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Planning for Adaptation to Climate Change: Methods and Lessons Learned from Mount Hamilton, California

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The Nature Conservancy
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Introduction

The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the land and waters they need to survive. To fulfill this mission, the Conservancy has developed a suite of conservation planning tools to identify the most strategic conservation actions to preserve the species in the most need of help. These tools are applied across a variety of scales, but the most common are the ecoregion and the landscape. These tools were designed under the assumption that the future climate will remain similar to the past climate, and subsequent conservation strategies were developed accordingly. Given the preponderance of evidence that this assumption is not valid, the Conservancy is developing new tools and methods to plan for a future with a different and uncertain climate.

The Nature Conservancy in California is developing a Climate Adaptation Framework to guide our efforts at multiple scales. As part of this framework, we have developed data and maps at the statewide scale to better understand the projected changes in climate, the biological responses to these changes, and inherent resiliency provided by the landscape. We have also completed several pilot projects to serve as laboratories for refining existing tools and developing new ones. These projects range in scale from an ecoregion (Mojave Desert Ecoregional Assessment 2010), to a sub-ecoregion [Southern Sierra and Northern Sierra (available in 2011)], to a landscape scale (Mount Hamilton). In this paper, we focus on methods and lessons learned from the Mount Hamilton planning effort.

A draft Conservation Action Plan (CAP) for the Mount Hamilton project was completed in 2007, but did not consider climate change in site or strategy selection. Conservation Action Planning is a common and powerful tool used in The Nature Conservancy and in a variety of other organizations. We built on this previous planning using Climate Change Project-Level Guidance provided by The Nature Conservancy's World Office to more explicitly consider climate change adaptation in our plan. Following this guidance and developing our own methods, we have updated the CAP process by developing and ranking a set climate adaptive strategies for key species in the Mount Hamilton range. Some of these strategies are similar or identical to those identified by the 2007 Mount Hamilton CAP and are already being implemented to address other threats. We are currently finding ways to implement the additional strategies developed through the climate change adaptation planning effort.

Using the methods and lessons learned in this document, we were able to identify and rank a suite of climate change adaptation strategies for key species in the Mount Hamilton range. Given the early stage of this process, we do not know if these methods will work for every project or that they are the best and most efficient, but we offer them as hypotheses that can be tested elsewhere. We hope other groups will use this information, test the results, and continue to innovate to develop better methods and results. Finally, we hope that other groups will document and share their lessons learned so we can continue to modify and improve our planning efforts, and more effectively achieve our conservation mission.

Planning Framework

We started with a planning framework that is informed by the CAP process, the Climate Change Project-Level Guidance, and the draft California Adaptation Strategy (in development). The outline below shows the steps we followed, and also serves as the outline for the structure of this report. Some of the steps below are not yet complete, and thus are not covered in detail in this report.

1. Select study area
2. Set goals for planning process
3. Select conservation targets
4. Assess climate change impacts
5. Conduct rapid vulnerability screening to select focal targets
6. Identify key human activities
7. Conduct detailed vulnerability assessment for focal targets
8. Set conservation goals and objectives for focal targets
9. Identify strategies to meet the objectives
10. Evaluate strategies
11. Cross reference with current strategies to identify gaps (not yet complete)
12. Identify existing and needed capacity to fill gaps (not yet complete)
13. Implement strategies (not yet complete)
14. Monitor (not yet complete)
15. Re-evaluate entire process as needed (not yet complete)

Some of the steps in this framework were completed in an efficient 2-hour meeting with the right mix of people, while other steps took days of research and analysis. For each step, we describe the methods we used, what we found most successful, and the lessons learned from the process.

1. Select study area

We selected the Mount Hamilton project area (see Figure 1) for our pilot site for landscape scale climate change adaptation planning for three reasons. Given the ecological importance of the species and the impending threats from the encroachment of the surrounding urban and agriculture landscapes, the Nature Conservancy of California has invested heavily in the area, working with partners to protect approximately 115,000 acres since 1998. Previous research had examined projected impacts of climate change for some key species (Klausmeyer 2005). In addition, a draft Conservation Action Plan for the project area was completed in 2007 (The Nature Conservancy of California 2007).

Lessons Learned

- **Select an area with an existing conservation plan (e.g. CAP)**. We found that having an existing CAP in place simplified several steps, including defining the boundaries of the study area, selecting conservation targets, and conducting vulnerability assessments. This gave us more time to focus on the climate change aspects of the assessment.

- **The vulnerability of an area affects the urgency of the climate adaptive strategies.** The Mount Hamilton project area is topographically diverse, is close to the ocean, and has large intact blocks of natural/semi-natural vegetation. These factors make some of species found there better able to adapt to climate change and thus less vulnerable. However, it is also hemmed in on three sides by urban and agricultural development, and does not have the broad climate gradients that an area of equivalent size might have in a more mountainous region like the Sierra. These factors make the species found there less able to adapt to climate change, so the Mount Hamilton range has relatively moderate vulnerability. While climate change is an important threat, addressing other threats may be more urgent when compared to climate change. In addition, several of the climate adaptive strategies we identified are already being employed to combat other threats. In retrospect, we could have chosen a pilot study area with a higher vulnerability to climate change to make the climate adaptive strategies more distinct from the existing strategies to abate other threats.

2. Set goals for planning process

We found explicitly setting goals for the planning process concentrated our efforts and helped us to track the effectiveness of our work. The goals we set are:

1. Identify adaptation objectives and management strategies that will help the plants, animals and ecosystems of Mount Hamilton and surrounding landscapes adapt to a changing climate.
2. Document and communicate best practices for identifying climate adaptive strategies for The Nature Conservancy and other conservation organizations.

Lessons Learned

- **Set goals that define what you would like to adapt.** The term “adaptation” can mean different things to different people, so be explicit about if you want to adapt your organizational practices, adapt your organizational strategies, or to facilitate the adaptation of species and habitats to climate change.

3. Select conservation targets

Under the terminology of CAP, a conservation target is “a limited suite of species, communities and ecological systems that are chosen to represent and encompass the full array of biodiversity found in a project area” (Conservation by Design website). The systems targets identified in the Mount Hamilton CAP include:

- Oak Woodlands / Grasslands
- San Joaquin Valley Kit Fox Habitat
- Chaparral / Scrub

- Sky Islands
- Serpentine Systems & Associated Endemic Species
- Sycamore Alluvial Woodlands
- Stream Systems
- Interior Wetlands & Ponds

As outlined in the CAP, the systems targets are groupings of many nested targets. For example, the “Oak Woodland / Grasslands” system target included 27 nested targets. In all, there are 124 targets nested within the 8 systems targets. We tried initially to focus only on the systems targets, but we surmised that climate change impacts and adaptive capacity will vary by nested target within each system target. For example, the Oak Woodlands / Grasslands system target includes the Tule Elk, a wide ranging mammal, and the Silvery legless lizard, a reptile with limited migration abilities. The climatic tolerances and ability to migrate varies greatly between these two species. We realized that we would have to consider the 124 nested targets rather than the more general systems targets.

We also had a discussion in our planning team about using ecosystem processes or services as targets, rather than species and communities. One benefit of this approach is the ability to choose a process that is important for a suite of species, such as stream flow or un-fragmented habitat. Another benefit is there is often a better understanding of the impacts of climate change to a process, as compared with the impacts of climate change on species. However, we found it difficult to establish the desired state of a process, since different species require different states. For example, we had trouble defining a desired stream flow regime since some native species prefer rapid cold water and others prefer warmer slower water. In addition, the impact of climate change on some processes or services was not clear, such as the impact on un-fragmented landscapes. For these reasons, we decided to focus on focal targets rather than ecosystem processes or services.

Lessons Learned

- **Select nested or individual targets over system or roll-up targets.** Individual species will respond differently to climate change, so assessing the impacts to a suite of species is difficult. Averaging impacts across a suite of species will also make it difficult to identify strategies for the most vulnerable species.

4. Assess climate change impacts

We spent a good deal of time determining the projected climatic changes for the study area from a suite of downscaled General Circulation Models (GCMs)) run to support the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (IPCC 2007). Downscaled data for a suite of GCMs did not exist when we first started looking at climate change impact for other project 4 years ago, so we downloaded raw GCM outputs and downscaled to the 800m resolution of the PRISM dataset (Daly et al. 2008) using the change factor approach described in the supporting information in Klausmeyer and Shaw, 2009 (Klausmeyer and Shaw 2009). Due to data availability we initially focused on end-of-21st century projections, but feedback from the project staff indicated this was too far into the future and too uncertain, so we downscaled new projections for mid-21st century. We also initially focused on several emissions scenarios (B1, A1b, and A2), but soon found that when combined with multiple GCMs, the number of potential scenarios was confusing. We focused on the A2 scenario because it had the greatest projected increase in emissions and thus generates the most dramatic projected climate changes. Recent observed greenhouse gas emissions data also show emissions that are higher than even the A2 scenario (Raupach et al. 2007), so we felt justified in focusing on the scenario with the highest emissions available. We hope more modeling groups will analyze higher emissions scenarios like A1FI for the next IPCC report to provide a more accurate "worst case" scenario.

We also had many discussions about how many and which GCMs to use for our analysis. We initially analyzed all realizations of all GCMs of all emissions scenarios, resulting in 136 unique scenarios of future climate. While all the GCMs project changes in average temperature and precipitation, only 11 GCMs include forecasts of minimum temperature and maximum temperature for the A2 emissions scenario. Data on maximum and minimum temperature are important for species distribution modeling, so we focused our analysis on these 11 GCMs. In order to avoid biasing our results toward modeling groups that provided data for multiple realizations of their model, we averaged the results of the realizations for each GCM. We initially tried averaging the results from the multiple GCMs, which works well for the projected changes in temperature. For precipitation, this gave misleading results because some models projected a wetter future, while other projected drier future, so the average of these models indicated no change. We considered using a bookend approach looking at the extreme projections in our suite of GCMs in order to encapsulate the full range of potential outputs. We found this method problematic because the extreme GCMs varied by variable considered. For example, GCM1 might be the wettest model and GCM2 might be the driest, while GCM3 projects the highest increase in maximum temperatures while GCM4 projects the least increase in maximum temperatures. When looking at multiple climatic variables, there was no way to select 2 GCMs that bookend the full range in variability. We finally used an average of the GCMs for the temperature projections, and looked at the percent of GCMs that project a wetter or drier future as a way to summarize the projected annual and seasonal climate changes.

Another set of information that we found useful was the historical variability in temperature and precipitation observed in the Mount Hamilton range. We used ~800m resolution PRISM data from 1895-2007 to summarize the inter-annual variability in annual temperature and precipitation, and then generate a 20-year moving average. We then plotted this data on a chart with the projected changes from each GCM to show how the future projected changes compare with the observed variability (see examples in Figure 2). We found that by 2050 the projected changes in temperature were well outside the range of historical variability, while the projected changes in precipitation were for the most part within the ranges of observed variability. Most of the GCMs project a drier future, and a few project a future as dry as the driest in the last 100 years. A drier future is likely to have more negative effects on the conservation targets of the region, so we decided to summarize the projected change in precipitation as uncertain, but possibly significantly drier. We developed the following two sentence summary of the projected changes: "Increases in temperature of 2-5°F by 2055 will increase evapotranspiration rates (likely). Precipitation may decrease by as much as 25% annually (uncertain)." Follow the links for a more detailed summary of the climate impact study methods and results and some charts of seasonal changes.

Lessons Learned

- **Focus on one future climate change scenario.** Given the complexity of the vulnerability assessments and strategy development, we found it most efficient to focus on one scenario of future climate that is not too far in the future, likely to occur, and will have the most negative effects on the conservation targets. Examining the projected impacts from a lower emissions scenario is often not helpful because preparing for the worst will also prepare for less climate change. However, if there is significant uncertainty in precipitation projections, it is best to do a sensitivity test to make sure your strategies will be effective given both a wetter and a drier future before implementing them.
- **Examine the historical climate as well as the projected future climate changes.** We found this comparison very useful to help people familiar with the area think about the projected future climate in terms of the known past. The historical PRISM dataset with a spatial resolution of ~800 meter grid cells is available to all Nature Conservancy staff for free, although other organizations may need to purchase it. The PRISM dataset with a coarser resolution of ~4 kilometers is available for free for anyone, but we did not test the sensitivity of our results with this dataset.
- **Utilize the work of others.** We spent years developing our own downscaled climate change dataset because other datasets did not exist at the time. This dataset covers the entire contiguous United States, is available to anyone who would like to use it (contact kklausmeyer@tnc.org for details). There are other similar datasets available online for free, including the Climate Wizard, data from WorldClim, and data from researchers at Santa Clara University. These tools and data are more than adequate to generate the generic climate impact summary statement and conduct the detailed vulnerability assessments needed to generate initial strategies.

5. Conduct rapid vulnerability screening to select focal conservation targets

Based on the experiences of others, we realized that conducting a detailed vulnerability assessment for 124 targets could take years and hundreds of thousands of dollars (Glick and Stein 2010). Instead, we conducted a rapid vulnerability screening to reduce the 124 targets to a more manageable 6 focal targets. In addition, we also determined the most vulnerable life stage or key ecological attribute to focus on for each target. A key ecological attribute (KEA) is an aspect of a target's biology or ecology that, if missing or altered, would lead to the loss of that target over time. The KEAs of some targets are very vulnerable to climate change, while other KEAs for the same target are very resilient to climate change. For example, the California tiger salamander larval stage requires pools that are not too hot and not too cold, stay wet for at least 10 weeks and then dry up after that, so that KEA is very sensitive to climate change. Once it reaches the adult life stage, it burrows underground for the hottest times of the year, so that life stage is much less vulnerable to change in air temperature.

To conduct the rapid vulnerability screening of the 124 nested targets, we used the following four criteria:

5.1. Representative. How well does the target represent a significant portion of the system? For example, blue oaks are representative of oak woodlands and grasslands in Mount Hamilton because it is the dominant oak species for most of the system.

5.2. Sensitive. Is the target sensitive to the projected climate changes? Some species are well adapted to change because they are wide ranging and can tolerate a wide variety of climates. Others are more sensitive because they are narrowly distributed and/or have specific climate tolerances for specific life stages. Certain groups of species, like most birds, have the ability to migrate long distances and thus have higher capacity to adapt to climate change. On the other hand, many species have very specific habitat requirements, such as edaphic plant communities, and thus will have to adapt to climate change in a single location.

5.3. Feasibility. Are the strategies to help the target adapt to climate change feasible? For some species, potential strategies are infeasible or ineffective to stem the threats caused by climate change. For example, the Mount Hamilton range supports isolated Ponderosa Pine stands that are thought to be relic populations from the last ice age on high peaks and north facing slopes. Since they thrive in cooler climates, the projected warming is likely to make in the entire range inhospitable. Any strategy to try to reduce the local warming of air temperatures is likely to be infeasible. In addition, most of these stands occur on protected lands, so there is little additional conservation work needed to protect them from other stresses like conversion. Instead, we focused on the species that need help adapting, and there is something we can do about it.

5.4. Sufficient Knowledge. Do we know enough about the species? If there are significant gaps in our understanding of the life history of the species, it will be difficult to generate hypotheses of change and adaptive strategies. We found that listed species often have the largest body of published research and observation data.

Using these criteria and the general knowledge about the targets from previous research, we were able to conduct the rapid vulnerability screening in one afternoon. While many of the targets are vulnerable to climate change, we were able to quickly select the best candidates for an initial planning exercise without doing any complicated analysis or modeling. The six focal targets we settled on include:

- American Badger (*Taxidea taxus)*
- Blue Oak (*Quercus douglasii*)

- California tiger salamander (*Ambystoma californiense*)
- Native Serpentine Plant Assemblage
- Steelhead- South Central Coast Distinct Population Segment (*Oncorhynchus mykiss*)
- Sycamore Alluvial Woodlands (*Platanus racemosa*)

Lessons Learned

- **Narrow the focal target list to a handful.** Given the complexities of the detailed vulnerability assessment and strategy development, it is best to focus the effort on a few representative vulnerable species. For the Mount Hamilton project area, the existing CAP included strategies to help conserve all of the broader system targets found in the study area. These existing conservation strategies are likely to reduce the stress from other threats and thus help the less vulnerable non-focal target species adapt to climate change. We found it useful to go through the entire process with a few focal species, rather than attempting to be more comprehensive, yet unable to complete the strategy development for any species within our planning timeframe.
- **Identify vulnerable KEAs for targets.** Species have complex life histories and vulnerability will vary in each life stage. Focusing in on the most vulnerable KEAs will also aid in strategy development.
- **Utilize existing expert knowledge.** There are many detailed modeling techniques to assess how species will react to climate change. These can be very useful and informative, but they can also be time consuming and require special expertise and data to complete. We found that talking to the right experts and relying on the knowledge of the project staff was sufficient to complete the vulnerability screening.
- **Be systematic about how the focal targets were selected.** We found that many people were interested in the process we used to do the screening, so be explicit about the criteria used to narrow the list, and how the decisions were made to include or exclude each target. We also had a few "runner up" species that we know are vulnerable to climate change but we did not have time to analyze in this initial planning effort. Keep a list of these vulnerable species for the next iteration of planning.

6. Identify key human activities

The focal targets will be directly impacted by climate change, but in some cases the indirect impacts of climate change will be more important than the direct impacts. As the climate changes, humans are likely to make changes to their activities, which will in turn have positive or negative impacts on the focal targets. In order to incorporate these impacts into our analysis and develop associated strategies to stop negative impacts and promote positive ones, we identified three human activities that affect the focal conservation targets and are sensitive to climate change. These three activities include:

- Ranching
- Land use / development

- Dams and diversions

We did not use a formal process to identify these activities, but relied on the knowledge of the project director and the prominent land uses in the study area.

Lessons Learned

- **Consider human activities.** We found that the human response to climate change in many cases could trump the direct impacts from climate change on our targets, so this is an essential step. In addition, the human response to climate change can either be positive or negative for a target. For example, dams may be managed in ways that exacerbate or ameliorate the affects of a change in the precipitation regime. Including these activities in your analysis will provide the opportunity to develop strategies to promote beneficial responses and discourage negative ones. We included the complex interactions of the direct impacts of climate change on our targets as well as the indirect impacts of the human response to climate change in our situation analysis (see step 7 below).

7. Conduct detailed vulnerability assessment for focal targets

We started the detailed vulnerability assessment with a literature review of climate change impacts on the focal conservation targets and on the key human activities. We also consulted with in-house experts on the targets and began to develop "hypotheses of change" for each KEA of each focal target and for each human activity. In other words, based on our knowledge of the species, we developed a specific statement about the anticipated impacts on climate change for the most vulnerable life stage of the species. We also developed specific hypotheses about the impacts of climate change on the key human activities, and how humans will likely respond to those impacts. For more information on developing hypotheses of change, refer to the Conservation Action Planning Guidelines for Developing Strategies in the Face of Climate Change (The Nature Conservancy Central Science Division 2009).

After developing draft hypotheses of change, we identified key external partners and experts and held a two day workshop to help complete the vulnerability assessment. For more information about the details and structure of the workshop, see the workshop webpage. The workshop participants were split into five groups with four groups focusing on one or two focal conservation targets each, and one group focusing on the human activities. The first task for each group in the workshop was to refine the draft hypotheses of change to make a final version and present back to the group.

In order to develop climate change adaptation strategies, we wanted to determine not only *the level* of vulnerability of each target to climate change, but to determine *why* it is vulnerable. This process is necessary to identify intervention points to begin to develop strategies to reduce vulnerability. At this stage of the workshop, the "human response" group was split up and joined the conservation target groups in order to share insights about how human activities will be affected by climate change. We then had each group make situational diagrams or box-and-arrow diagrams to illustrate the mechanisms of vulnerability to climate change and other associated threats. The diagrams were developed using the terminology and methods for developing situational analyses during a traditional CAP process (described here). The process for developing these diagrams went as follows:

- Diagram the hypothesis of change for each KEA of each target
  - The "stress" was the elements of the hypothesis of change
  - The "source of stress" was the climate impact
  - The "situational factor" was global climate change
- Identify other stresses
- Identify other sources of stresses
- Identify other situational factors
- Incorporate the human responses to climate change

Figure 3 shows and example of the diagrams that resulted from this process. Diagrams for the other targets can be found online.

Lessons Learned

- **Simplify the hypotheses of change.** We initially had very complex hypotheses of change with multiple scenarios of how the species would respond to different types of climate change. We found these complex hypotheses difficult to communicate and difficult to review. Instead, we focused on the most likely hypotheses that would have the most negative impact on the target. This simplifying step was important to facilitate the review process and the situational diagram process.
- **Pull from diverse backgrounds.** We found it very helpful to have a broad range of perspectives at our workshop. We invited scientists, conservation planners, conservation strategists, and representatives of the key human activities (ranchers and land use planners). Unfortunately, some people were not able to come at the last minute, making some of our groups made up mostly of scientists and conservation planners. In retrospect, we should have invited more people from diverse backgrounds to ensure a better mix in all of the groups.
- **Diagrams really help.** Given the complex nature of species interactions with humans, climate, and the environment, we found the process of developing a diagram in a group setting to be challenging but rewarding. The standard CAP guidance gives great tips on how to do a situation analysis in a group setting. The primary difference we used was to define the nature of the interactions between factors by linking them with red "increase" lines or blue "decrease" lines (see Figure 3). This helps the diagrams show why a target is vulnerable to climate change and other stresses, making the development of strategies a logical next step.
- **Humans adapt too.** Given the complex nature of all of the threats that affect the focal targets, we found the situational diagrams a good way to capture the human responses to climate change, and then trace how those responses will positively or negatively affect the focal targets. It was also useful to have consistent

hypotheses of change for each of the human activities, so that each group could incorporate the same responses in the diagrams.

8. Set conservation goals and objectives for focal targets

Setting goals and objectives for conservation targets is a key step that is often overlooked perhaps because it is assumed to be explicit. The general goal is often to conserve the target, but more specificity is needed when considering climate change adaptation. A goal could be as ambitious as restoring the vitality to some pre-human state or as constrained as maintaining one core population as climate change and other threats consume remaining habitat. The goal should be attainable and ensure the long-term viability of the target. While the use of terminology varies, we used the term goal to mean the desired future state, and the term objective to mean the specific near term milepost we need to reach to achieve the goal.

Instead of asking the groups to set conservation goals and objectives for each focal target at the beginning of the workshop, we had them set goals after they had a better understanding of the vulnerability of the target to climate change and other stresses. This allowed the groups to set objectives that were more reasonable and feasible given the situational constraints. We asked the groups to establish and document specific and measureable objectives for each target.

Lessons Learned

- **Setting goals and objectives takes prior preparation and time.** Due to time limitations, we only set aside 30 minutes for this portion of the agenda, and we only asked the groups to generate objectives without first setting the broader goals. In retrospect, we should have developed straw-man goals and objectives before the workshop for the groups to revise. We could have also reviewed and presented existing conservation efforts and strategies as background for each target. Finally, we should have also given the groups more time and guidance on how to set the goals and objectives, and provided time for the full group to provide feedback and review.

9. Identify strategies to meet the objectives

After completing the situational diagrams and setting objectives, the process of identifying climate change adaptation strategies was relatively straight forward. We provided a summary presentation of the conservation strategies identified in the existing CAP, and then had teams review their situation diagrams in groups. The groups looked for intervention points on the diagrams where a strategy could make a positive change or reduce a negative effect. We had the groups document the objective, strategy, and the rationale, and then present to the group.

Lessons Learned

- **Reduce other threats.** We found that in most cases stopping the direct impacts of climate change was not a feasible strategy at a local scale, so many of the strategies developed focused on reducing other stresses that are exacerbated by the impacts of climate change. For example, there may be no feasible way to stop the changes in the location of the vegetation that badgers need for denning, but the badger team did find good strategies address fragmentation in the project area and to enhance connectivity to allow the badgers to move in response to these vegetation shifts. These strategies include better planning for new infrastructure and building road underpasses to reduce road related mortality.
- **Learn from the past.** We provided a brief summary of the strategies currently employed at Mount Hamilton, but we could have given more information about the success and failures that the Mount Hamilton team has experience in the past while implementing these strategies. This would have helped steer the team away from strategies that have not worked in the past, and allowed them to focus on way to improve the pace and scale of the successful strategies to address climate change.
- **Document as much as possible.** Be sure to assign one person in each group to document the details and rationale for the strategies. This will help in the evaluation and implementation steps later.

10. Evaluate strategies

After the workshop, we had a list of 25 strategies for refinement and evaluation. To perform and initial screening and ranking of the strategies, we used the strategy evaluation tool in Appendix 3 of the Conservation Action Planning Guidelines for Developing Strategies in the Face of Climate Change (The Nature Conservancy Central Science Division 2009). This tool identifies three factors for evaluation, including the benefits, feasibility, and cost of the proposed strategy. We identified three additional factors including the degree to which the strategy is an organizational strength, the level of risk of unforeseen and negative consequences in completing the strategy, and any potential synergies with other existing in-house or external initiatives. We ranked each strategy as either low, medium, high, or very high for each factor in an internal meeting that lasted about 2 hours.

Lessons Learned:

- **Work closely with project staff to evaluate strategies.** We included the project director and the regional director in this meeting, which was essential to rate elements like the feasibility and cost of each strategy. This was also a good opportunity to discuss the strategies in more detail and begin thinking about which ones are the most likely to be implemented in the near term.

Final Steps

We have identified the following final steps to complete the evaluation stages and begin implementing the most promising climate change adaptation strategies:

11. Cross reference with current strategies to identify gaps
12. Identify existing and needed capacity to fill gaps
13. Implement strategies
14. Monitor
15. Re-evaluate entire process as needed

Unfortunately, we have not completed these steps and thus have not finalized the methods and lessons learned for these elements of the process. We plan on updating this document as our process continues.

Conclusion

Climate change is happening and will impact the species and natural systems that we seek to conserve. Some species will be able to adapt to the changes, while others will face extinction without our assistance. Anticipating the negative impacts to species associated with climate change is complicated, but the planning process presented here is designed to identify some of the most vulnerable species in an area and strategies to reduce that vulnerability. This process can be completed in 2-6 months and does not require a large budget, specialized data, or technical skills. This process does not identify all of the potential impacts to all species, so it is designed to be a first-iteration of an ongoing adaptive management effort to combat the effects of climate change. We hope others will replicate this process, refine it, and communicate the lessons learned to make climate change adaptation planning a standard practice for all conservation organizations.

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Figure 1: Mount Hamilton study area with TNC interests and managed areas.

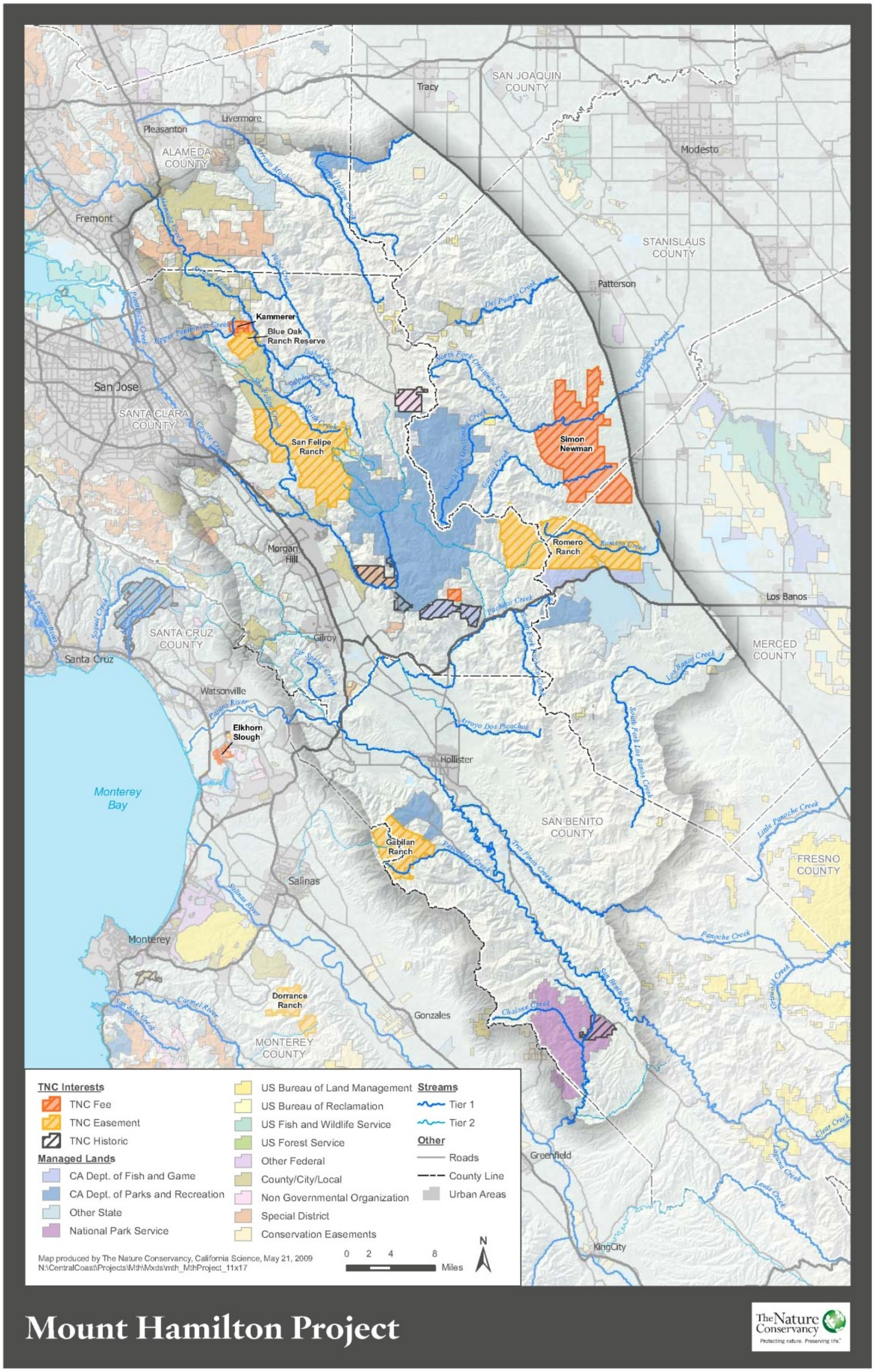
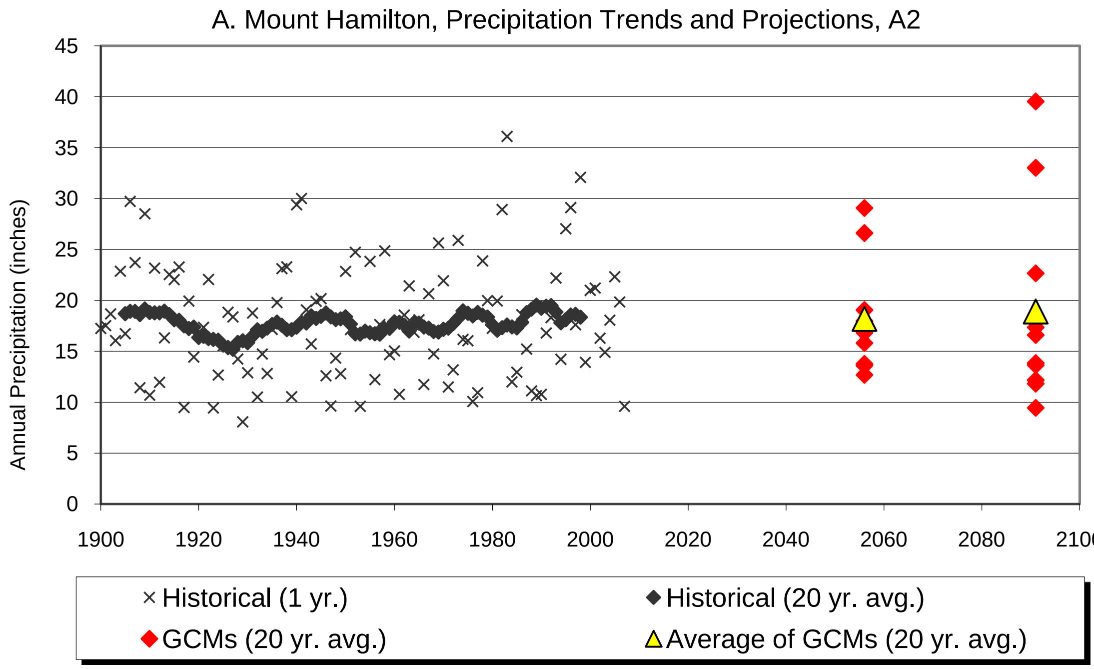


Figure 2: Historical trends and future projections from 11 General Circulation Models (GCMs) under the A2 emissions scenario for the Mount Hamilton range for (A) precipitation and (B) minimum temperatures.



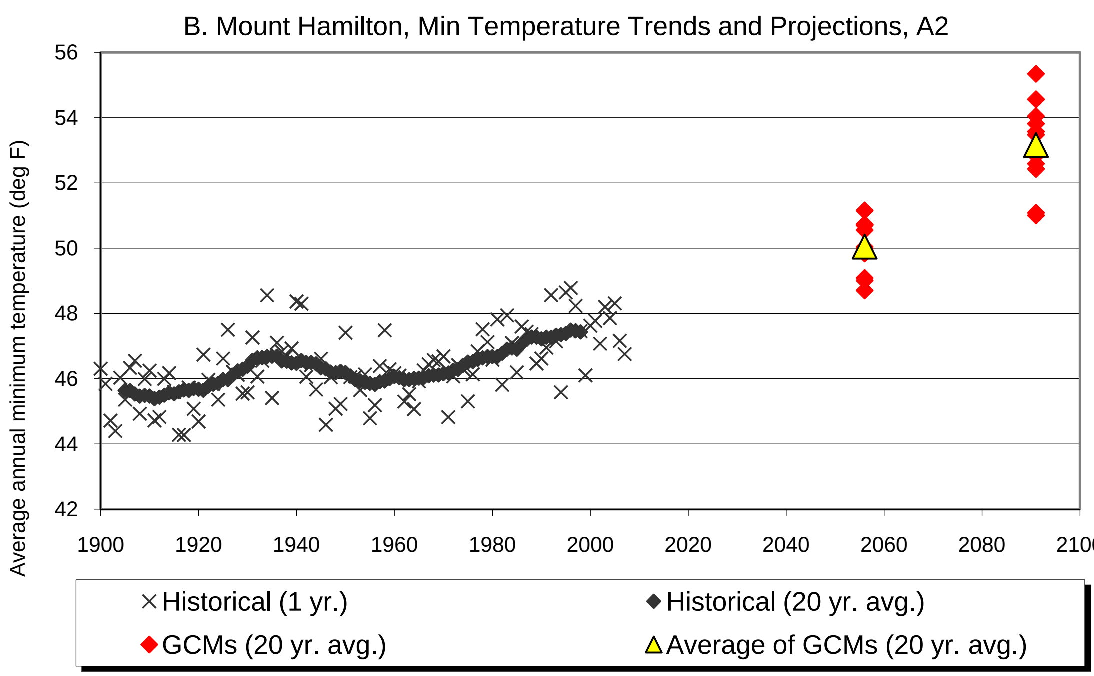


Figure 3. Example of a situation analysis diagram for the California Tiger Salamander.