not familiar with the environmental problem at hand (Gentile et al. 2001). Through the construction of a conceptual model, the scientific community can become engaged in an important dialog to clearly articulate the individual perspectives of scientists regarding how an ecosystem functions and responds to stress (Gentile et al. 2001). A consensus of the scientific community and public can emerge if assumptions and relationships are made explicit and defended (Gentile et al. 2001).

Establishing baseline conditions is a key step in developing conceptual models for adaptive management.

One of the starting points of conservation planning and adaptive management efforts is the establishment of ecological baseline conditions across a landscape of interest. The term “landscape” refers to a mosaic of heterogeneous land forms, vegetation types, and land uses (Urban et al. 1987). In establishing baseline conditions for conservation, unique patterns or combinations of community types should be evaluated, instead of individual community types. Habitat corridors and networks that promote species and gene flow between habitat patches should be inventoried, such as riparian corridors, which can be especially important to landscape connectivity (Noss and Harris 1986).

In addition to establishing the combinations of community types and habitat corridors, it is also effective to compile quantitative baseline data on those species or other biodiversity features believed to be most at risk from threatening processes (Gaston et al. 2002). For example, quantitative values can be expressed as the areal extent of a vegetation or habitat type, the total population size of a species, or the number of different areas in the network in which it should be present (replication).

At the landscape scale, biodiversity can be inventoried, monitored, and assessed using compositional, structural, and functional indicators (Noss 1989). Compositionally, indicators can be species identity, distribution, richness, collective patterns of species distributions, and proportions of patch types. At the structural level, community heterogeneity, connectivity, spatial linkage, patchiness, fragmentation, configuration, perimeter-area ratios, and patterns of habitat layer distributions are all indicators of biodiversity. Finally, measurable or observable indicators at the landscape level may include disturbance processes, nutrient cycling rates, energy flow rates, patch persistence and turnover rates, rates of erosion and geomorphic and hydrologic processes, and human land-use trends.

It is also useful to compile historical data on landscape structure through aerial photography or satellite imagery to establish baseline conditions (Noss 1989). Monitoring temporal landscape structure can be useful for identifying ecosystem responses to disturbance regimes such as grazing, climate change, deforestation, road density, agriculture, or other stressors (Noss 1989).
Baseline conditions will help prioritize management objectives, for the effective monitoring of future trends on Tejon Ranch. Through the formulation of objectives, conceptual models, and establishment of baseline conditions, an adaptive management approach can be taken to achieve conservation goals. In the case of this project, these deliverables will contribute to the Tejon RWMP currently in development by the Tejon Ranch Conservancy.

**Approach**

The project will begin with a literature review to further our understanding of the ecosystems processes that are at work within Tejon Ranch. This information will be an important component of our project, contributing to the development of conceptual models, such as models of environmental subsystems. A review of scientific literature and existing management programs on landscape connectivity, grasslands, riparian corridors, oak woodlands, conifer and mixed hardwood conifer forests, montane shrublands, wetlands, water resources, and watersheds will determine:

- The importance of each ecosystem within the Tejon Ranch landscape
- Approaches that have been used to conserve and enhance these systems
- The presence and extent of these ecosystems on Tejon Ranch
- Past development and human uses of Tejon Ranch ecosystems
- Documented anthropogenic and natural stressors on these ecosystems
- Relationships between anthropogenic and natural stressors on ecosystem processes and structure on Tejon Ranch

This project will characterize ecosystem processes and define ecological baselines on Tejon Ranch. These baselines will be used in conjunction with current scientific understanding of the systems to develop conceptual models (e.g., of select ecological systems such as mojave desert grasslands) in support of the creation of an adaptive management plan for Tejon Ranch. Figure 1 represents the components of our project and the relationships between them.

![Figure 1. Components of Tejon Ranch project.](image-url)
Our project will entail the following components:

1. **Conservation goals.** Conservation goals will be refined and articulated in cooperation with the Tejon Ranch Conservancy and based on the Conservancy’s mission statement and the stipulations of the Agreement. We will refine these goals through a series of quarterly meetings with the Conservancy staff and/or Board of Directors, including a presentation of interim work products at Conservancy board meetings.

2. **Collect existing baseline data and incorporate a historical review to characterize trends.** Existing knowledge needs to be collected and analyzed to identify data gaps, management uncertainties, and establish baseline conditions (including assessments of system variability) for further modeling of system dynamics and responses.

   a) **Visual representations of historical conditions.**
   - *Historic aerial photographs:* Digital aerial photographs of Tejon Ranch (acquired from the Map and Imagery Library at UCSB) will be used to assess regional to landscape-scale changes in vegetation community types. Aerial photographs from different time periods will be compared to present conditions to assess configurations of community heterogeneity, connectivity, fragmentation, perimeter-area ratios, and patterns of habitat layer distributions over time. This will allow for the identification of key structuring variables.
   - *Photogrammetry:* Photogrammetry is a form of remote sensing in which geometric properties of objects are determined using historic images. We will assess vegetation community responses to climate change and land use by evaluating changes in community extents (e.g. lateral width of riparian canopy) over time using historical aerials and cross-referencing with other available historical data. For community changes and trends related to weather patterns, changes in vegetation structure and community extent will be correlated with available data on climate and precipitation including historical precipitation data, precipitation isopleths, stream gauge data, and groundwater well depth data (when available).
   - *Wieslander Vegetation Type Mapping (VTM):* The VTM project has datasets of California vegetation dating back to the early 20th century (University of California 2005a). We will use this data to compare the spatial distributions of vegetation types on Tejon Ranch over time. Fieldwork, vegetation classifications, and mapping will be conducted according to the Wieslander Protocol, as described in the VTM Field Manual (University of California 2005b).
   - *Digital Stream Assessment/Riparian Transects:* We will assess trends in riparian community extent over time by visually comparing riparian canopy width across selected transects overlain digitally on aerial photos.

   b) **Paired landscape photographs:** Using Wieslander VTMs and photographs we will compare current and historic landscape conditions (University of California 2005a). Historic ground-level photos of Tejon Ranch taken between 1920-1941 are available representing land type, species, timber stand conditions, logging, mining, and fire. We will select a representative sample of historic photo points that can be identified and take the same photo of the current landscape. This will create a representation of how the Tejon Ranch landscape has changed over time, allowing us to assess vegetation community and structure changes.

   c) **Geographic Information Systems (GIS) data:** Using data from Tejon Ranch we will reconstruct landscape data on topography, soil composition, road networks, and special-status species.

   d) **Historic land use documents:** Hunting records, historic grazing records, construction permits, etc. will be used to evaluate land use changes through time.
e) **Field Monitoring**: Field monitoring (e.g., riparian assessments, photo-monitoring) will be used to supplement remote sensing and GIS analyses to refine conditions in key habitat types (e.g. riparian habitats).

f) **Qualitative comparison of resource conditions to surrounding landscape**: We will qualitatively compare resource conditions, such as oak density or landscape connectivity on Tejon Ranch to those observed on surrounding properties to model the effects of various land use practices on resource conditions.

3. **Establishing management objectives.** Management objectives are more specific than conservation goals and lead into the development of performance measures. The selection of management objectives will cover multiple spatial and temporal scales. Objective setting will identify ecosystem processes to be managed, including both short and long-term planning horizons, incorporating the key aspects of representation, redundancy, and resilience in the selection process. This will ensure that management efforts adequately cover or capture the range of biodiversity elements. The objective setting process will follow the scientific method, quantifying and stating uncertainty and sources of error as well as being peer-reviewed and publicly accessible. Objective setting will be evidence-based, using the best available science. Restoration projects can be a part of management objectives.

4. **Identify performance measures relating to management objectives.** Assessment criteria will be established in order to evaluate and compare various management strategies. Management objectives will be tailored to the specific ecosystems. Therefore, a variety of performance measures may be selected for individual drivers or stressors depending on the diversity and complexity of the systems or species involved. This step involves selecting quantifiable metrics (e.g. oak seedling recruitment) for use in analyzing management alternatives (e.g. cattle exclusion) in an experimental management design.

5. **Develop conceptual models** of select ecological systems (such as foothill oak woodlands). Conceptual models of relationships and processes can be applied to a system in order to predict the effectiveness of alternative management strategies in achieving specific conservation goals. Modern conservation planning principles such as landscape connectivity, inter-species interactions, and natural and anthropogenic disturbance regimes will be applied in each conceptual model (Pastorok et al. 2007). Through the process of modeling, we will assess opportunities for ecological restoration and land use modification to restore or enhance ecological functions on Tejon Ranch. The steps prescribed in the scientific literature to develop conceptual models appear in a sequential list, but for the purpose of this proposal it will be necessary to address some tasks simultaneously. The steps involved include:

   a) **Clearly stating the goals of the conceptual model.**
   b) **Identifying bounds of the system and important subsystems.** Establish a common vision of the relevant spatial and temporal bounds, as well as the most important system components. What are the major subsystems and processes that must be represented? Do the properties to be addressed contain obvious vegetation, topographic types, or gradients? Have we identified dominant ecological processes that require separate submodels?
   c) **Developing control models of key systems and subsystems.** This step requires our group to consider a wide range of ecosystem processes, spatial and temporal scales, and disciplines. To develop useful control models, we will simultaneously identify major system drivers and stressors.
   d) **Identifying natural and anthropogenic stressors.** Stressors cause significant changes in ecological components, patterns, and processes in natural systems. Since stressors act at different temporal and spatial scales, an organizational framework is necessary to ensure that all necessary scales and disciplinary areas are addressed.
   e) **Modeling relationships of stressors, ecological factors, and responses.** Integrate an understanding of system dynamics and responses in a set of models that clearly communicate linkages between drivers, stressors, ecological responses, and ecosystem attributes.
f) Articulating key questions or alternative approaches.
g) Identifying and prioritizing indicators.
h) Reviewing, revising, and refining models.


6. **Create a monitoring framework.** We will identify potential approaches to monitor priority management objectives. A field monitoring framework will be developed (e.g. monitoring structural diversity of riparian vegetation) to supplement data and refine conditions in key habitat types (e.g. San Joaquin Valley grasslands).

**MANAGEMENT PLAN**

**Group Structure and Responsibilities**

The following roles and responsibilities have been identified as necessary to execute the project.

- **Project Manager (PM) – Dana Roeber Murray**
  Responsible for planning, organizing, and focusing of the group project. Primary responsibilities include: scheduling weekly meetings, developing meeting agendas, correspondence with client and faculty advisor, delegating responsibility, ensuring deadlines are met, and promoting communication throughout the project team.

- **Financial Manager – Jonathan Appelbaum**
  Responsible for creating and tracking project budget, resource scheduling and budgeting, estimating expenses, and accounting for costs. Costs may include phone calls, poster printing, travel, software, equipment, laboratory fees, business cards, reference books, poster production, presentation materials, photocopying, and publication expenses. Collaborate with Internship Coordinator on internship budget.

- **Data Manager – Lisa Kashiwase**
  Responsible for maintaining the group’s shared online information, briefing group members on the use of directory and file permissions, and the management of information. Coordinate data transfer with client, manage GIS database, and act as the group’s consultant on computer programs and software.

- **Web Manager – Erin Brown and Lisa Kashiwase**
  Responsible for the development and maintenance of the group’s website. Ensure timely posting of information, accuracy, and verification of posted links. Updates the website as needed.

- **Internship Coordinator – Shaina Forsyth**
  Responsible for communicating and collaborating with Dave Parker, Frank Davis, and the Tejon Ranch Conservancy to develop intern job descriptions and coordinate internship logistics (e.g. housing, schedule). Collaborate with Financial Manager on internship budget.

**Quality Control Process**

All group members will contribute to working documents, unless specifically assigned. Document review should be performed using track changes by at least two group members. Shaina Forsyth will act as the Quality Control Manager, ensuring that formatting is consistent among documents and that adequate review of each document is performed. The PM will accept or reject changes. Where necessary, the PM will
redistribute the document to a specific author for revision. Once this is complete, the PM will save it in the “Final” folder for submittal.

Meeting Structure

Meetings will be held twice a week, one of which will include the faculty advisor. The PM will schedule meetings using Corporate Time and distribute an agenda prior to the meeting. The agenda will be available for edits and additions by group members at least 2 hours prior to each meeting. Meetings will be run by the PM to keep group meeting tasks on track. Group members (except PM), will take meeting minutes on a rotating basis. As schedules allow, meeting minutes shall be posted within 24 hours of the meeting, or at earliest possible juncture to allow for the next meeting’s agenda to be formulated. Agendas and minutes will be saved in the ‘Meetings’ folder in the project directory and are open to additions by all group members.

Systems to ensure deadlines are met

Deadlines will be identified and discussed during project meetings. Any final decisions will be made by the PM. Establishing deadlines agreed to by all group members will help ensure they are met. There will be clear distribution and access to set deadlines. Action items and deadlines will be assigned to group members and noted in meeting minutes, and group members will be asked to present their tasks at the following meeting. If a group member is unable to complete an assigned task within the deadline, or needs assistance, they are to communicate with the group as a whole or contact the PM to coordinate assistance.

Conflict resolution process

Any problems arising in the group should be addressed quickly in order to effectively address the problem/issue. Issues should be addressed to the PM, which can then be dealt with in a confidential manner.

Procedures for documenting, cataloging, and archiving information

All information and documents pertaining to the group will be accessible on the project directory. The Data Manager will establish folders and permissions and will brief the group on directory layout and organization to ensure quality control and reduce confusion. The Data Manager will also catalog important group e-mails and store them in the shared project directory. Website updates will be the responsibility of the Web Manager, with pages saved in the directory prior to uploading webpage updates. Corporate Time will be used as the primary scheduling tool and group members are expected to keep their Corporate Time calendars current. Budget expenditures and budget projections will be the responsibility of the Financial Manager and will be kept in a file on the shared project directory. All data stored on the project directory will be backed up and archived regularly by the Data Manager.

Guidelines for interacting with faculty advisor, external advisors, and clients

The role of the faculty advisor will be to provide feedback and guidance on the group’s work. The faculty advisor will attend at least one meeting per week with group members. Client meetings will be held at least three times per quarter. Interim updates and documents will also be sent to the client. Additional briefing to the Board Members of the Tejon Ranch Conservancy may occur at quarterly board meetings. Correspondence with external parties should primarily be in electronic form, unless otherwise specified.

E-mail correspondence will be sent from the group email, tejon@bren.ucsb.edu. All group members and the faculty advisor will be included on the project alias.
Overall expectations of group members and faculty advisors

The faculty advisor’s expectations for group members include the production of scientific, scholarly work. All group members should contribute to the overall project. Grading criteria is contingent upon the above expectations.

Group member expectations of the faculty advisor include the attendance of weekly meetings, thorough review of documents, guidance, and recommendations in developing and achieving the project objectives.

DELIVERABLES

The results of this project will be contained within a final report. This final report will include:

- Refining of ecosystem targets and conservation goals
- Conceptual models
- Baseline conditions
- Recommendations for monitoring targets and approaches
- Identify opportunities for restoration on Tejon Ranch

MILESTONES/TIMELINE

Spring Quarter 2009

<table>
<thead>
<tr>
<th>Task</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Final Proposal to Review Committee</td>
<td>May 26, 2009</td>
</tr>
<tr>
<td>Web Site Operational</td>
<td>May 26, 2009</td>
</tr>
<tr>
<td>Review Committee Meeting</td>
<td>June 2, 2009</td>
</tr>
<tr>
<td>Final Proposal Submitted</td>
<td>June 8, 2009</td>
</tr>
<tr>
<td>Summary of Proposal Review Meeting</td>
<td>June 10, 2009</td>
</tr>
<tr>
<td>Submit Self/Peer Evaluations</td>
<td>June 12, 2009</td>
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</table>

Summer 2009

<table>
<thead>
<tr>
<th>Task</th>
<th>Deadline</th>
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</thead>
<tbody>
<tr>
<td>Preliminary Field Condition Assessments</td>
<td>End of September 2009</td>
</tr>
<tr>
<td>Begin Historical landscape Analysis</td>
<td>End of September 2009</td>
</tr>
<tr>
<td>Perform Literature Review on Assigned Tasks</td>
<td>End of September 2009</td>
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</table>

Fall 2009

<table>
<thead>
<tr>
<th>Task</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Historical Landscape Analysis</td>
<td>End of October</td>
</tr>
<tr>
<td>Refine Conservation Goals</td>
<td>End of October</td>
</tr>
<tr>
<td>Establish Baseline Conditions</td>
<td>Mid-November</td>
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<tr>
<td>Develop Conceptual Models</td>
<td>Early December</td>
</tr>
<tr>
<td>Progress Review Completed</td>
<td>November 13, 2009</td>
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<tr>
<td>Written Progress Report Due</td>
<td>December 4, 2009</td>
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<tr>
<td>Submit Self/Peer Evaluations</td>
<td>December 4, 2009</td>
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</table>

Winter 2010

Tejon Project Proposal
June 8, 2009
Create Project Defense Presentation | Mid-January
---|---
Project Defense | Early February
Draft of Final Report to Advisor | February 15, 2010
Submit Presentation Program Abstract | March 10, 2010
Final Report with Signatures Due | March 19, 2010
Project Brief Due | March 19, 2010
Submit Self/Peer Evaluations | March 19, 2010
Submit Faculty Advisor Evaluation | March 19, 2010

Spring 2010

Draft Power Point Presentation Submitted to Advisor | One to Two Weeks Before Presentation
Poster Submitted to Printer | One to Two Weeks Before Presentation
Public Project Presentation | Early April
Submit Project Poster to Bren | Early April

**BUDGET**

*Bren Allocation*

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Printing</td>
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<tr>
<td>Final poster/brief printing</td>
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<tr>
<td>Copying</td>
<td>$50</td>
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<tr>
<td>Phone</td>
<td>$25</td>
</tr>
<tr>
<td>Administrative supplies</td>
<td>$25</td>
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<tr>
<td>Final Presentation</td>
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<tr>
<td>Travel</td>
<td>$750</td>
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<td>Miscellaneous</td>
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<td><strong>Bren Total</strong></td>
<td><strong>$1,500</strong></td>
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*Tejon Ranch Conservancy Allocation*

<table>
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<th>Item</th>
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</thead>
<tbody>
<tr>
<td>Travel (Vehicles, Lodging, Meals)</td>
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<tr>
<td>Field Surveying Equipment</td>
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</tr>
<tr>
<td>Software &amp; Licensing</td>
<td>$500</td>
</tr>
<tr>
<td>Maps and Aerial Photographs</td>
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</tr>
<tr>
<td>Photo Printing</td>
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</tr>
<tr>
<td>Local Records (e.g. County Assessors Maps)</td>
<td>$250</td>
</tr>
<tr>
<td><strong>Conservancy Total</strong></td>
<td><strong>$7,000</strong></td>
</tr>
</tbody>
</table>

**BUDGET JUSTIFICATION**

The Bren School of Environmental Science and Management will provide $1,300, plus an additional $200 for printing costs. In addition, the Tejon Ranch Conservancy will provide $7,000 for incidental field expenses including travel, equipment, and material costs. Any adjustments to our budget will be addressed by the group through the Financial Manager. This budget will be updated to reflect the discussed changes within three business days.

*Bren Allocation*
• Phone: The telephone setup fee is $10, the monthly maintenance fee is $1, and the cost of calls is $0.05/min. Conference calls are necessary to maintain communication with our client and other stakeholders when they are unavailable to meet in person. The money allocated will allow for 3 ½ hours of call time per month for 9 months.
• Printing: Our initial $200 printing allotment will be used for routine printing of literature and document drafts. The professional printing of our final project poster and briefs are expected to cost an additional $300.
• Copying: We plan on purchasing a library copy card and estimate $50 for copying expenses.
• Administrative supplies: We anticipate spending up to $50 on administrative supplies, such as folders and other office products.
• Final presentation: We expect to spend $50 on our final presentation.
• Travel: We anticipate traveling to our project site four times (twice in spring quarter, once each in fall and winter quarters) over the project and attending one Conservancy Board Meeting in the greater Los Angeles Area and have estimated the total costs, including the rental car and gas, to be approximately $750.
• Miscellaneous: An additional $100 is reserved for any unforeseen expenses otherwise not covered above (e.g. coffee and bagels for hosted meetings with client).

**Tejon Ranch Conservancy Allocation**

• Travel: We anticipate travel costs including: vehicle rentals, reimbursement of personal vehicle mileage, limited lodging expenses, and meals, of approximately $5,000.
• Field Equipment: Costs of approximately $500 for field surveying equipment is expected.
• Software and digital imagery licensing: $500 for computer software and licensing and $500 for the purchase of digital maps and aerial photographs.
• Printing: $250 for photo printing costs.
• Records: $250 has been allocated for purchasing local records such as grazing lease records and title information.
CONTACT INFORMATION

Project Team
Jonathan Appelbaum  jappelbaum@bren.ucsb.edu
Erin Brown  erbrown@bren.ucsb.edu
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Bren Faculty Advisor
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Client
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Bren Faculty Reviewers
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Christina Tague  ctague@bren.ucsb.edu

External Reviewers
David Stoms  stoms@bren.ucsb.edu
Claudia Tyler  tyler@lifesci.ucsb.edu
Michael White  mdwhite@consbio.org

Other Information
Project Email  tejon@bren.ucsb.edu
Project Website  http://www.bren.ucsb.edu/~tejon
REFERENCES


Tejon Project Proposal
June 8, 2009


APPENDIX A: GLOSSARY

Conceptual Models – visual interpretation of the current understanding of a system’s entities and relationships.

Conservation Goals – represent the broad overarching purpose of a project, such as maintaining biodiversity. Goals are well defined, unambiguous statements that inspire more specific objective setting.

Drivers – Drivers are large, over-arching factors that cause measurable changes in the properties of biological communities. Examples of drivers include environmental factors such as rainfall variability and available soil nitrogen, as well as management factors such as livestock grazing practices and prescribed burning.

Management Objectives – more specific then conservation goals. They target a specific system or outcome which can lead to defining a performance measure (or quantifiable metric to measure outcome).

Natural Heritage – a place of natural heritage significance may have ecosystems, biological diversity, and geodiversity which are important for their existence or intrinsic value, or for present or future inhabitants in terms of their scientific, social, aesthetic and life support values. Natural heritage can also be the legacy of natural places, objects, and intangible attributes encompassing the countryside and natural environment, including flora and fauna, scientifically known as biodiversity.

Performance Measure – quantifiable gauge of the conditions of specified management objectives that are being achieved.

Stressors – physical, chemical, and biological changes that result from natural and anthropogenic drivers affecting other changes in ecosystem structure and function. Drivers can be considered first-order influences, and stressors can be considered second-order influences in chains of cause and effect, where there are several links before the final effects on model endpoints.