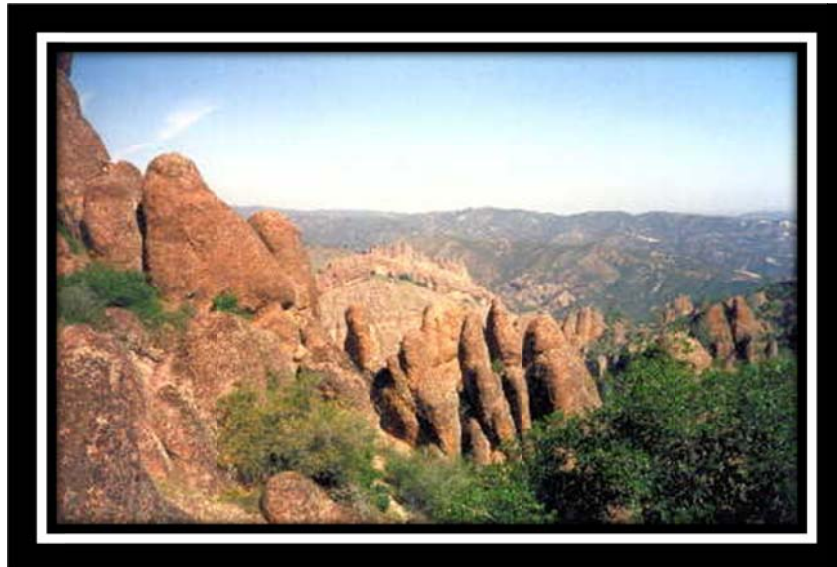


Pinnacles National Monument Climate Change Scenario Planning Summary Report

July 2012



Prepared for:
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U.S. Department of the Interior
Natural Resource Stewardship and Science

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Acronyms

BMP	Best Management Practice
CCC	Civilian Conservation Corps
FRV	Fundamental Resources and Values
GMP	General Management Plan
GBN	Global Business Network
IPCC	Intergovernmental Panel on Climate Change
NPS	National Park Service
OIRV	Other Significant/Important Resources and Values
PINN	Pinnacles National Monument
PORE	Point Reyes National Seashore
PWR	Pacific West Region
RSS	Resource Stewardship Strategy
T.E.K.	Traditional Ecological Knowledge
WRD	Water Resources Division

1. INTRODUCTION

This is a summary report for the Pinnacles National Monument (PINN) scenario planning project conducted in May-June 2012. The project objective was:

To explore a range of plausible, science-based climate change scenarios that are relevant and challenging to Pinnacles National Monument and to describe the associated impacts and management implications, with emphasis on the monument's fundamental resources and values.

This report summarizes three future climate scenarios and their implications, and suggests potential management responses to inform development of Pinnacle's Resource Stewardship Strategy (RSS), and other future planning efforts. Project outcomes also include potential management actions for consideration and suggested monitoring to track the climate change scenarios generated from the workshop.

Note: Climate change scenario planning is a living process – the plausible climate change futures generated from this project require regular review and updating as new climate change observations and modeled projections with new data become available.

1.1 The Overarching Goal: Climate Change Adaptation

As described in more detail later in this document, scenarios provide a tool to support planning and decision-making under conditions of uncertainty, and influences that are beyond the control of managers. The ultimate goal of scenario planning in the National Park Service (NPS) is to inform development of climate change adaptation strategies that will best serve park purposes, resources, and visitors in a relatively rapidly changing environment.

Fundamentally, climate change adaptation is an “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC 2007a), and may include a variety of social, economic, or ecological responses, some of which are triggered naturally, and others that are planned. Adaptation actions aim to reduce the vulnerability of the resource or facility of concern to climate change effects, through minimizing sensitivity and/or exposure, and/or increasing adaptive capacity (“adaptability”).

Adaptation strategies may include activities intended to promote system resilience or “rebound” capacity, such as removing or minimizing other anthropogenic insults or stressors, restoring degraded ecosystems, or protecting refugia (West et al. 2009). Other adaptation strategies may support or promote transition of an ecosystem or habitat to a new state, such as accelerating – in a controlled fashion – conversion of forests to grasslands in an area projected to experience more numerous, or prolonged droughts. Similarly, adaptation for facilities may consider alternatives for siting, location, building materials, design, or use.

In all cases, climate change adaptation requires us to continue to learn from the past, but be “forward looking,” anticipate plausible but unprecedented conditions, and expect surprises. In this context, we must revisit our management goals and “desired conditions,” since frequently these describe our expectations based on *historic* conditions.

To that end, scenario work explores and describes characteristics of several plausible futures, enabling managers to consider how to define and meet their goals (desired conditions) under changing, and new circumstances. This will be the work of the RSS, informed by climate scenarios.

1.2 Project Overview

The project consisted of two preparatory webinars and a 2.5-day workshop. To meet project objectives, individuals invited to participate in the process represented a variety of disciplines including: management, natural and cultural resources, facilities, interpretation, visitor use and visitor protection (Appendix A, participant list).

Participants attended two webinars in advance of the workshop that provided basic information on the scenario process as well as the climate science required to build the climate change scenarios.

- **Webinar 1:** An overview of scenario planning, project design, and schedule.
- **Webinar 2:** An overview of the climate science, historical climate change observations, and the range of modeled climate change variables projected for the national monument, as well as information on resource vulnerabilities and impacts based on observed and projected climate change information.
- **Workshop:** Participants explored a range of plausible climate change futures, associated impacts, management implications, potential management responses, and monitoring approaches to track the plausible climate change futures.

1.3 Park Resources and Values

In developing the climate-related impacts, implications, and management considerations, PINN resources and values described below were the primary focus. The following fundamental resources and values (FRVs) for the national monument were identified in the PINN General Management Plan (Chapter 2):

- *Landforms and geologic faults reflecting past and present tectonic forces*
 - The Pinnacles Volcanics – remnants of ancient volcanic layers, containing eroded rock spires, cliffs, ledges and grottos.
 - Physical evidence of plate tectonics and faulting – steep terrains, uplifted and tilted layers, spires eroded from fractured rock, varied landscapes, springs, narrow canyons, landslides and associate features.
- *Scenic views and wild character*
 - Wilderness attributes – undeveloped land with high quality viewsheds, natural landscapes, dark night skies, Class 1 air quality, natural smells, and natural systems.
 - Scenic viewsheds – dramatic views of the Pinnacle Rocks formation and the surrounding geologic landscapes.
 - Inspiration and challenge provide varied opportunities for primitive recreation and solitude in wild settings.

- *Talus caves*
 - Talus caves – structures and physical processes.
 - Ecosystems within the caves – including temperatures, water, plants, animals.
- *Native species and ecological processes*
 - Diverse assemblage of native species.
 - Integrity of native habitats, including living and nonliving components and the interactions among them.
 - Dynamic natural processes including erosion, flooding, fire and tectonic activity.
 - Pinnacles National Monument’s role as a component of larger interdependent ecosystems.
- *Opportunities for research and study*
 - Knowledge about Pinnacles geology and plate tectonics – cumulative knowledge and opportunity for understanding the features and processes.
 - Knowledge about the talus caves – cumulative knowledge and continued opportunities for understanding the geologic and ecologic features and processes.

The PINN General Management Plan (GMP; Chapter 2) also identifies the following other significant/important resources and values (OIRVs) for the monument.

- The Native American archeological and ethnographically significant resources of PINN are preserved within their ecological context and provide opportunities to study and continue traditional practices and resource management.
- PINN still reflects the historically significant dry land subsistence agriculture practice by homesteaders from the early period of American settlement in California.
- The development and character of PINN were strongly influenced by the grassroots efforts that established the national monument, and by the work of federal unemployment relief programs including the Civilian Conservation Corps (CCC).
- PINN plays a key role as a reintroduction site for the California condor, fostering public understanding and scientific research with the goal to one day remove this species from the federal Endangered Species List for the benefit of future generations.

2. SCENARIO PLANNING

2.1 Value of Scenario Planning

Scenario planning is a process designed to support management decisions under situations of high uncertainty and lack of control, which fit the characteristics of climate change.

Scenario planning is not a technique for predicting the most probable future. Rather, the objective is to develop and test decisions under a variety of plausible futures. Doing this proactively, essentially rehearsing for multiple futures, strengthens our ability to recognize, adapt to, and take advantage of changes over time (Global Business Network 2009).

2.2 Climate Change Scenario Planning Process

Numerous approaches are available for scenario development. An approach practiced by the Global Business Network (GBN) and adapted by the NPS uses five steps, as illustrated in Figure 1.

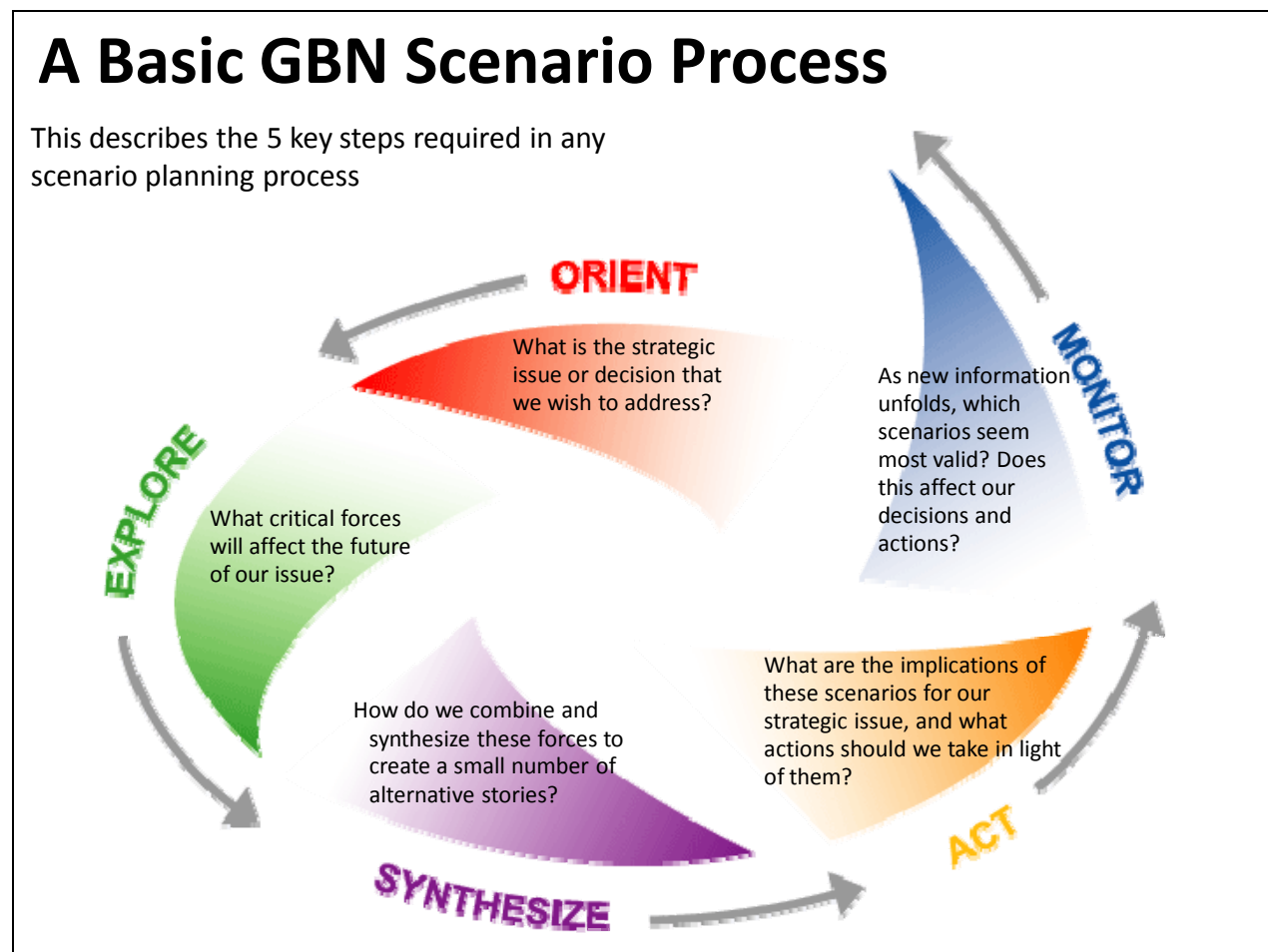


Figure 1. Basic Scenario Planning Process (Global Business Network, a member of the Monitor Group).

2.2.1 Orient

The first step in the five-step scenario planning process is to identify the strategic issue or focal question relevant to the management need or decision(s) at hand.

For PINN, the focal question was, “*What are the best management strategies to meet the national monument’s mission given the influences from climate change over the next 50-100 years?*”

2.2.2 Explore

The exploration phase identifies critical forces that will affect the issue or focal question. Table 1 presents these critical forces (climate variables) for PINN, with the corresponding historic observations, three “emission” modeled projections, and the associated confidence for the projections.

2.2.3 Synthesize

In this step, workshop participants synthesize the critical forces (climate variables and projections) and information regarding observed and potential effects into plausible scenarios, using four criteria to select scenarios for further development:

1. *Plausible*: “Is the scenario possible?”
2. *Relevant*: “Does it matter to the national monument?”
3. *Challenging*: “Are there big consequences if the scenario becomes a reality?”
4. *Divergent*: “Do the scenarios create a broad range of possibilities for how the future could unfold?”

Through the synthesis step at PINN, workshop participants developed three potential climate change scenarios for the monument – *Subtle Shifts*, *Desert Dry*, *Wet and Wild(flowers)*. Table 2 presents variables and projections for these scenarios.

Table 1. Historic and Projected Climate Change Variables at Pinnacles National Monument.

Variable	Trend	Historical 20 th Century Change	Projected 21 st Century Change			Confidence in Scientific Understanding (IPCC Terms)
			Lower Emissions Scenario (IPCC B1)	Central Emissions Scenario (IPCC A1B)	Higher Emissions Scenario (IPCC A2)	
Temperature	↑	50 km x 50 km area: +0.5 +/- 0.2°C (Gonzalez et al. 2010); Central Coast: Spring has warmed more than other seasons (Cordero et al. 2011)	50 km x 50 km area: +2.2 +/- 0.8°C (3 GCMs, Gonzalez et al. 2010)	50 km x 50 km area: +2.9 +/- 0.8°C (3 GCMs, Gonzalez et al. 2010)	Pinnacles NM: +3.4 +/- 0.8°C (18 GCMs, data Conservation International http://futureclimates.conservation.org , method of Tabor and Williams (2010)); minimum winter temp. +2-2.7°C, maximum summer temp. +3.7-4°C (2 GCMs, Davis et al. in review)	Very High (IPCC 2007b)
Precipitation	↔	50 km x 50 km area: +11% +/- 11% (Gonzalez et al. 2010)	50 km x 50 km area: -13% +/- 26% (3 GCMs, Gonzalez et al. 2010); Northern California -4% (2 GCMs, Cayan et al. 2008)	50 km x 50 km area: -11% +/- 26% (3 GCMs, Gonzalez et al. 2010);	Pinnacles NM: +1% +/- 26% (18 GCMs, data Conservation International http://futureclimates.conservation.org , method of Tabor and Williams (2010)); Northern California: more drying in summer (Cayan et al. 2008)	Very Low (IPCC 2007b)
Extreme temperature events	↑	Southwestern U.S.: Increase of approximately 90% of four-day periods of one-in-five year hot temperatures (or 80% extreme) (Kunkel et al. in review)	Western North America: one-in-twenty year hot temperatures (or 95% extreme) may increase in frequency to one in two years (12 GCMs, IPCC 2012)	Western North America: one-in-twenty year hot temperatures (or 95% extreme) may increase in frequency to one in one and a half years (12 GCMs, IPCC 2012)	Western North America: 10-20% increase days >30 °C, one-in-twenty year hot temperatures may increase in frequency to occurring every year (12 GCMs, IPCC 2012); 6-9 more days per year of consecutive days >35 °C (4 GCMs, Kunkel et al. in review)	High (IPCC 2012)

Variable	Trend	Historical 20 th Century Change	Projected 21 st Century Change			Confidence in Scientific Understanding (IPCC Terms)
			Lower Emissions Scenario (IPCC B1)	Central Emissions Scenario (IPCC A1B)	Higher Emissions Scenario (IPCC A2)	
Extreme precipitation events	↑	Southwestern U.S.: No statistically significant change (Kunkel et al. in review)	Western North America: one-in-twenty year storms may increase in frequency to one in 10 years (14 GCMS, IPCC 2012)	Western North America: one-in-twenty year storms may increase in frequency to one in nine years (14 GCMS, IPCC 2012)	Western North America: one-in-twenty year storms may increase in frequency to one in eight years (14 GCMS, IPCC 2012); Northern California: 25-200% increase in 99% extreme storms (2 GCMS, Cayan et al. 2008); Southwestern U.S.: 12-30% increase in number of days with rainfall >25cm per day (4 GCMS, Kunkel et al. in review)	Low (IPCC 2012)
Growing season length	↑	Southwestern U.S.: Increase of approximately one month (Kunkel et al. in review); Pinnacles NM: no significant trend (Davis et al. in review)			Southwestern U.S.: Increase of 35-40 days (4 GCMS, Kunkel et al. in review); Pinnacles NM: increase 32-38% or 11-13 days (Davis et al. in review)	High

Table 2. Climate Change Scenarios for Pinnacles National Monument.

Scenario	Variables and Projections (2100)					
	Temperature	Drought	Growing Season	Precipitation	Extreme Precipitation Events	Extreme Temperature Events
Subtle Shifts “Least Change”	Temperature increase 1.4°C (2.5°F)	Drought: additional 6 consecutive days/year with rainfall <3 mm (0.12 in)	Growing season: increase by 11 days	No change in precipitation	Extreme precipitation events: 1 in 20 year storms occurring every 10 years	Extreme temperature events: average annual max temp of 26°C (79°F) might occur once every 2 years (versus current once every 20 years) and 6 more consecutive days/year of temps >35°C (95° F)
Desert Dry	Temperature increase of 4.2°C (7.5°F); Increase in winter min temp +2 to 2.7°C (+3.6°F to 4.9°F); Increase in summer max temp +3.7 to 4°C (+6.6°F to 7.2°F)	Drought: additional 10 consecutive days/year with rainfall <3 mm (0.12 in)	Growing season: increase by 40 days	Precipitation decrease 39%	Extreme precipitation events: 1 in 20 year storms occurring every 8 years, with 25 to 200% increase in 100 year storm events; 2 more days/year with rainfall >25 mm (1 in)	Same as Subtle Shifts
Wet and Wild(flowers)	Same as Subtle Shifts	Same as Subtle Shifts	Same as Subtle Shifts	Precipitation increase 27%	Extreme precipitation events: 1 in 20 year storms occurring every 8 years, with 25 to 200% increase in 100 year storm events; 2 more days/year with rainfall > 25 mm (1 in)	Same as Subtle Shifts

Scenario 1: *Subtle Shifts*

Parameters (variables) of “Subtle Shifts” represent the *least change* scenario, which Dr. Patrick Gonzalez (NPS Climate Scientist) provided to the workshop. This scenario represents a plausible climate future with the least change from existing climate conditions relative to other modeled projections.

The Subtle Shifts scenario represents a future with a gradual average annual temperature increase of 2.5°F by 2100 and no significant change in annual precipitation. Intense storms occur more frequently along with extreme warm temperature events. Regional agriculture is increasing due to a longer growing season, creating more demand on local water resources. Increased growth in population along the western side of the national monument (King City, Greenfield, Soledad and Gonzales) is compounding the demands on limited water resources. The need for fire preparedness is increasing as the landscape becomes dryer. Flashy flood events are more frequent, contributing to erosion along developed areas and sensitive riparian habitat in the national monument. The visitor shoulder seasons are slowly shifting due to warming conditions and changes in phenology that attract visitors to the national monument. Even as engagement with tribal governments increases, the threat of losing traditional ecological knowledge (TEK) of the region is an increasing concern as ecological changes eliminate the opportunity for continuing some traditional uses.

Scenario 2: *Desert Dry*

Scenario 2, “Desert Dry” represents a scenario that was selected by the workshop participants using a card-based scenario planning synthesis process. Starting with the “Subtle Shifts” (least change) scenario, participants changed a select number of climate variables using different emission modeled projections to explore and create another plausible climate future.

The Desert Dry scenario represents a future with an average annual temperature increase of 7.5°F by 2100 and an increase in extreme warm temperature events. Annual precipitation will decrease 39% by 2100 with storms occurring more frequently, including a 25% to 200% increase in 100-year storms. Some perennial streams are ephemeral, and some current ephemeral systems remain completely dry year-round. Extreme storm events are causing debris flows, changing the geomorphology of stream channels, and creating flood impacts along the riparian areas. Wildfires are an annual occurrence with a longer fire season, straining staff and financial resources at the national monument. Extreme water conservation measures are in place with restricted releases from Bear Gulch Reservoir. Due to the warming temperatures, a decrease in air quality is impacting viewsheds and night sky qualities of the monument. Wilderness character is diminished with more open habitat, increases in visitor encounters, and loss of solitude. Increased weathering of historic structures and exposure of paleontological/archeological sites is requiring new ways to protect and interpret cultural resources in the national monument. Visitor use patterns are changing as temperatures continue to increase.

Scenario 3: *Wet and Wild(flowers)*

Scenario 3 “Wet and Wild(flowers)” represents a scenario that was also selected by the workshop participants using a card-based scenario planning synthesis process. Starting with the “Subtle Shifts” (least change) scenario, participants changed a select number of climate variables to create another climate future using the modeled climate variable projections.

The Wet and Wild(flowers) scenario represents a future similar to the Subtle Shifts scenario but wetter with a 27% increase in average annual precipitation, including a 25% to 200% increase in 100-year storms. Under this scenario there is a shift toward woodlands and mesic shrublands as a result of the increased precipitation. Extreme events are causing flooding and debris flows, impacting infrastructure within the floodplain and increasing visitor safety issues and response. There are more invasive species present and increased insect populations, both having impacts on other species. The increase in surface water and shallow groundwater recharge has increased springs and seeps in the national monument, as well as aquatic/riparian habitats, benefitting some plants and animals that require these types of habitats. Fire preparedness in the national monument is a priority as fire fuel loads are increasing due to the increase in precipitation and extended growing season. The increased water on the landscape continues to promote the regional agricultural-based economy, supporting an increase in local agricultural development and intensity. The wildflower season is a big visitor attraction at the national monument and surrounding areas.

2.2.4 Act

In this step of the process, participants identify effects of each scenario, assessing the potential impacts and management implications (both problems and opportunities). Appendices B, C, and D list effects/impacts and management implications of the three scenarios generated during the workshop; Tables 3, 4, and 5 contain excerpts to illustrate the range of impacts and implications developed during the workshop. Note that there is a soft boundary between impacts and implications, and there could be some argument that some of the impacts are actually implications...or some of the implications are actually impacts. We did not hold a strict definition with either and allowed participants to communicate their professional experience and understanding.

Table 3. Selected Impacts and Implications for the Subtle Shifts Scenario.

Scenario 1: Subtle Shifts	
Effects/Impacts	▪ Increase in fire frequency ▪ Event driven shift to grasslands ▪ Urban interface expanding closer to PINN ▪ Decrease in aquifer recharge impacting seeps and spring habitat ▪ Altered phenology
Implications	▪ Vulnerability of water-dependent species such as red legged frog ▪ Increased difficulty accommodating indigenous community needs ▪ Loss of traditional ecological knowledge (T.E.K.) ▪ Changes in fire management due to differing fuels and ignition sources ▪ Facilities in flood-prone areas ▪ Changes in visitation seasons with increased visitor conflicts and emergency response

Table 4. Selected Impacts and Implications for the Desert Dry Scenario.

Scenario 2: Desert Dry	
Effects/Impacts	- Some perennial streams become ephemeral with a loss of some ephemeral systems - Increase in fire season, fire frequency and fire intensity - Potential loss of grey pines and important habitat for owls, raptors and condor - Increase in flashy flood events with erosion and sedimentation impacts - Decrease in air quality - Extirpation of some water-dependent species - More open habitat, shift from shrubs to herbs
Implications	- Need for alternative sources for potable water supply on the western side of the national monument - Decrease in pig population - More visitor pressure at talus caves due to cooler cave environment - Greater need for interagency coordination on watershed function - Challenges to maintain viable/harvestable populations of culturally significant plant and animal populations - Loss of wilderness character - Decreased viewsheds and night sky quality due to degraded air quality - Increased weathering of historic structures with greater exposure of paleontological/archeological sites from storms and fires - Opportunities to communicate/educate on climate change

Table 5. Selected Impacts and Implications for the Wet and Wild(flowers) Scenario.

Scenario 3: Wet and Wild(flowers)	
Effects/Impacts	- New seeps and springs with a wider distribution of water-dependent species - Changes in stream morphology, increases in sedimentation and turbidity - Increase in flooding - Increased fire fuel loads - Increase in mass wasting/debris flows/landslides - Higher cave humidity - Increase in regional agriculture and associated land development
Implications	- Easier to manage cultural landscapes - Infrastructure impacted by increase in fires and flooding - Visitation patterns more dynamic with seasonally concentrated visitation - Increase in exotic species - Opportunities to communicate/educate on climate change

Outcomes from this effort support development of potential management responses that make sense under a particular climate change scenario. Appendices B, C, and D list the potential responses generated during the workshop, with the “Robust Actions” (or “no regrets” actions) that apply to all three climate change scenarios listed here (Table 6).

Table 6. Robust Strategies Identified for the Three Scenarios.

Potential Actions to Consider, common to <i>all three scenarios</i>			
Activity	FRV/ OIRV	Sub-element	Action to Consider
Inventory/ Monitoring/ Research	FRV/ OIRV	Native Species / Processes	Implement/continue fire effects monitoring program. Monitor fire in the region (frequency, acres burned, intensity, per year).
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	In restoration work, consider including plant species adapted to a range of plausible futures.
Planning; Management; Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Early detection and monitoring of invasives/exotics (plant and animal). Incorporate climate change scenarios into prioritization for invasive species control (Cal-IPC is doing this; CalWeed and mapper). Intensify control of invasive species in areas most susceptible to changes as a result of fire or flood, or edge of where plant community boundaries may change.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Maximize use of imagery to quantify change in vegetation, hydrology, and groundwater.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Investigate pests/pathogens, monitor zonal distribution changes and stay aware of new "threats."
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Monitor pollinator-floral interaction. Emphasis on phenology shifts.
Partner; Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Increase interagency coordination such that watershed function can be monitored and managed with decreasing relevance of property boundaries. Develop quantifiable metrics of watershed function that can be monitored in conjunction with other agencies (San Benito Watershed Profile).
Inventory/ Monitoring/ Research	FRV	Native Species / Processes; Scenic Views/Wild Character	Monitor stream morphology, water quality, stream aggradation/incision/geomorphology, and aquatic species.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Research into groundwater hydrology (aquifer characterization) to understand source and sustainability of groundwater resources with regards to park domestic water supply, natural resources/processes, and external demands, and to be able to predict how climate change and external land use changes might impact park water resources. Also investigate surface water

Potential Actions to Consider, common to <i>all three scenarios</i>			
Activity	FRV/ OIRV	Sub-element	Action to Consider
			resources.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Inventory springs/seeps; select a subset to monitor discharge, water stage, and other parameters (e.g., water quality, IBI, sedimentation, etc.). Monitor species in riparian zones and around springs and seeps.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Monitor riparian acreage.
Planning	FRV/ OIRV	All	Consider developing a land resource strategy to purchase (or protect via conservation easements) additional acres in adjoining watersheds.
Inventory/ Monitoring/ Research	FRV/ OIRV	All	Continue to build and refine historical reference information on flora, fauna, landforms, waterways, human modifications. The past may become the future in some respects so the better we know it the better we can adapt.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Information gathering/research into fog – will patterns change as a result of higher temperatures?
Inventory/ Monitoring/ Research	FRV	Native Species / Processes; Talus Caves	Interdisciplinary evaluation of Bear Gulch dam water level management (retention and/or controlled release); investigation into whether the Bear Gulch dam can/should be used to mitigate increase in extreme water events and/or impacts on rare biota (in caves) from increased temperatures.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Research on host-specific relationships for key species.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Start trying to model new habitats that global climate change will create (how they will be populated, from where, by what, etc.) and how the park can facilitate that, while at the same time providing habitat “buffers” for existing communities to either adapt or migrate.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	For each scenario, update (hydrologic) watershed loads, floodplain/zones (for 100 year, 50 year, 20 year, and 10 year), and landslide hazards.
Inventory/ Monitoring/ Research	Other*	Visitors, Facilities	Monitor changes in watershed and site drainage patterns/potential breaches and new drainage paths for threat to visitors and staff facilities.
Policy, Regulations, and/or Visitor Use Management	Other	Operations	Evaluate/consider closure of wilderness trails and backcountry camp during extreme heat periods. Evaluate need and operations for reservation system (trail and park use).

Potential Actions to Consider, common to <i>all three scenarios</i>			
Activity	FRV/ OIRV	Sub-element	Action to Consider
Policy, Regulations, and/or Visitor Use Management	Other	Visitors	Monitor visitor use data, trends, and seasons. Monitor visitor use to plan for staff needs and other management issues arising from intensive visitor use. Develop park budget earlier and shift hiring season in response to changing visitor use patterns. Develop richer non-personal interpretive services to accommodate fluctuating visitor seasons. Need to consider/develop visitor use management plans and permit systems.
Inventory/ Monitoring/ Research	FRV	Native Species / Processes	Evaluate current weather station to improve reliability of information. Monitor temperature (maximum, minimum), growing days, precipitation, and seasonality, storm events, etc.
Planning; Partners; Inventory/ Monitoring/ Research	OIRV	Homestead / CCC; Native American Resources	Prepare cultural resources preservation/treatment/monitoring research plans. Accelerate all section 110 inventory, documentation, and evaluation condition assessments. Develop a stewardship plan to address loss of extant cultural landscapes with a plan for recordation and interpretation (partner project). Assess historic buildings susceptible to increased pests and pathogens. Complete documentation of vulnerable cultural resources in anticipation of impending impacts and as a management tool to establish baseline documentation for assessing impacts and changes. Determine and implement best management practices (BMPs) for protecting cultural resources – historic structures and archeological sites. Identify acceptable practices for stabilizing or salvaging historic structures and landscapes and historic and pre-contact sites. Prioritize paths for understanding sites, structures, and landscapes at risk; vulnerability assessment. Inventory archeological sites (complete park comprehensive inventory). Monitor archeological site conditions. Prioritize and monitor changes to culturally important species (e.g., deergrass, white-root sedge, and chia).
Partners	OIRV	Native American Resources	Evaluate and act on NPS policy regarding tribal gathering/park management and sustainable uses. Support tribal sovereignty. Be proactive and adaptive in partnering with Tribe to attain shared goals.
Inventory/ Monitoring/ Research	FRV/ OIRV	All	Design inventory monitoring to capture rapid or subtle changes cost effectively. Design a comprehensive reliable researchable information database – spatially based “atlas,” “imap,” GIS.
Outreach/ Education; Planning; Inventory/ Monitoring/ Research	FRV	Scenic Views / Wild character	Monitor air quality/AQRVs, dark skies, soundscapes, viewsheds; increase education and outreach regarding dark night sky preservation and why it matters as a natural and cultural resource; take a regional approach to night skies, air quality, and water resources (use non-lead outreach as model). Establish wilderness character monitoring program (indicators: soundscapes, viewsheds, dark skies, air quality) to understand changes to these qualities: natural, untrammeled, undeveloped, solitude or primitive and unconfined recreation, and other features (including cultural) in general and with regard to climate change adaptation.

Potential Actions to Consider, common to <i>all three scenarios</i>			
Activity	FRV/ OIRV	Sub-element	Action to Consider
Inventory/ Monitoring/ Research	FRV/ OIRV	All	Develop a historical map series (from monitoring) in partnership with surrounding land stewards.
Planning; Inventory/ Monitoring/ Research	FRV/ OIRV	All	Incorporate climate in Fire Management Plan and Emergency Preparedness Plan and updates. Interdisciplinary approach in evaluating all options/alternatives for values at risk from fire, flood, drought. Develop a combined cultural resources/natural resources condition assessment plan identifying emergency stabilization responses for major wind and fire driven events. Create fire and flood preparedness plan/values at risk due to fire and/or post-fire watershed effects, then identify mitigations such as prescribed fire and mechanical reduction. Use updated watershed and floodplain data to identify facilities (infrastructure) at risk and implement BMPs to accommodate additional loading for sustainable condition. Park management will need to consider alternatives for administrative facilities if existing are lost to fire or floods. Provide for emergency egress for visitors and staff in the event of fires and floods. Evaluate fuel loads and fuel load accumulations near resources and values at risk. Develop plans to rehabilitate Bear and Condor Gulch historic structures to include "fire wise" protections; determine if Bear Gulch facilities can be fire-proofed and flashflood-proofed to a level that staff occupation is considered safe, even with anticipated increased fire and flood danger. Set up a post-event response team for triage, stabilization, and recording impacts for historic structures. Set up a post-event response team/system for investigation and triage of newly exposed cultural resource sites (with checklist and identified informational goals).
Inventory/ Monitoring/ Research; Planning	FRV/ OIRV	All	Develop a research plan and implementation strategy to inventory/assess climate impacts to the park, in order to adjust and adapt park actions (aid in being nimble).
Inventory/ Monitoring/ Research	FRV/ OIRV	All	Increase primary research on park natural and cultural resources – with special focus on taxa potentially threatened by global climate change. Special focus on resilience attributes. All primary research should have a TEK component.
Planning	FRV/ OIRV	All	Relocate archives / move museum collections to appropriate and safe storage.
Planning; Inventory/ Monitoring/ Research; Sustainability	Other	Facilities	Evaluate location of infrastructure and move towards finding sustainable strategy to house offices and educational/operational facilities. Implement greater water conservation measures (i.e., remove dishwashers, garbage disposals, replace 60 year old water lines). Monitor building materials/systems performance (especially sacrificial coatings and weatherization materials). Monitor changes in building wear patterns and material life (correlate to management practices). Evaluate facility capacity to meet operational and visitor services/uses relating to climate change related scenarios variables. Be committed to sustainable and less energy intensive

Potential Actions to Consider, common to <i>all three scenarios</i>			
Activity	FRV/ OIRV	Sub-element	Action to Consider
			practices in every aspect of park operations. Provide incentives for reducing waste stream, reducing energy use in park operations and how employees get to work.
Planning	Other	Facilities	Analyze factors influencing campground placement and development – develop management plans.
Outreach/ Education	Other	Gateway	Bring Pinnacles to communities (e.g., interagency information centers in Hollister, Soledad). Engage youth in park “management” actions and have them provide forms of outreach to develop park stewards in local communities. More rangers in classroom and communities. Local recruitment of staff to better engage with local communities, stewardship. Develop gateway communities for relaying information and community involvement buy-in.
Inventory/ Monitoring/ Research	Other	Landscape	Monitor pesticide use outside of park and transport into the park. Use may increase? Monitor pollutant loads in air and water especially with regard to agricultural pesticides.
Planning	FRV/ OIRV	All; Native Species / Processes	Continue to develop MOUs, TAs, with tribal and community organizations for coordinated education, outreach, and compatible land management. Lead regional, multi-agency, inter-institutional planning effort to coordinate climate adaptive actions region-wide. Partner with community organizations, agencies, recipients, on habitat connectivity with economic feasibility considered. Create win-win solutions and common ground.
Planning	FRV/ OIRV	All	Consolidate information from climate change workshop with GMP and RSS. Develop 1-5 year park action plan. All development planning incorporates climate change scenarios. Develop a policy statement regarding balancing the need to prepare for anticipated changes with the uncertainty of the scenario.
Outreach/Ed	Other	Visitors	Make climate information and data available to visitors. Communicate with the public the steps the park is taking in response to climate change and why.

* Other: Not directly associated with a FRV or OIRV.

2.2.5 Monitor

The final step in generation of scenarios is not actually “final,” but is an ongoing process of monitoring to evaluate actual events against the projected futures. In this case, park managers would monitor climate drivers and/or indicators of effects to “calibrate” the three scenarios (*Subtle Shifts*, *Desert Dry* and *Wet and Wild(flowers)*) against reality, possibly adjusting or developing new scenarios as warranted, and revising strategies accordingly. This enables the monument staff to recognize what climate future is unfolding or what new scenarios may be evolving.

Monitoring
▪ Temperature ▪ Precipitation ▪ Storm events ▪ Drought ▪ Extreme temperature events ▪ Selected indicators of climate-driven effects

Monitoring selected indicators of climate-driven effects in the park will be necessary to evaluate the response of PINN priority resources and values to climate change, and to understand the evolving relationships between the climate drivers and ecosystem response. Appendices B, C, and D list some suggested monitoring actions for each of the three scenarios.

2.3 Recommendations for Using Outcomes from Climate Change Scenario Planning

As noted in the introduction, the ultimate goal of scenario planning in the NPS is to inform development of climate change adaptation strategies that best serve the park purpose, resources, and visitors in a rapidly changing environment.

While we continue to learn from the past, climate change adaptation also requires us to explore potential, unprecedented future conditions so we are not caught by surprise, and can make more informed management decisions. Traditionally, for natural resources, NPS park management goals and “desired conditions” reference *historic* conditions, i.e., the documented range of natural variation. We need to revisit these goals with a fresh perspective of how the future might unfold, and how we might best meet our mission under new conditions. The three climate change futures (scenarios) generated during this project (Section 2.2.3) provide a view into the range of plausible future conditions to support development of management strategies, some of which may entail novel approaches. The scenarios (*Subtle Shifts*, *Desert Dry*, and *Wet and Wild(flowers)*) represent a range of possible climate change futures at PINN that are relevant, challenging, and divergent.

When considering existing, or developing new management strategies at PINN, managers can use these scenarios to ask, “Do these strategies make sense under the scenarios?” Seen through the context of the scenarios, it may be apparent that continuing some current activities is an unwise expenditure of time/resources, while other activities may warrant additional effort. In some cases, entirely new approaches may also be prudent. Scenarios enable park managers to make better informed decisions regarding what level of risk they are willing to take with future

park investments. The term used to describe this process is sometimes referred to as "wind tunnel" testing.

Table 6 in the report describes "robust" or "no regrets" strategies that make sense for all three climate change scenarios. These actions provide good preparation for future events, and represent low risk with respect to influences from the three plausible climate change futures. The climate projections diverge more widely after the next 20-30 years, such that in the near term, a broader array of these "robust" strategies are available. Many of these are activities the park may already have underway, or planned – the scenarios can help to set priorities among them.

Lastly, "Monitoring," in section 2.2.5 is another critical element in the report. Climate change scenario work is a living process that requires review of new information and understanding to further develop, validate, or potentially invalidate a given scenario(s). Monitoring the climate variables (temperature, precipitation, storm events, drought, extreme temperature events) as well as the effects that form the climate change scenarios is important in tracking how the future unfolds relative to the scenario projections, so that decisions use the most current information possible.

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APPENDIX A – Participant List

The following individuals participated in the Pinnacles Climate Change Scenario Planning Workshop held Tuesday June 5 through Thursday June 7, 2012 in Hollister, California.

Name	Title/Affiliation
Brent Johnson	PINN Botanist
Cat Hawkins Hoffman	NPS National Climate Change Adaptation Coordinator
Chuck Striplen	San Francisco Estuary Institute, Associate Environmental Scientist, Historical Ecology Team
Debbie Simmons	PINN Facility Manager
Denise Louie	PINN Chief Resource Management
Don Weeks	NPS Climate Change Resource Planner
Elizabeth Pidgeon	PWR Historical Architect
Heather Rickleff	PINN Resource Stewardship Strategy Co-Author
Jay Goldsmith	PWR Chief Scientist, Natural Res. Mgmt Specialist
Jeff Albright	WRD Natural Resource Condition Assessments
Karen Beppler-Dorn	PINN Superintendent
Kelly Green	North Wind Resource Consulting
Kirstie Haertel	PWR Archeologist
Mark LaShell	PINN Operations Supervisor
Nichole Andler	PINN Chief of Interpretation
Paul Johnson	PINN Wildlife Biologist
Robert Steers	PORE Network I&M
Sandee Dingman	Wilderness Character Team, Biologist

APPENDIX B – “Subtle Shifts” Least Change Scenario

Potential Impacts of the “Subtle Shifts” Scenario

The potential impacts identified for the least change scenario represent a combination of the efforts of both breakout groups (groups 1 and 2) during the workshop.

Least Change Climate Variables Considered in this Scenario:

- Temperature increase 1.4°C (2.5°F)
- Growing season: increase by 11 days
- Precipitation no change
- Drought: additional 6 consecutive days/year with rainfall <3 mm (0.12 in)
- Extreme temperature events: average annual max temp of 26°C (79°F) might occur once every 2 years (versus current once every 20 years) and 6 more consecutive days/year of temps >35°C (95° F)
- Extreme precipitation events: 1 in 20 year storms occurring every 10 years; 1 more day/year with rainfall > 25mm (1 in)

Potential impacts of this scenario were developed by the two breakout groups during the workshop. They considered both biophysical systems and human dimensions of change:

Increased Fire:

- Increased ignition sources.
- Increased fire frequency.
- Longer fire season.
- More fire resulting from human ignitions.
- Event-driven shift to grasslands (could benefit some species e.g., badgers). (Are badgers in grasslands due to structure or species composition?)

Increased Storminess:

- More storms would leave to increased stream incision, increased erosion, and increased sediment transport.
- Impacts to historic structures (e.g., molds, direct floods), archeological sites, park infrastructure located in floodplains (e.g., visitor center).

Increased Human Populations:

- Decreased night skies.
- Increased noise.
- Urban interface would be located closer to Pinnacles.
- Decreased quality of viewshed.
- Increased fragmentation.
- Decreased air quality.

Longer Growing Season:

- Altered phenology decoupling of host-specific relationships/timing (e.g., bees, bats).

Water Resources:

- Potential change in aquifer systems and decrease in surface water.
- Shallow aquifer systems would be more impacted by climate change.
- External impacts from increased human populations and agriculture.
- Impacts to riparian/seeps and springs/microhabitats – effects on species in these areas.
- Coyote Creek may return to an ephemeral system – stop artificial recharge.

Visitation:

- Shift to shoulders seasons and winter.
- Change in use patterns.
- Potential for increased use of caves.
- Increased demand for information, communication.

Vegetation:

- Decreased shrub cover.
- Decreased riparian woodlands.

Tribal Governments:

- Increased difficulty accommodating indigenous community needs.

“Subtle Shifts” Scenario Implications

Table 7. Implications under the “Subtle Shifts” Scenario.

Resource Category	Implications
Natural Resources	• Preserve native plant dominated communities. • Increase in human ignitions leading to more frequent fire and possibly type conversion of shrublands to grasslands. • Proactive fuel load treatment to protect vulnerable values at risk. • Stem die back or whole loss of woody perennials. • Change in precipitation patterns may favor native annual wildflowers over exotic and invasive annuals. • Vulnerability of water-dependent species. • Loss of biodiversity, e.g., loss of specialized pollinators or host plants. • Water resource – unknown and missing data. • Red legged frogs vulnerability. • Loss of spring/seep habitats and obligate species (including rare endemics?). • Lack of knowledge about acceptable levels of impact. • Loss of trees with high evapotranspiration rates may increase water in streams, offsetting overall decreases in surface water on the landscape. • Need to understand watersheds and aquifers. • Management implications will require management to define species/habitats of concern that will be managed intensively. • Increase in non-native species, new species, expansion of existing species. • Park management will need to consider providing water resources to maintain species if natural water sources disappear. • Anticipating changes in habitat connectivity, e.g., migratory bird corridors. • More difficult to implement prescribed burns. • Manage onsite ignitions, buffer/protect/mitigate offsite ignitions, design fire mosaics within the park. • Instability of current knowledge disables current models - will require more dynamic management. • Need for better understanding of basic natural history attributes (i.e., pollinators, T&E species, culturally significant taxa) and ecological relationships. • Better understanding of new, post-disturbance community assembly processes. • Lack of information regarding pollinator ecology and vulnerability to climate change. • Increase in exotic annual plants, mainly invasive species. Biodiversity loss. • Loss of culturally important species = loss of T.E.K. • Consider role of cultural burning in light of projected increase in temperature and fire frequency. • Changes in visitation will require adjustments to address both direct and indirect visitor impacts. • Potential changes in fire management plans based on differing fuels and ignition sources.
Cultural Resources	• Need for better understanding of basic natural history attributes (i.e., pollinators, T&E species, culturally significant taxa) and ecological relationships. • Loss of culturally important species = loss of T.E.K. • Identify pathway for prioritizing inventory and documentation of sites, materials, buildings, and structures at risk of fire.

Resource Category	Implications
	• Consider role of cultural burning in light of projected increase in temperature and fire frequency. • Identify acceptable practices for stabilizing or salvaging historic structures and landscapes and historic and pre-contact sites. Prioritize paths for understanding sites, structures, and landscapes at risk; vulnerability assessment. • Changes in visitation will require adjustments to address both direct and indirect visitor impacts. • Proactive fuel load treatment to protect vulnerable values at risk. • Manage onsite ignitions, buffer/protect/mitigate offsite ignitions, design fire mosaics within the park. • More difficult to implement prescribed burns. • Increase efforts for understanding the disposition and spatial relationships of sites, structures, landscape features (e.g., limited cultural inventory has occurred). • May cause problems for park stewardship of artifacts and archives, requiring new facility/location. • Loss of cultural landscape elements. • Increased likelihood of degradation of identified cultural landscape features. • Potential changes in fire management plans based on differing fuels and ignition sources. • Cultural resource management policies may be challenged by need to protect sites and artifacts from environmental shifts. • Need to plan for increased threat to cultural resources that lie along riparian corridors (built and archeological) (monitoring/pre-planned action). • NPS policy regarding tribal gathering/park management and sustainable uses.
Facilities	• Facilities in areas of heavy fuel (vegetation) areas. • Provide for emergency egress for visitors and staff in the event of fires and floods. • Facilities in floodplain or flood prone areas. Roads, operations, visitor facilities, utilities. • Park management will need to consider alternatives for admin facilities if existing is lost to fire or floods. • May cause problems for park stewardship of artifacts and archives, requiring new facility/location. • Proactive fuel load treatment to protect vulnerable values at risk. • More difficult to implement prescribed burns.
Communication and Visitor Protection	• Provide for emergency egress for visitors and staff in the event of fires and floods. • Opportunity to spread visitation to a greater portion of the year may allow park to dispose of shuttle or formalize shuttle service for rest of year. • Degraded opportunities for visitors to experience integral vistas and other air quality related values. • Degraded visitor experience. • What is park's future role in and engaging with local communities? Other local policy ordinances and viewsheds. • Increase visitor conflicts, SARs. • Human population wanting more and sooner technological advances – management needs to keep up with technology. • A shift in season/staffing – when and how many visitors are coming? • Opportunities to supplement/partner with tribal government and other

Resource Category	Implications
	partners. • Shifts in visitation may impact species/habitat (breeding, etc.). • Are there wilderness implications for these least change conditions? • Opportunities for increased outreach and education programs and partnerships. Opportunity for new programs and audiences. • Consider communication strategies for flash flood events. • Consider new strategies for heat related injury (for visitors and employees). • Park will need to communicate to the public what the park's objectives are in response to climate change. • Prevention, detection, and management of human caused fires.
Other	• Cumulative land use changes adjacent to park boundaries. • Budget formulated sooner to have staff sooner. • Unknown, missing data on tribal government. • Management within a living process (more flexible planning). • Fire season = the park is danger zone for visiting public and staff. • More or less lead in landscape? Or will it be phased out by then? • Maximize engagement and collaboration to achieve shared goals; co-management wherever possible; adherence to trust responsibility. • As human population increases, the park will be a greater refuge for escaping the city. • Urban population: Fragmentation may require broader scope planning and partnerships (to secure migration paths and habitat). • Partnership opportunities increase for working together to protect wildlife connectivity as the need becomes clearer. • Park management will need to review plans and strategies and revise based on new data and changing conditions; be more nimble. • Need for greater energy, might result in more wind turbines and solar panels in area. • Shifts in visitation may impact species/habitat (breeding, etc.). • Prevention, detection, and management of human caused fires.

“Subtle Shifts” Scenario Management Considerations

Table 8. Management Considerations under the “Subtle Shifts” Scenario.

Resource Category	Management Considerations
Communication	• Increase education and outreach regarding dark night sky preservation and why it matters as both a natural and cultural resource.
Cultural Resources	• Set up a post-event response team for triage, stabilization, and recording impacts for historic structures. • Set up a post-event response team/system for investigation and triage of newly exposed cultural resource sites (with checklist and identified informational goals). • Tribal governments evaluate and act on NPS policy regarding tribal gathering/park management and sustainable uses. • Tribal governments evaluate and act on NPS policy regarding tribal gathering/park management and sustainable uses. • Prepare preservation/treatment/monitoring research plans. • Move museum collection to safe storage. • Accelerate all section 110 inventory, documentation, evaluation, and condition assessments. • Identify acceptable practices for stabilizing or salvaging historic structures and landscapes and historic and pre-contact sites. Prioritize paths for understanding sites, structures, and landscapes at risk; vulnerability assessment. • Incorporate historic structures fire response plan for vulnerable bottom lands structures in fire management plan (protective wrap) and/or mist systems.
Facilities	• Implement greater water conservation measures (i.e., remove dishwashers, garbage disposals, replace 60 year old water lines). • Provide for emergency egress for visitors and staff in the event of fires and floods. • Campground: will increase in pathogen concerns require need to have firewood policy? • Determine if Bear Gulch facilities can be fire-proofed and flash-flood proofed to a level that staff occupation is considered safe, even with anticipated increased fire and flood danger. • Park management will need to consider alternatives for administrative facilities if existing are lost to fire or floods. • Move administration and infrastructure to gateway community. Beneficial by connecting with community; but adverse because it disconnects with park. • Evaluate location of infrastructure and move towards finding sustainable strategy to house offices and educational/operational facilities. • Evaluate need for creating shade in areas where we have invited visitors to gather (like visitor centers, picnic tables, and the campground) and possibly other shade stations throughout the park. • Evaluate wood burning in campground all year. • Evaluate facility capacity to meet operational and visitor services/uses relating to climate change related scenarios variables.
Natural Resources	• Design inventory monitoring to capture rapid or subtle changes cost effectively. • Incorporate climate change scenario into prioritization for invasive species control (Cal-IPC is doing this. CalWeed and mapper). • Need for quantifiable, monitorable metrics of watershed function in coordination with other agencies. San Benito Watershed Profile. • Need for greater interagency coordination such that watershed function can be monitored and managed with decreasing relevance of property boundaries.

Resource Category	Management Considerations
	• Intensify control of invasive plants in areas most susceptible to changes as a result of fire or flood or on the edge of where plant community boundaries might change. • May need to create back-up refugia for water-dependent species to prevent their extirpation as the location of available water shifts due to storm events, groundwater changes, seismic events. • In restoration work consider including plant species that are adapted to a range of plausible futures. • Consider establishing refugia for rare species dependent on spring, seep, or other water body habitat that might disappear. • Maintain enough staff capability to respond to emergency fence monitoring and repair and erosion control to ensure pigs do not breach fences after increased storm events. • Comprehensive reliable researchable info database – spatially based “atlas,” “imap,” GIS.
Other	• Be committed to sustainable and less energy intensive practices in every aspect of park operations. • Develop a policy statement regarding balancing the need to prepare for anticipated changes with the uncertainty of the scenario. • Provide incentives for reducing waste stream, reducing energy use in park operations and how employees get to work. • Increase interpretation/enforcement to respond to potential increase in desire to leave trails in pursuit of shade. Perhaps add temporary shade structures at key places.
Outreach/ Education	• Communicate with the public the steps the park is taking in response to climate change and why. • Engage youth in park “management” actions and have them provide forms of outreach to develop park stewards in local communities. • Bring Pinnacles to communities (e.g., interagency information centers in Hollister, Soledad).
Partnerships	• Local recruitment of staff to better engage with local communities, stewardship. • Work with other state, federal, local agencies on fire education and outreach. • Partner with community organizations, agencies, recipients, on habitat connectivity with economic feasibility considered. Create win-win solutions and common ground. • Take a regional approach to night skies; air quality; and water resources (potentially). Use non-lead outreach as a model. • Continue to develop MOUs, TAs, with tribal and community organizations for coordinated education, outreach, and compatible land management.
Planning	• Lead regional, multi-agency, inter-institutional planning effort to coordinate climate adaptive actions region-wide. • Consolidate information from climate change workshop with GMP and RSS. Develop 1-5 year park action plan. • Evaluate/ revise and practice continuity of operations plans with climate change scenario extremes. • Interdisciplinary approach in evaluating all options/alternatives for values at risk from fire, flood, drought. • Increase fire preparedness and response (weather, fuel, equipment, staffing, Cal Fire). • Complete CLR for the bottomlands – include development of management zones,

Resource Category	Management Considerations
	coordinate with natural resources plans/issues and development of emergency response checklist (most vulnerable landscape in all scenarios?). • Develop plans to rehabilitate Bear and Condor Gulch historic structures to include “fire wise” protections. • Update planning and or management documents to provide guidance on: fire response; flood response; BMPs for management regarding light touch; condition assessment tools for emergency response. • All development planning incorporates climate change scenarios. • Analyze factors influencing campground placement and development – develop management plans. • Include future climate scenarios in Fire Management Plan and updates. • Identify values at risk due to fire and/or post-fire watershed effects, then identify mitigations such as prescribed fire and mechanical reduction.
Research	• Update floodplain/zones with climate change scenarios (for 100 year, 50 year, 20 year, and 10 year). • Update landslide hazards with climate change scenarios. • Update (hydrologic) watershed loads with climate change scenarios. • Research on host specific relationships for key species. • Interdisciplinary evaluation of Bear Gulch dam water level management (retention and/or controlled release). • Aquifer characterization needed to understand source and sustainability of groundwater resources with regards to park domestic water supply, natural resources/processes, and external demands. • Understand aquifer in terms of water use, availability and external uses. • Continue to build and refine historical reference information on flora/fauna/landforms/waterways/human modifications. The past may become the future in some respects so the better we know it the better we can adapt. • Investigation into whether the Bear Gulch dam can/should be used to mitigate increase in extreme water events and/or impacts on rare biota (in caves) from increased temperatures. • Investigate surface and subsurface water resources. • Develop a research plan and implementation strategy to inventory/assess climate impacts to the park, in order to adjust and adapt park actions (being nimble). • All primary research should have a TEK component. Increase primary research on park natural and cultural resources – with special focus on taxa potentially threatened by global climate change. Special focus on resilience attributes. • Information gathering/research into fog – will patterns change as a result of higher temperatures? • Information gathering/research into fog – will patterns change as a result of higher temperatures? • Start trying to model new habitats that global climate change will create (how they will be populated, from where by what, etc.) and how the park can facilitate that, while at the same time providing habitat “buffers” for existing communities to either adapt or migrate.
Tribal Government	• Support tribal sovereignty. Be proactive and adaptive in partnering with Tribe to attain shared goals.
Visitors	• Work to reduce (or at least maintain) the time the public has to wait for the shuttle as the visitation in the shoulder season increases. • Develop park budget earlier and shift hiring season in response to changing visitor use patterns. • Evaluate/consider closure of wilderness trail and backcountry camp during

Resource Category	Management Considerations
	extreme heat periods. • Develop gateway communities for relaying information and community involvement buy-in. • Need to consider/develop visitor use management plans and permit systems.
Monitoring	• Community – Indicators to monitor include Common Ground Alliance, number of organizations, agencies, community members engaged. Number of success stories where habitat improvement and connectivity is economically viable. • Cultural Resources – Prioritize and monitor changes to culturally important species (e.g., deergrass, white-root sedge, and chia). • Cultural Resources – Monitor archeological site conditions. • Cultural Resources – Inventory archeological sites (complete park comprehensive inventory). • Fire – Implement/continue fire effects monitoring plan/program. • Fire - Monitor vegetation cover, etc. (indicators from fire effects program data). • Fire – Monitor fire in region: frequency per year; acres burned per year; and intensity per year. • Multiple Categories – Monitor dark skies, soundscapes, viewsheds, and air quality. • Natural Resources - Increased early detection of invasives/exotics. • Natural Resources – Maximize use of imagery to quantify change in vegetation; hydrology; and groundwater (in the future). • Natural Resources – Monitor pathogens to stay aware of new “threats.” • Natural Resources – Monitor pollinator-floral interaction. Emphasis on phenology shifts. • Natural Resources – Monitor early detection/response for plant/animal invasive species. • Natural Resources - Monitor invasive plants. • Other – monitor pesticide use outside of park and transport into the park. Use may increase? • Population – Monitor population of San Benito, Monterey, Santa Cruz, and Santa Clara counties. • Visitors - Monitor visitor use data, trends, and seasons. • Visitors – Monitor user-capacity studies incorporate shifts in use due to climate change. • Facilities – Monitor changes in building wear patterns and material life (correlate to management practices). • Water - Monitor water quality. • Water – Monitor riparian acreage. • Water - Monitor seeps, springs.... for sedimentation for sensitive species. • Water – Monitor changes in watershed and site drainage patterns/potential breaches and new drainage paths for threat to visitors and staff facilities. • Water – Monitor springs and seeps to detect changes with seismic events, etc. • Water – Monitor stream morphology. • Water – Monitor species in riparian zones and around springs and seeps. • Weather - Automate weather station. • Weather - Monitor temperature through weather station. • Weather - Monitor temperature (maximum, minimum), growing days, precipitation, and seasonality. • Weather - Evaluate current weather station to improve reliability of information. • Weather – Monitor temperature and precipitation and storm events.

Resource Category	Management Considerations
	• Weather – Be sure to continue weather station data collection (as pointed out by Patrick Gonzalez). • Wilderness - Establish wilderness character monitoring program (indicators: soundscapes, viewsheds, dark skies, air quality) to understand changes to these qualities: natural, untrammeled, undeveloped, solitude or primitive and unconfined recreation, and other features (including cultural) in general and with regard to climate change adaptation. • Wildlife - Monitor for badgers or other wildlife changes as ground cover vegetation changes. • Wildlife – Monitor California red-legged frog. • Wildlife (and Water) - Monitor species dependent on spring/seeps/ponds/reservoirs.

APPENDIX C - “Desert Dry” Scenario

Potential Impacts of the “Desert Dry” Scenario

The potential impacts identified for the “desert dry” scenario were developed by breakout group 1.

Climate Variables Considered in this Scenario:

- Temperature increase of 4.2°C (7.5°F); increase in winter min temp +2 to 2.7°C (+3.6°F to 4.9°F); increase in summer max temp +3.7 to 4°C (+6.6°F to 7.2°F)
- Growing season: increase by 40 days
- Precipitation decrease 39%
- Drought: additional 10 consecutive days/year with rainfall <3 mm (0.12 in)
- Extreme temperature events: average annual max temp of 26°C (79°F) might occur once every 2 years (versus current once every 20 years) and 6 more consecutive days/year of temps >35°C (95° F)
- Extreme precipitation events: 1 in 20 year storms occurring every 8 years, with 25 to 200% increase in 100 year storm events; 2 more days/year with rainfall >25 mm (1 in)

Group 1 captured how this world looks by describing potential impacts. They considered both biophysical systems and human dimensions of change:

- This areas still has enough water and water use efficiency has increased so agricultural lands in this area are even more valuable.
- Creation of agriculture preserve zones based on the nation's needs for food production.
- Salinas Valley changes less than Pinnacles and less than other areas of nation. This may result in a population increase.
- The need to retain water on the landscape may drive development of new agricultural methods – sustainability actions measures.
- There may be a decrease in the number and/or size of ephemeral streams. Some perennial streams become ephemeral.
- More exaggerated differences between west and east sides – increase in regional rainshadow effects.
- An increase in the number of windy days and more intense winds, subsequent increase in evapotranspiration.
- Canyon bottoms do not stay as moist at night – increase fire chimney effect.
- Increased agriculture irrigation – unknown effects on humidity, convection patterns, and temperature moderation.
- California condor could do well as a result of not using lead ammunition.
- Lichens on Pinnacles formations would likely be affected.
- Visitor use patterns/locations change – more open areas – visitors increase likely to go off-trail.
- Potential over use/ changes in use patterns – rock climbers escaping heat.
- Raptor nesting may be affected which may also affect rock climbing routes/timing.
- Potential effects on raptor prey base. Increased use of rodenticides may affect raptors.
- Pathogens lead to pesticide changes and domino effects in ecosystem
- Potential loss of grey pines – loss of perch/hunting for owls, some raptors, and condors
 - o Potential shift to raptors that hunt more over grasslands
 - o Shift to grassland changes herbivore/prey populations.
- Longer fire season – begins earlier, ends later, larger areas burned. Possibility for year-round fire season.
- Increased flood events, erosion, sedimentation.
- Possibility that endemic or rare species (e.g., perhaps in caves) could be affected.
- Potential change in Bear Gulch Reservoir (management implications) could affect moisture in Bear Creek drainage.
- Potential for increased air pollution/particulates – inversions may occur on calmer days.

- Viewsheds and air quality changes – especially changes in the viewshed with increased development on the west side of the park.
- Star gazing opportunities diminish with decreased night sky qualities (increased development, especially on the west side).
- Decrease in wild/wilderness character with more open habitat/plant community and with increased likelihood of contacting other parties, or seeing other parties
- Increased human population may increase overflights and noise.
- More openness means more potential vandalism to archeological sites and other cultural resource artifacts.
- Increased weathering of historic structures.
- Paleontological/archeological sites exposed from storms/fire.

“Desert Dry” Scenario Implications

Table 9. Implications under the “Desert Dry” Scenario.

Resource Category	Implications
Natural Resources	• Design inventory monitoring to capture rapid or subtle changes cost effectively. • Potential decrease in the pig population. • Identify sensitive species and develop strategies for preservation. • Need for quantifiable, monitorable metrics of watershed function in coordination with other agencies. San Benito Watershed Profile. • Need for greater interagency coordination such that watershed function can be monitored and managed with decreasing relevance of property boundaries. • May need to create back-up refugia for water-dependent species to prevent their extirpation as the location of available water shifts due to storm events, groundwater changes, seismic events. • Greater investment in fire response (safety) and creating a fire safe park. • Native annual forbs may persist or increase. • Loss of critical structure for raptors and other avian species (e.g., grey pines and condors). • New to Pinnacles non-native species. Perhaps species that are currently in more arid sites (e.g., Sahara mustard). • Need more information on surface and subsurface water. • Need/opportunity to work with partners in surrounding landscape to enhance connectivity and facilitate migration. • Some plant and animal species that are currently rare may be at more risk and some at less risk. Some may be extirpated no matter what we do. Some will be fine without intervention. Some may require action to enable them to persist and thrive. • Shifts at the ecosystem level (e.g., decreased shrubs may lead to increased herbs). This would alter faunal community. Creates novel systems. • Shift in shrubs to herbs. May increase access to remote sites. May affect cultural resource and wilderness values. • Wilderness concept challenged at Pinnacles. Are we able to manage it under the Wilderness Act mandates? • Need for Bear Creek Reservoir as a cultural resource/ historic resource and as a habitat preservation tool. • Based on need to retain water in landscape, develop partner program between science and cultural resources to investigate/consider low tech/dry land water management practices. • Increase in pathogens.
Cultural Resources	• Shift in shrubs to herbs. May increase access to remote sites. May affect cultural resource and wilderness values. • Wilderness concept challenged at Pinnacles. Are we able to manage it under the Wilderness Act mandates? • Need for Bear Creek Reservoir as a cultural resource/ historic resource and as a habitat preservation tool. • Based on need to retain water in landscape, develop partner program between science and cultural resources to investigate/consider low tech/dry land water management practices. • Repeat archeological site inventories to identify exposed resources. • Implement cultural resource conditions assessment report as a management tool to track impacts/develop alternative strategies.

Resource Category	Implications
	• Incorporate historic structures fire response plan for vulnerable bottom lands structure in fire management plan (protective wrap) and/or mist systems. • Increase in pathogens. • Maintaining site protection and anonymity given potentially greater exposure and greater visitor encroachment. • Maintaining viable/harvestable populations of culturally significant plant and animal populations.
Facilities	• Increased hazard trees. • Increased pig fence maintenance due to greater number of storms. • Campground: will increase in pathogen concerns require need to have firewood policy? • Will extreme desert dry climate require us to seriously consider cost effective shade structures (not tens of thousands of dollars each)? Not permanent expensive structures. • Will increased costs of park operations lead us to evaluate existing infrastructure not being adaptively reused? • Shuttle system may need to be evaluated in light of increased temperatures (shade structures; wait times). • Consider removal of facilities from flood prone areas. Design facilities and roads and trail systems to withstand large flood events. • Construction of seasonal, widely distributed shade structures made of locally grown plant material (willow, brush, tule). • Greater effort required to maintain trails and access routes to climbing areas with concentrated use and extreme precipitation regime. • Does campground need to be redesigned/resited to preserve resources and increase visitor enjoyment?
Communication and Visitor Protection	• Opportunity to partner with west-side schools/communities to expand stewardship, citizen science, environmental education experiences. • Need to consider/develop visitor use management plans and permit systems. • Greater need to communicate risks of hiking in heat and for SAR. • Need for new safety programs: - o Heat - o Fire - o Flash flood - o Keep wildlife wild. • More off-trail hiking, off-road vehicles, and trespass. • Need to be agile in managing shifting patterns of visitor use and access – spatial and chronological. • Visitor safety issues, SARs, due to potential increased visitation and longer hot/dry periods. • Need for strong communication/interpretation programs to deter visitors from leaving trails for the shade resulting in damage to resources. • Develop gateway communities for relaying information and community involvement buy-in. • Increased threat to safety due to increased fire/flood events. • Increase education and outreach regarding dark night sky preservation and why it matters as both a natural and cultural resource. • Need for aid stations and fire refuge sites for staff and visitors. • Greater need to coordinate with west side communities/zoning to protect viewshed.
Other	• Ability to convey the cultural landscape lost due to environmental changes and visual changes.

Resource Category	Implications
	• Do all management plans need regular revision to adjust to changing conditions? • Greater challenges in staff communication and coordination due to separation of offices (offsite offices for administration and management team staff). • Need to position facilities and staff based on fire response. • Need more robust fire management program.

“Desert Dry” Scenario Management Considerations

Table 10. Management Considerations under the “Desert Dry” Scenario.

Resource Category	Management Considerations
Communication	• Increase education and outreach regarding dark night sky preservation and why it matters as both a natural and cultural resource.
Cultural Resources	• Set up a post-event response team for triage, stabilization, and recording impacts for historic structures. • Set up a post-event response team/system for investigation and triage of newly exposed cultural resource sites (with checklist and identified informational goals). • Tribal governments evaluate and act on NPS policy regarding tribal gathering/park management and sustainable uses. • Complete recordation of vulnerable cultural resources in anticipation of impending impacts and as a management tool to establish baseline documentation for assessing impacts and changes. • Identify acceptable practices for stabilizing or salvaging historic structures and landscapes and historic and pre-contact sites. Prioritize paths for understanding sites, structures, and landscapes at risk; vulnerability assessment. • Incorporate historic structures fire response plan for vulnerable bottom lands structures in fire management plan (protective wrap) and/or mist systems. • Relocate archives and collections to a secure site. • Develop a stewardship plan to address loss of extant cultural landscapes with a plan for recordation and interpretation (partner project).
Facilities	• Provide for emergency egress for visitors and staff in the event of fires and floods. • Campground: will increase in pathogen concerns require need to have firewood policy? • Determine if Bear Gulch facilities can be fire-proofed and flash-flood proofed to a level that staff occupation is considered safe, even with anticipated increased fire and flood danger. • Park management will need to consider alternatives for administrative facilities if existing are lost to fire or floods. • Move administration and infrastructure to gateway community. Beneficial by connecting with community; but bad because it disconnects with park. • Evaluate location of infrastructure and move towards finding sustainable strategy to house offices and educational/operational facilities. • Evaluate need for creating shade in areas where we have invited visitors to gather (like visitor centers, picnic tables, and the campground) and possibly other shade stations throughout the park.
Natural Resources	• Design inventory monitoring to capture rapid or subtle changes cost effectively. • Need for quantifiable, monitorable metrics of watershed function in coordination with other agencies. San Benito Watershed Profile. • Need for greater interagency coordination such that watershed function can be monitored and managed with decreasing relevance of property boundaries. • Intensify control of invasive plants in areas most susceptible to changes as a result of fire or flood or on the edge of where plant community boundaries might change. • May need to create back-up refugia for water-dependent species to prevent their extirpation as the location of available water shifts due to storm events, groundwater changes, seismic events. • In restoration work consider including plant species that are adapted to a range of plausible futures.

Resource Category	Management Considerations
	• Develop a combined cultural resources/natural resources condition assessment plan identifying emergency stabilization response for major wind and fire driven events. • Maintain enough staff capability to respond to emergency fence monitoring and repair and erosion control to ensure pigs do not breach fences after increased storm events. • Consider establishing refugia for rare species dependent on spring, seep, or other water body habitat that might disappear. • Consider developing a land resource strategy to purchase additional acres in adjoining watersheds.
Other	• Be committed to sustainable and less energy intensive practices in every aspect of park operations. • Develop a policy statement regarding balancing the need to prepare for anticipated changes with the uncertainty of the scenario. • Provide incentives for reducing waste stream, reducing energy use in park operations and how employees get to work. • Increase interpretation/enforcement to respond to potential increase in desire to leave trails in pursuit of shade. Perhaps add temporary shade structures at key places.
Outreach/ Education	• Communicate with the public the steps the park is taking in response to climate change and why. • Engage youth in park “management” actions and have them provide forms of outreach to develop park stewards in local communities. • Bring Pinnacles to communities (e.g., interagency information centers in Hollister, Soledad).
Partnerships	• Partner with community organizations, agencies, recipients, on habitat connectivity with economic feasibility considered. Create win-win solutions and common ground. • Take a regional approach to night skies; air quality; and water resources (potentially). Use non-lead outreach as a model.
Planning	• Lead regional, multi-agency, inter-institutional planning effort to coordinate climate adaptive actions region-wide. • Consolidate information from climate change workshop with GMP and RSS. Develop 1-5 year park action plan. • Update planning and or management documents to provide guidance on: fire response; flood response; BMPs for management regarding light touch; condition assessment tools for emergency response. • Develop plans to rehabilitate Bear and Condor Gulch historic structures to include “fire wise” protections. • Complete CLR for the bottomlands – include development of management zones, coordinate with natural resources plans/issues and development of emergency response checklist (most vulnerable landscape in all scenarios?). • Analyze factors influencing campground placement and development – develop management plans. • All development planning incorporates climate change scenarios.
Research	• Understand aquifer in terms of water use, availability and external uses. • Continue to build and refine historical reference information on flora/fauna/landforms/waterways/human modifications. The past may become the future in some respects so the better we know it the better we can adapt. • Investigation into whether the Bear Gulch dam can/should be used to mitigate

Resource Category	Management Considerations
	increase in extreme water events and/or impacts on rare biota (in caves) from increased temperatures. • Investigate surface and subsurface water resources. • Develop a research plan and implementation strategy to inventory/assess climate impacts to the park, in order to adjust and adapt park actions (aid in being nimble). • All primary research should have a TEK component. Increase primary research on park natural and cultural resources – with special focus on taxa potentially threatened by global climate change. Special focus on resilience attributes. • Information gathering/research into fog – will patterns change as a result of higher temperatures? • Research into groundwater hydrology of the area to be able to predict how climate change and external land use changes might impact park water resources. • Start trying to model new habitats that global climate change will create (how they will be populated, from where by what, etc.) and how the park can facilitate that, while at the same time providing habitat “buffers” for existing communities to either adapt or migrate.
Tribal Government	• Support tribal sovereignty. Be proactive and adaptive in partnering with Tribe to attain shared goals.
Visitors	• Develop gateway communities for relaying information and community involvement buy-in. • Need to consider/develop visitor use management plans and permit systems. • Consider partial/full trail closures during summer season. • Work to reduce (or at least maintain) the time the public has to wait for the shuttle as visitation in the shoulder season increases.
Monitoring	• Community – Indicators to monitor include Common Ground Alliance, number of organizations, agencies, community members engaged. Number of success stories where habitat improvement and connectivity is economically viable. • Cultural Resources – prioritize and monitor changes to culturally important species (e.g., deergrass, white-root sedge, and chia). • Facilities – Monitor building materials/systems performance (especially sacrificial coatings and weatherization materials). • Facilities – Monitor changes in building wear patterns and material life (correlate to management practices). • Fire – Monitor changes in fire fuel distribution and erosion impacts for response management use (event locations and new response impediments). • Natural Resources – Maximize use of imagery to quantify change in vegetation; hydrology; and groundwater (in the future). • Natural Resources – Monitor pathogens to stay aware of new “threats.” • Natural Resources – Monitor pollinator-floral interaction. Emphasis on phenology shifts. • Natural Resources – Monitor early detection/response for plant/animal invasive species. • Natural Resources - Monitor invasive plants. • Natural Resources – Incorporate climate change scenario into prioritization for invasive species control (Cal-IPC is doing this. CalWeed and mapper). • Other – monitor pesticide use outside of park and transport into the park. Use may increase? • Natural Resources – Monitor zonal changes in plant/insect/wildlife/pathogen

Resource Category	Management Considerations
	distributions (need baseline?). • Partnerships – Develop a historical map series (from monitoring) in partnership with surrounding land stewards. • Visitors – Monitor user-capacity studies incorporate shifts in use due to climate change. • Visitors – Monitor social trailing in the more open landscape as chaparral is lost after fire events. • Water – Monitor changes in watershed and site drainage patterns/potential breaches and new drainage paths for threat to visitors and staff facilities. • Water – Monitor springs and seeps to detect changes with seismic events, etc. • Water – Monitor species in riparian zones and around springs and seeps. • Weather – Be sure to continue weather station data collection (as pointed out by Patrick Gonzalez).

APPENDIX D - “Wet and Wild(flowers)” Scenario

Potential Impacts of the “Wet and Wild(flowers)” Scenario

The potential impacts identified for the “wet and wild(flowers)” scenario were developed by group 2.

Climate Variables in this Scenario:

- Temperature increase 1.4°C (2.5°F)
- Precipitation increase 27%
- Extreme precipitation events: 1 in 20 year storms occurring every 8 years, with 25 to 200% increase in 100 year storm events; 2 more days/year with rainfall > 25 mm (1 in)
- Growing season: increase by 11 days
- Extreme temperature events: average annual max temp of 26°C (79°F) might occur once every 2 years (versus current once every 20 years) and 6 more consecutive days/year of temps >35°C (95°F)
- Drought: additional 6 consecutive days/year with rainfall < 3mm (0.12 in)

Group 2 captured how this world would look by describing potential impacts. They considered both biophysical systems and human dimensions of change:

Hydrologic processes:

- There would be more and longer lasting (surface) water.
- Shallow aquifer recharge; there would be a wider distribution of aquatic species and non-native riparian vegetation and riparian corridors.
- Increased turbidity in streams/ponds/reservoir.
- Increased sediment.
- New seeps/springs.
- Changes in stream morphology.
- Potential loss of ponds/reservoirs.
- Reservoir would overtop more frequently.

Soils:

- Increased mass wasting/debris flows/landslides.
- Increased erosion/incision.
- Changes in channel geomorphology.

Geology:

- Constant/stable.

Wild character:

- Opportunity for solitude would increase during periods of low visitation.
- Opportunity for solitude would decrease during increased visitation periods (spring/fall).
- Scenic views – potential for protection, less particulates in air.
- Dark skies could be affected.

Soundscapes:

- Increased soundscape impacts – changes in soundscapes due to aircraft, insects, amphibians (some positive influences).

Visitation:

- Visitation patterns would be more dynamic, it may decrease on an annual basis, but seasonally it would be more concentrated.

Humans:

- The climate may be attractive for living regionally, resulting in a potential boom, and creating external

pressures on Pinnacles.

- Changes in land use (agriculture may shift varieties).

Talus caves:

- Localized gravel/trail erosion.
- Relative humidity would increase in caves; cave dependent species (e.g., bat populations) may decrease.
- Effects on macroinvertebrate populations unknown.

Facilities:

- There would be a need to manage overtopping (e.g., drop reservoir levels in fall to collect, manage releases in winter)

Fire:

- Increased fuel load, increased fire intensity and severity.
- Problems related to post-fire watershed/soil effects.
- Fire season may shift.
- Changes in fog occurrence could decrease its influence on moderating fire behavior.

Native plants:

- There would be a shift to more complete coverage of shrubs.
- Expansion or retention of riparian woodlands and valley oaks.
- Unknown effects to bottomlands area and potential for oak recruitment.
- Flower bloom period extended.
- Non-native: grasses, herbs, woody plants, increase in shrublands.

Wildlife:

- Unknown effects to wildlife; species-specific.
- Increase in invertebrates and insectivores.
- Increase wildlife diseases.
- Increase fungicides and pesticides, potential loss of bees (fungus).
- Loss of lichens and microhabitats
- Increased turbidity would affect frog populations.

Cultural resource preservation:

- Challenges would be presented by wet climate.
- Cultural landscape would be easier to manage, treatments are simpler.
- Potential floods/debris flows would impact cultural landscape.

“Wet and Wild(flowers)” Scenario Implications

Table 11. Implications under “Wet and Wild(flowers)” Scenario.

Resource Category	Implications
Natural Resources	• Increase in exotic species, especially plants, maybe animals, maybe invertebrates. • Increased stream turbidity. • Increased fungicides, insecticides, and other pesticides as environmental pollutants in air, water, and food chains (e.g., bioaccumulation). • Reservoir and pond-dependent species impacted due to sedimentation. • Changes in microhabitat (+ and -) due to loss of coastal fog and changes in aquatic habitats. • Increased fuel loads contribute to increased fire intensity and increased soil burn severity which increases post-fire watershed effects; maybe shift in fire season. • Impacts to lichens due to decrease of coastal fog. • Widespread changes in vegetation (shift toward more mesic shrublands) and associated wildlife habitat. • Stream morphology changes. • More suitable environment for aquatic species with expanded riparian areas. • Changes in external viewsheds as a result of changing land uses adjacent to the park (as air quality related values). • Increase in wildlife diseases. • Increased invertebrates (general) and their predators (bats, birds, lizards, shrews...). • Decrease in bee diversity (bee nests susceptible to fungus). • Increase in non-vascular plant distribution and diversity? • Unknown natural resource effects of visitation being more concentrated in spring and fall. • Increase in flooding. • General wildlife impacts mixed/unknown. • Increased rainfall and streamflow leads to higher relative humidity in caves, condensation on walls more frequent therefore Townsend's big-eared bats leave caves sooner in winter. Destination and impacts unknown. • Changes to natural soundscapes both positive and negative: - o Increase in amphibians and invertebrates adds natural noise - o Increase in crop dusting on adjacent lands adds unnatural noise. • Groundwater saturation increases creating opportunity for land slumps – shifts more (spring) water expression, longer stream flow (season). • Unknown bottomland valley oak recruitment. • Unknown – regional population increases and expansion and how it affects natural resources within the park and regionally.
Cultural Resources	• Unknown and undocumented historic properties – don't know /can't quantify impacts. • Increased erosion places known historic properties at greater risk for damage and loss; also increases loss of information/sites that haven't been identified (soils, unknown cultural resources). • Increased risk of loss of structures, buildings, sites, and objects from fire. • Degradation of some structures (e.g., dam at reservoir) (hydrologic processes). • Increase in flooding that would impact structures, sites, and objects along the stream corridors. • Monitor visitor impacts on cultural resources.

Resource Category	Implications
	• Preservation efforts more difficult in a wetter climate, growth, more treatment needed. • Wetter climate could help preserve some historic vegetation features. • Ethnographically significant species (e.g., deer grass?) could improve initially then may also be out-competed later. • Museum collections are housed in an area that is at considerable risk for fire, flooding, and debris flow.
Facilities	• Flooding and debris flows impact operations and facilities (structures and infrastructure), roads, buildings, picnic areas and campgrounds, trails, utilities, housing, historic structures. • Fire, frequent and intense, impacts facilities and operations. • Concentrated high visitor periods impact facilities maintenance/operations. • Changes in stream channel morphology affect park access. • Potential for degrading the undeveloped quality of wilderness character due to research and science installations.
Communication and Visitor Protection	• Visitor safety during extreme events (fire, floods). • How to take advantage of greater local population for education/outreach/stewardship? • Manage visitor impacts on resources during limited visitor season. • What type and level of visitor access to maintain? • Plan and/or develop new/evolving ways to engage with communities about adjacent land uses. • Compressed season creates staffing challenges. • Alternative ways to provide interpretation to visitors not coming to the park. • Solitude increases during periods of low visitation; solitude decreases during periods of high visitation. • Increased visitation loads on operation, functions, and protections. More demands for visitor services. • Changes in external viewsheds as a result of changing land uses adjacent to the park (as air quality related values).
Other	• Can't preserve and conserve alone – need partners (Tribal governments, traditionally associated peoples). • Increase in flood prone areas affect visitor use and opportunities. • Culture of creating living documents; nimble and flexible management. • Fire intensity and frequency affects visitor use, opportunities, and safety. • Increased tendency/need to intervene in biophysical environment degrades untrammeled quality of wilderness character. • Operational costs increased to meet needs and changes.

“Wet and Wild(flowers)” Scenario Management Considerations

Table 12. Management Considerations of the “Wet and Wild(flowers)” Scenario.

Resource Category	Management Considerations
Cultural Resources	• Assess historic buildings susceptible to increased pests and pathogens. • Create comprehensive reliable, researchable information database that is spatially based (“atlas,” “map,” GIS). • Accelerate all section 110 inventory, documentation, and evaluation condition assessments. • Determine and implement BMPs for protecting cultural resources – historic structures and archeological. • Move museum collection to appropriate and safe storage.
Facilities	• Use updated watershed and floodplain data to identify facilities (infrastructure) at risk and implement BMPs to accommodate additional loading for sustainable condition. • Establish proactive integrated pest management program with consideration of facility pests and disease vectors. • Increase solar system battery capacity to adapt to less/fewer sunny days to minimize the additional run time of generators. • Evaluate removal of all facilities from Bear Gulch.
Natural Resources	• Manage controlled released from Bear Gulch dam/reservoir. Manage also for siltation. • Control invasive plants.
Other	• Recognize that “core” resources remain despite climate change. • Provide incentives for reducing waste stream, reducing energy use in park operations and how employees get to work. • Be committed to sustainable and less energy intensive practices in every aspect of park operations. • Develop a policy statement regarding balancing the need to prepare for anticipated changes with the uncertainty of the scenario.
Outreach/ Education	• Develop richer non-personal interpretive services to accommodate fluctuating visitor seasons. • Engage youth in park “management” actions and have them provide forms of outreach to develop park stewards in local communities. • Communicate with the public the steps the park is taking in response to climate change and why. • More rangers in classroom and communities.
Planning	• Develop plans to rehabilitate Bear and Condor Gulch historic structures to include “fire wise” protections. • Consolidate information from climate change workshop with GMP and RSS. Develop 1-5 year park action plan. • Analyze factors influencing campground placement and development – develop management plans. • Prepare preservation/treatment monitor/research plans. • Create fire and flood preparedness plan/values at risk. Incorporate climate in Fire Management Plan and Emergency Preparedness Plan and updates.
Research	• Natural Resources - Evaluate possibility for prescribed fire and traditional burning practices. • Natural Resources - Investigate pest and pathogens presence and monitor once

Resource Category	Management Considerations
	found. • Natural Resources - Investigate changes in invertebrate and macroinvertebrate populations and distributions. (monitoring?) • Evaluate fuel loads and fuel load accumulations near resources and values at risk. • Investigate surface and subsurface water resources. • Develop a research plan and implementation strategy to inventory/assess climate impacts to the park, in order to adjust and adapt park actions (aid in being nimble).
Tribal Government	• Continue to develop MOUs, TAs, with tribal and community organizations for coordinated education, outreach, and compatible land management.
Visitors	• Evaluate need and operations for reservation system (trail and park use). • Use new assets (i.e., extended wildflower season) to disperse visitor use into other safe seasons. • Wet and Wild(flowers) “ad” campaign to encourage use during less popular weather and seasons; promote solitude. • Make climate information and data available to visitors.
Monitoring	• Fire – Implement/continue fire affects monitoring plan/program. • Natural Resources - Monitor raptors, land birds, and condors for impacts from increased precipitation. • Natural Resources - Monitor bat populations in talus caves. • Natural Resources - Monitor lichens and microhabitat distribution (related to loss of fog). • Natural Resources - Monitor natural landscape blocks for changes and fragmentation of landscapes and species populations (California Essential Habitat Connectivity Project) • Natural Resources - Investigate pest and pathogens presence and monitor once found. (also in research). • Natural Resources - Monitor invasive plants. • Other – monitor pollutant loads in air and water especially with regard to agricultural pesticides. • Other - monitor air quality and air quality related values. • Other – investigate external pressures from lands future plans surrounding Pinnacles to water, pesticides, land use, aircraft traffic. • Visitors - Monitor visitor use to plan for staff needs and other management issues arising from intensive visitor use. • Water - Monitor water quality, stream aggradation and incision (geomorphology) and aquatic species. • Water – Inventory springs/seeps; select a subset to monitor discharge, water stage, and other parameters (e.g., water quality, IBI, etc.). • Weather – Monitor precipitation and temperature. • Wilderness - Establish wilderness character monitoring program (indicators: soundscapes, viewsheds, dark skies, air quality) to understand changes to these qualities: natural, untrammelled, undeveloped, solitude or primitive and unconfined recreation, and other features (including cultural) in general and with regard to climate change adaptation.