Northern California Climate Adaptation Project

Adaptation Implementation Workshop Proceedings

2021

EcoAdapt™
Meeting the challenges of climate change

Acknowledgements

EcoAdapt Workshop Team

Laura Hilberg (Organizer)
Kathryn Braddock
Lara Hansen
Eric Meilbrecht
Carey Schafer

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Project Partners

Cover Photo

The Black Butte River Valley in Mendocino National Forest, which was burned in the 2020 August Complex Fire. The Black Butte River is a tributary of the Middle Fork Eel River, and is a federally-designated Wild & Scenic River. Photo © Chad Roberts (used with permission).

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Further information on the Northern California Climate Adaptation Project is available on the project website (https://tinyurl.com/NorCalAdaptation).

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Project Background

Northwestern California is known for its rich coastal resources, diverse temperate forests, and high numbers of endemic species and unique plant communities. However, climate changes such as warmer air temperatures, altered precipitation patterns, reduced snowpack, increased heat waves and drought, and uncharacteristically frequent and/or severe wildfire are already affecting the habitat and species of northwestern California, as well as the human communities that depend on them. To support natural resource managers in addressing these challenges, the U.S. Forest Service (USFS) and Bureau of Land Management (BLM) partnered with EcoAdapt on the Northern California Climate Adaptation Project (Figure 1), with a specific focus on the Six Rivers, Klamath, Shasta-Trinity, and Mendocino National Forests and Arcata, Redding, and portions of the Ukiah BLM field office areas.

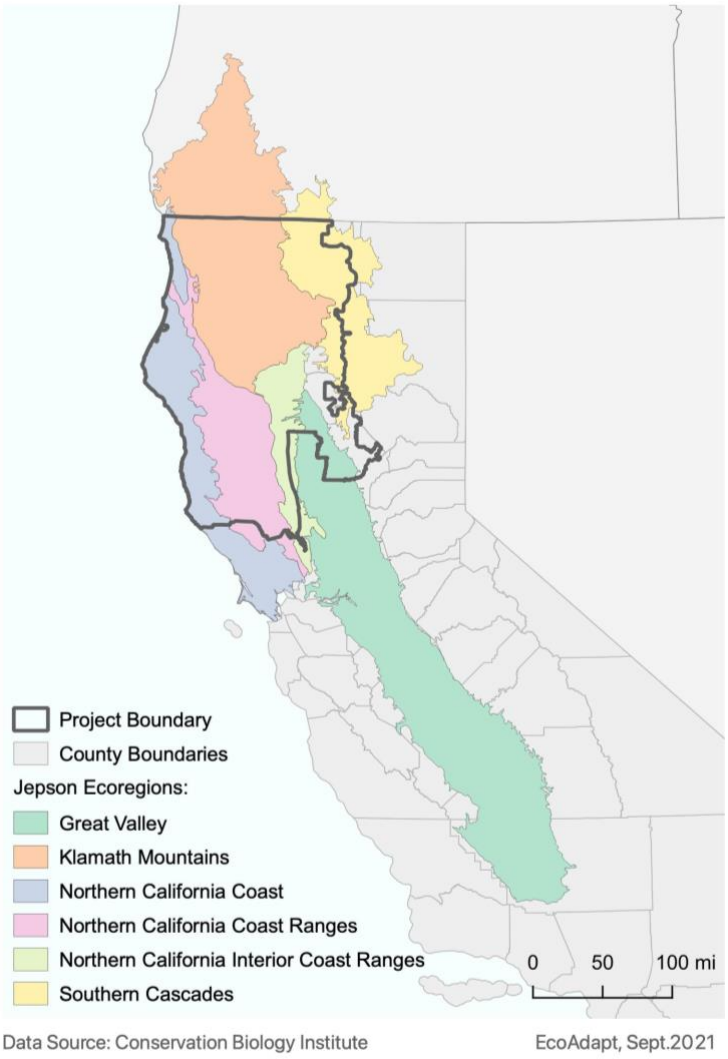

Figure 1. Study area geography and overlapping ecoregions for the Northern California Climate Adaptation Project.

The goal of the Northern California Climate Adaptation Project was to improve understanding of current and projected climate impacts on regionally-important habitats and species, and to develop adaptation options that would help reduce climate-related vulnerabilities of these resources. Project objectives included:

1. Convene a science-management partnership involving multiple agencies and organizations to evaluate the impacts of climate change on northwestern California natural resources and develop potential adaptation options;
2. Increase understanding of the climate-related vulnerabilities of regionally-important natural resources;
3. Facilitate the creation of adaptation actions that reduce vulnerabilities and develop a portfolio of "best bet" options to increase overall resilience of natural resources to climate change;
4. Support the integration and implementation of adaptation into conservation and management plans and projects; and
5. Create a climate-engaged public that can make informed decisions to sustain natural resources.

This project involved a series of four workshops:

1. **Focal Resource Selection and Scenario Planning.** The first workshop, held in March 2016, brought together scientists, resource managers, and other stakeholders to collaboratively identify a suite of focal resources (i.e., regionally-important habitats and species; Table 1) and explore alternative future climate scenarios for the region.
2. **Vulnerability Assessment.** The second workshop was held in May and June 2017, and focused on assessing the vulnerability of the selected focal resources to climate change. Following the workshop, EcoAdapt drafted comprehensive vulnerability assessment syntheses for each resource, which included vulnerability rankings and associated confidence evaluations as well as narratives summarizing participant input and relevant information from the scientific literature.
3. **Adaptation Strategy and Action Identification.** The third workshop, held in December 2017, convened participants from the first and second workshops, as well as other stakeholders, to develop climate-informed adaptation strategies and actions for focal resources.
4. **Adaptation Implementation Planning.** The fourth and final workshop was held in November 2021, and focused on developing implementation plans designed to support natural resource managers in on-the-ground adaptation activities on high-priority sites in northwestern California.

Table 1. Regionally-important habitats and species/species groups identified as focal resources for the Northern California Climate Adaptation Project.

HABITATS	SPECIES/SPECIES GROUPS
Coastal Habitats	
• Coastal dune systems • Coastal bluffs and scrub	
Forest & Woodland Habitats	
• Black oak and tanoak woodlands • Coastal conifer-hardwood forests • Coastal redwood forests • Mixed conifer and ponderosa forests • Mixed evergreen forests • Oak savannas and open woodlands • Subalpine forests • True fir forests	• Knobcone pine and cypress species • Late-successional-dependent species • Marbled murrelet • Native ungulates • Pacific yew • Salamanders • Sugar pine
Shrubland & Grassland Habitats	
• Alpine grasslands and shrublands • Chaparral shrublands • Mixed grasslands	• Migratory birds • Native insect pollinators

HABITATS	SPECIES/SPECIES GROUPS
Freshwater Habitats	
• Freshwater marshes • Lakes and ponds • Rivers, streams, and floodplains • Seeps and springs • Vernal pools • Wet meadows and fens	• Frogs • Native freshwater mussels • Northwestern pond turtle • Port-Orford-Cedar • Riparian-nesting birds
Endemic Habitats	
• Endemic habitats (e.g., caves, karst, cliffs, talus slopes, etc.)	• Bats

This report summarizes the activities and outcomes of the fourth workshop (described above). It includes an **Overview of Climate Adaptation Planning**, a description of the activities of the **Northern California Adaptation Implementation Workshop**, then presents **Priority Sites for Adaptation Implementation Planning** and the **Adaptation Implementation Plans** created by workshop participants for six sites in the northwestern California study area.

Overview of Climate Adaptation Planning

The impacts of climate change have significant implications for the habitats and species of northwestern California, particularly within the context of ongoing non-climate stressors such as land-use change (i.e., conversion to development or agriculture), fire exclusion, timber harvest, invasive species, dams/water diversions, and pollution, among others. Natural resource managers are now faced with the challenge of developing and implementing strategies that offer a path forward for these habitats and species given changing climate conditions. Strategies undertaken to address the causes and effects of global climate change are classified as either *mitigation* or *adaptation*. *Mitigation strategies* aim to reduce the rate and extent of change by reducing greenhouse gas emissions or enhancing carbon uptake and sequestration. *Adaptation strategies* help people prepare for, respond to, and/or recover from the unavoidable effects of climate change.

Climate change adaptation enables decision-makers to take a deliberate approach to evaluating vulnerabilities and designing adaptation strategies that enable climate-informed conservation and management. The adaptation planning process (Figure 2) reflects the intentional integration of climate change into management and conservation. These actions may include current management approaches, modifications to current strategies, and/or new and novel approaches to address climate change.

Figure 2. Climate adaptation planning process (image modified from Glick et al. 2011).

Climate change adaptation actions are organized into three general management approaches (Schuurman et al. 2021):

- **Resistance/Resilience** actions are focused on managing for persistence of existing ecosystems. This is generally a management-intensive approach with a near- to mid-term planning horizon. Examples include preventing the spread of invasive species or removing barriers to habitat connectivity.
- **Acceptance** actions are focused on accommodating change in response to novel conditions. These actions generally utilize a long-range planning horizon, and involve no management action beyond observation. Examples include accepting transition from one habitat type to another in response to changing climate conditions.
- **Direct/Response** actions are focused on actively facilitating change/transformation in response to novel conditions. They may be management-intensive, and generally utilize a long-term planning horizon. Examples include favoring native (and regionally-appropriate) species or genotypes that may be better adapted to future conditions.

Two additional approaches describe adaptation strategies that support management efforts and may be precursors to implementing a strategy that falls under one of the approaches above.

- **Knowledge** actions are focused on gathering more information about climate changes, impacts, and/or the effectiveness of management actions in addressing the challenges of climate change. The goal of these strategies is to gather and use the best available information to help

determine which actions to implement and how. Examples include improving methods for native species propagation or monitoring the long-term effectiveness of rare species management and restoration.

- **Collaboration** actions are focused on coordinating management efforts and/or capacity across organizational, departmental, or jurisdictional boundaries. Examples include improving data sharing within and between agencies and organizations or expanding collaborative monitoring efforts or projects.

Northern California Adaptation Implementation Workshop

The Northern California Adaptation Implementation Workshop was held on November 15–16, 2021 for participants from the Redding area, and then repeated on November 17–18 for participants from the Eureka/Arcata area. Each workshop consisted of two 3-hour sessions held from 9am–12pm.

Day 1: Reviewing Project Results and Evaluating Adaptation Strategies and Actions

The first day of the workshop began with welcoming remarks from EcoAdapt, followed by an introduction to the Northern California Climate Adaptation Project. The workshop organizer then introduced the facilitator team, and reviewed the workshop objectives and the day's agenda. Next, EcoAdapt presented an overview of the vulnerability assessment findings and trends, climate impacts report and associated climatic water deficit maps, and the suite of adaptation strategies and actions developed for this project. Then workshop participants split up into breakout groups based on the major habitat groupings (coastal, forests/woodlands, shrublands/grasslands, freshwater), and provided input on the effectiveness, feasibility, and potential co-benefits and conflicts associated with adaptation strategies and actions focused on those habitats. Finally, each breakout group identified several potential sites for the implementation planning activity and then selected one based on evaluations of value, current condition, and future climatic suitability.

Day 2: Developing Adaptation Implementation Plans

Day 2 began with brief welcoming remarks, followed by an introduction to the adaptation implementation planning activity. The majority of the day was spent in breakout group sessions, where workshop participants were asked to develop detailed adaptation implementation plans for the site that each breakout group had selected at the end of Day 1. The adaptation implementation plans included background information on the site (e.g., key climate-related vulnerabilities, potential barriers to adaptation), implementation steps (e.g., adaptation actions to take place along with information on timeline, leads and potential partners, and existing/needed resources), monitoring and evaluation (e.g., desired outcomes/restoration targets, metrics to determine whether those outcomes/targets are being achieved, thresholds that might indicate management intervention is needed), and funding and communications. Following the breakout group activity, participants reconvened to share their implementation plans. A short wrap-up presentation concluded the workshop.

The workshop agenda, presentations, and supporting materials can be accessed through the workshop support page: http://ecoadapt.org/workshops/norcal-adaptation-implementation. Workshop participants, including affiliations and breakout group assignments, can be found in Appendix A.

Priority Sites for Adaptation Implementation Planning

Workshop participants discussed a wide range of potential sites for management and restoration projects within the northwestern California study area or shortly beyond, which included both existing projects and proposed or imagined projects. Each site was then evaluated according to its value, current ecological condition, and future climatic suitability (
Table ***2***). Considering these factors can inform the selection of sites and corresponding adaptation approaches that balance current priorities with realistic future expectations for management and use of limited resources.

Table 2. Critical questions to guide the evaluation of potential sites for climate-informed management and restoration (adapted from Table 2 in Kershner et al. 2020).

VALUE *Low/Moderate/High*	**CURRENT CONDITION** *Poor/Moderate/Good*	**FUTURE CLIMATIC SUITABILITY** *Unsuitable/Marginal/Suitable*
What is the ecological, cultural, and/or socioeconomic value of the site? • Does the site support rare/endemic species, unusually high species diversity, or unique habitat features not found elsewhere? • Does the site provide critical wildlife habitat, important ecosystem services, or human uses (e.g., recreation) that cannot be relocated or found elsewhere? • Is the site highly valued by the public? • Is the site highly valued by regional tribes, or does it support critical populations of culturally-valued species? • Is the value of the site likely to persist into the future?	What is the current ecological condition of the site? • What is the level of current disturbance/degradation of the site? • Does the site support healthy native plant species and a functioning plant community? Are invasive plants currently present and to what degree? • What is the current ecological condition of the rare/endemic species or unique plant communities supported by the site (if any)? • Is woody plant/conifer presence and abundance appropriate for the site given disturbance/successional dynamics? • Is the site currently isolated, or does it support connectivity for native plants? • Is the soil nutrient status appropriate for the site?	What is the future climatic suitability for native plant communities on that site? • Is the projected direction and magnitude of change on the site expected to allow the persistence of native species on this site? • Will projected changes in regional fire regimes likely result in significant vegetation change and/or type conversion? • Is the site in an area that is naturally buffered from changes (e.g., north-facing slopes)? • Are projected conditions likely to result in the loss of connectivity with nearby suitable sites? • Are projected changes likely to increase the negative influence of invasive species or other non-climate stressors on this site?

Table 3 and Table 4 present the sites suggested by workshop participants along with their value, condition, and suitability rankings and key advantages or challenges that might be associated with prioritization of that site for restoration and management.

Table 3. Evaluation of priority sites for restoration and management by Redding area workshop participants.

Site	Value	Current Condition	Future Suitability	Rationale		
				Critical Needs	***Advantages***	***Challenges***
Forest & Woodland Habitats						
Jordan Hill (dry mixed conifer forest in Butte County)		Poor	Low	Post-fire restoration following conversion to chaparral (burned in the 2018 Camp Fire)	+	– Huge time and effort required to restore forest that is already undergoing type conversion – Successful restoration could take many decades
Rancho Breisgau (riparian oak woodland in Shasta County)	High	Very poor	Potentially good	Conversion of walnut orchard back to native woodland	+ Not many riparian oak woodlands so valuable + Great potential wildlife habitat + Restoration plan already complete + Public land	– Difficult to find funding – Lots of invasive weeds (old-growth star-thistle!)
Mixed conifer forest southeast of Weaverville				Post-fire restoration following Monument Fire	+	–
Indian Meadow (mixed conifer forest)					+	– Has been difficult to get the project off the ground re: partners, etc.
Grassland & Shrubland Habitats						
Plaskett-Keller Post-Fire Restoration Site, Mendocino NF (grassland, shrubland, forest)	High	Poor	High	Fuel management followed by post-fire restoration	+ Variety of habitat + Spotted owl habitat + Higher, cooler/wetter site + Presence of campground and summer homes + Valued for public use	– Severely burned (also an opportunity) – Would require personnel, funding – Invasive species are present – Heavy public use

Site	Value	Current Condition	Future Suitability	Rationale		
				Critical Needs	***Advantages***	***Challenges***
Indian Valley (Shasta-Trinity National Forest)	High	Poor (degraded – down cut, lost water table)	High	Streambank stabilization, controlling flow of water	+Beavers and water +Dispersed camp sites (educational component) +Restoration already taking place	–Likely has issues with invasive species –Would require personnel, funding, time –Road-stream crossings –Private land ownership
Bald Hills Prairie (in Redwood National Park near Lady Bird Johnson Grove)	High	Good (well-managed)	High		+In the national park +Lots of native species +Low water stress	–Douglas-fir encroachment (needs continuous management)
Freshwater Habitats						
East Fork Scott River (meadow/floodplain complex that feeds into the Klamath River, in Siskiyou County)	High	Moderate to poor	Probably low	Thinning hillslopes, decommissioning roads, culvert repairs, floodplain reconnection, restore sheet flows in meadows	+ Important fishery +Several spring-fed meadows support endangered species that could persist with help +Lots of community support in the Scott Valley (e.g., Scott River Watershed Council) +Existing partnership with the Forest Service, new partnerships with conservation-minded landowner downstream	– Hydrology affected by roads on both sides, hanging culverts in main channels –Experiencing conifer encroachment and drying soils –Trailheads up the roads – Large area – complicated to work with two streams at the same time, making work (though the potential gains are also greater) – Concern about different perspectives re: needs

Table 4. Evaluation of priority sites for restoration and management by Eureka/Arcata area workshop participants.

Site	Value	Current Condition	Future Suitability	Rationale		
				Critical Needs	***Advantages***	***Challenges***
Coastal Habitats						
North Spit Humboldt Bay (between Eureka Dunes and Ma-lel)	High	Degraded (some restoration has occurred)	Potentially high (if successful)	Extensive restoration of native dune vegetation to reestablish dynamic dune replenishing	+ Vital SLR/storm surge barrier for Humboldt Bay + High value to Wiyot people + Friends of the Dunes already working on site + NGOs and government already work together	– Broad coordination would be needed due to multiple landowners (private, local government, and NGOs)
South Spit Humboldt Bay	High	Moderate (some restoration has occurred)	Marginal	Nourishment using dredged sediment, restoration of inland dunes to improve mobility	+ SLR/storm surge barrier for Humboldt Bay + High value to Wiyot people + Rapid response of native vegetation to disturbances	– Roadway challenges restoration -> sand transport – Low elevation, so more vulnerable to future SLR/storm surge
Eel River spits				Restoration	+ High value to Wiyot people	–
Forest & Woodland Habitats						
Black oak/tanoak on Yurok lands (Humboldt/Del Norte County)	High	Moderate (fixer-upper)	High	Canopy release of encroached stand	+ Culturally-valued + High value for wildlife habitat	– Would need to monitor for invasives after canopy is opened (to guide management) – Sudden oak death
Siskiyou Wilderness montane conifer (includes enriched stands)	High	Poor	Moderate		+ Extremely high species diversity	– Concern about high-intensity fire, disease (Shasta red-fir) – Fire exclusion has resulted in dense stands adjacent to enriched mixed conifer or other unique ecosystems – could increase fire severity – Hesitancy to use active management approach to wilderness

Site	Value	Current Condition	Future Suitability	Rationale		
				Critical Needs	***Advantages***	***Challenges***
Old-growth redwoods at Headwaters Reserve (Humboldt Co.)	High	Relatively good			+	– Dense second-growth stands adjacent to old-growth, concern about spreading fire
Freshwater Habitats						
Marble Mountain (high-elevation wet meadow)					+	– Limited options in high-elevation systems
Indian Creek watershed in the Mid-Klamath area (extensive floodplains, sub-drainages with many, many miles of streams)	High	Poor	Uncertain (depends on fire)	Post-fire restoration (Slater Fire) to reduce need for future fire suppression, riparian restoration (native grass seeding), control invasive species and reintroduce endemic aquatic species	+ Very large area important for anadromous fish (e.g., coho) and other valued species + High societal and tribal value + Important nursery habitat for fish in the Klamath River + Diverse opportunities for action related to off-channel ponds and wood loading (some recruitment of large woody debris is accelerating natural recruitment) + Post-fire management is a crucial issue	– Very large area – System very degraded – concern about impacts of invasives on freshwater systems, high levels of disturbance (99% loss) – Post-fire emergency actions are allowable, but not clear how long they can continue within NEPA – Funding has scale limitation ($28,000 won't cover the whole watershed) – Vulnerable to future type conversion (depending on pre-fire condition)

Using the matrix below (Table 5), value and condition rankings were considered together with future suitability to identify potential adaptation approaches for use on sites. For example, on sites that are of high value, in good condition, and are expected to remain climatically suitable over the coming century (e.g., the Bald Hills Prairie in Redwood National Park), management activities might focus on resistance/resilience actions to maintain existing conditions and defend against potential future disturbances. On high-value sites in moderate or good condition in areas that are expected to become unsuitable for existing native plant communities by the end of the century, activities might focus on holding off significant changes in the short-term (resistance/resilience actions), and then shift to an acceptance approach (e.g., monitoring changes) when the cost and level of effort to maintain the site is no longer feasible.

Table 5. Matrix of potential adaptation approaches based on site value, current condition, and future suitability (adapted from Table 3 in Kershner et al. 2020).

Value	Current Condition	Future Suitability		
		Climatically Suitable	***Climatically Marginal***	***Climatically Unsuitable***
High	Good	Resistance/Resilience Acceptance	Resistance/Resilience Direct/Respond	Resistance/Resilience Acceptance
	Moderate	Resistance/Resilience	Resistance/Resilience Direct/Respond	Resistance/Resilience Acceptance
	Poor	Resistance/Resilience	Resistance/Resilience Direct/Respond	Direct/Respond Acceptance
Moderate	Good	Resistance/Resilience Direct/Respond	Resistance/Resilience Direct/Respond	Resistance/Resilience Acceptance
	Moderate	Resistance/Resilience Direct/Respond	Resistance/Resilience Direct/Respond	Resistance/Resilience Acceptance
	Poor	Resistance/Resilience	Resistance/Resilience Direct/Respond	Direct/Respond Acceptance
Low	Good	Direct/Respond Acceptance	Direct/Respond Acceptance	Acceptance
	Moderate	Acceptance	Acceptance	Acceptance
	Poor	Acceptance	Acceptance	Acceptance

The following six sites were chosen by Redding and Eureka/Arcata area workshop participants for the development of detailed implementation plans designed to support on-the-ground management action (Table 6).

Table 6. Priority sites chosen by workshop participants for adaptation implementation plan development, along with value, condition, and future suitability scores and potential adaptation approaches.

Site Name	Value	Condition	Future Suitability	Adaptation Approach
Rancho Breisgau riparian oak woodland	High	Poor	Suitable	Resistance/Resilience
Plaskett-Keller Post-Fire Restoration Site, Mendocino National Forest	High	Poor	Suitable	Resistance/Resilience
East Fork Scott River meadow/floodplain complex	High	Moderate to Poor	Probably unsuitable	Resistance/Resilience Direct/Respond Acceptance
North Spit Humboldt Bay	High	Moderate	Suitable	Resistance/Resilience
Black oak and tanoak stands on Yurok tribal lands	High	Poor	Suitable	Resistance/Resilience
Indian Creek watershed of the Mid-Klamath	High	Poor	Uncertain	Resistance/Resilience Direct/Respond Acceptance

Climate Adaptation Implementation Plans

During the second day of the workshops, partners developed climate adaptation implementation plans for six of the priority restoration sites (three during the Redding area workshop and three during the Eureka/Arcata area workshop). The plan template is adapted from Gregg 2021, and includes sections to help users identify the rationale for restoration (including desired outcomes/restoration targets), actionable steps (e.g., tasks, responsible parties and roles, resources needed, and anticipated costs), adaptive management options (e.g., performance metrics and management triggers associated with restoration targets), and funding and communications/outreach requirements. The template was designed to answer critical questions typically posed by funders (e.g., foundations, state and federal agencies) in requests for proposals, many of which are shifting towards supporting “shovel-ready” climate adaptation projects.

Implementation plans for the six priority restoration sites are presented below.

Adaptation Implementation Plan for Rancho Breisgau Riparian Oak Woodland

SECTION 1. BACKGROUND

PROJECT SITE: Rancho Breisgau riparian oak woodland (converted walnut orchard)			
Value: High	**Current Condition:** Poor	**Future Suitability:** Suitable	**Potential Approach:** Resistance/Resilience
Overarching management goal: Restore native plant community (riparian oak woodland) to increase resilience of the system, expand priority habitat, and improve habitat availability/quality for wildlife			
Key climate-related vulnerabilities to be addressed: • Climate-driven increases in wildfire risk (benefits of native riparian plants, potential benefits of restoring hydrology/beavers if that was included in the project) • Loss of spatial heterogeneity (reduces wildfire risk, disease vulnerability) and population connectivity (pollination) • Loss of genetic diversity in riparian oaks (e.g., valley oaks) • Hotter/drier conditions and increased drought stress (improved water filtration/supplies from native vegetation, provides climate refugia/movement corridors for wildlife)			
Potential barriers to meeting management goal: • Difficult to find funding for this project • Lots of invasive weeds already on the site (old-growth star-thistle!) • Potential impacts to soils of agricultural activities (walnut orchard monoculture + star thistle)			
Potential conflicts or unintended consequences with non-target ecosystems/species, human communities, and/or other management goals: • Potential conflicts due to restoration of agricultural site (but probably not still in use since it is public land owned by BLM) • Could take a lot of work to address invasive species, taking resources from other projects			

SECTION 2. IMPLEMENTATION STEPS

Adaptation Actions	Timeline	Lead & Potential Partners	Implementation Costs	Existing/Needed Resources
Remove invasive plants > Use volunteer for removal > Consider goats to eat star thistle	Should happen first (before planting/seeding, and would need to be maintained)	*Lead:* BLM *Partners:* Non-profit partner to provide volunteer support	*Initial:* Relatively low if mostly using volunteers *Maintenance:* Would need to be maintained, particularly if disturbance frequency increased (e.g., increased flooding)	*Needed:* Volunteers for invasives removal (method of removal would influence use of volunteers – more difficult with herbicides vs. mechanical)
Plant riparian oaks	Following invasives removal	*Lead:* BLM	*Initial:* May need to hire field techs	*Needed:* Experienced volunteers or staff for planting to maximize tree survival (or plenty of training and supervision)
Seed with native understory species > Consider planting palette adapted to future climate > Prioritize the use of at least some species that would establish quickly to prevent invasives coming back right away	Following invasives removal	*Lead:* BLM *Partners:*	*Initial:* May need to hire field techs	
Improve soil health and condition and consider amendments if needed	Monitor soils throughout the project and after restoration	*Lead:* BLM *Partners:* Academic partner, soil scientist to analyze data and train staff in sampling techniques	*Initial:* May need to hire field techs *Maintenance:* Ongoing soil monitoring	*Existing:* Grant to analyze soil profiles (River Partners?)

Model future wildfire behavior to better understand risk and inform adaptive management		*Lead:* BLM *Partners:* Academic institution for modeling		*Needed:* Fuels data, climate models
Determine future management plan for the site, including thinning/prescribed burning needed after restoration is complete > Consider allowing traditional uses and tribal management practices to maintain site and increase resilience to climate change through cultural burning, etc.	Consider long-term thinning/ prescribed fire needs	*Lead:* BLM *Partners:* Local tribes		*Needed:* Funding (AB32 climate change investments grant program through Cal Fire could provide funding for thinning/rx fire as long as it has a carbon benefit)

SECTION 3. MONITORING & EVALUTION

Adaptation Actions	Desired Outcomes/Restoration Targets	Timeframe	Metrics to Measure Outcomes/Targets
Invasives removal	Reduced presence of invasives (ideally none)	Near-term	% cover of invasives (target <20%)
Plant riparian oaks	High seedling survival Riparian oaks as canopy dominant	Near-term Long-term	% seedling survival % canopy cover # mature oaks per acre
Seed with native understory species	Increased cover of native plants in the understory	Near-term (but has to be maintained over longer time scales)	% cover of native understory species

Improve soil health and condition and consider amendments if needed	Appropriate levels of organic matter and nutrients for each soil profile Low levels of erosion and soil compaction	Near-term for initial changes; mid-to long-term ongoing	% and/or depth of organic matter Ideal ratio of nutrient levels (nitrogen, potassium, phosphorus) based on soil test Streambank condition (use channel monitoring) Bulk density and resistance (for soil compaction)
Model future wildfire behavior to better understand risk and inform adaptive management	Superimposed maps of post-restoration management (thinning/burning) with fire maps		
Determine future management plan for the site, including thinning/prescribed burning needed after restoration is complete	Reduced fire risk in response to site restoration/treatment (including ongoing management)		
Thresholds that would indicate intervention/additional action is needed (what/when/how to respond): •			

SECTION 4. FUNDING & COMMUNICATIONS

Funding mechanisms/options: • AB32 (climate change investments grant program) through Cal Fire could provide funding for ongoing site maintenance with thinning/rx fire as long as it has a carbon benefit • Look for grants focused on planting native species/oak restoration
Communication/public outreach plan: •

Adaptation Implementation Plan for Plaskett-Keller Post-Fire Restoration Site, Mendocino National Forest

SECTION 1. BACKGROUND

PROJECT SITE: Plaskett-Keller Post-Fire Restoration Site, Mendocino National Forest			
Value: High	**Current Condition:** Poor	**Future Suitability:** Suitable	**Potential Approach:** Resistance/Resilience
Overarching management goal: Manage fuels to reduce future wildfire risk in shrublands (and preserve connectivity of shrublands with forest), post-fire restoration, increase shrubland and hydrologic connectivity			
Key climate-related vulnerabilities to be addressed: • Extreme hydrologic events (e.g., atmospheric rivers) • More rain, less snow • Increased temperatures & climatic water deficit → more severe wildfire in the future ○ Altered watershed response – loss of soil productivity (loss of permeability), water moves offsite quicker • Decreased ability of landscape to support conifers (primarily driven by increased water stress)			
Potential barriers to meeting management goal: • Mixed ownership • Grazing represents a challenge for grassland health (invasive spp.) & fire recovery in general • Lack of resources (personnel, $$) • Potential concern from local tribes about management of the land (unknown at this time) • Conifer dominance in FS (cultural challenge) ○ Grasslands/Shrublands don't have the monetary/cultural backing that the conifers do			
Potential conflicts or unintended consequences with non-target ecosystems/species, human communities, and/or other management goals: • Potential impacts to the wild and scenic river corridor • Summer homes and camp ground in the project area – public use is a concern • FS likes to manage forest – grassland/shrubland are not a priority (not actively managed at this point			

SECTION 2. IMPLEMENTATION STEPS

Adaptation Actions	Timeline	Lead & Potential Partners	Implementation Costs	Existing/Needed Resources
Plant oaks instead of conifers	Continuous (on-going effort)	*Lead:* Forest Service – Botany, Silviculture, & Wildlife *Partners:* Rocky Mountain Elk Foundation; tribes; schools (field trips); private landowners	*Initial:* $ (paid for by reforestation budget – generally cheaper than planting conifers) *Maintenance:* $–$$ (monitoring, potential need for replanting)	
Create a mosaic of multi-age shrublands	Near and mid-term (needs to happen ASAP, but may be delayed by institutional barriers)	*Lead:* Forest Service – Fuels and Wildlife, Fire Managers *Partners:* Rocky Mountain Elk Foundation; tribes; schools (field trips); private landowners	*Initial:* $$ (personnel & equipment) *Maintenance:* $$$ (personnel & equipment)	
Restore grasslands through invasive species management and reintroduction of native species	Continuous	*Lead:* Forest Service – Botany, Range *Partners:* Private landowners	*Initial:* $ ($500/acre) *Maintenance:*	
Develop landscape management plans that address all habitat types within the project area, including hydrologic connectivity	Start now and complete within 5 years	*Lead:* Forest Service – Silviculture, Ecology, NEPA *Partners:* Private landowners	*Initial:* May need to hire field techs *Maintenance:* Ongoing soil monitoring	
Reduce/manage conifer encroachment	Any time	*Lead:* Forest Service – Botany, Range *Partners:* Private landowners		

SECTION 3. MONITORING & EVALUTION

Adaptation Actions	Desired Outcomes/Restoration Targets	Timeframe	Metrics to Measure Outcomes/Targets
Plant oaks instead of conifers	Expansion of oak habitat Survival of planted oaks	Near-term	Acreage of oak woodland on the site Connectedness of oak patches # of surviving oaks in a patch
Create a mosaic of multi-age shrublands	Multi-age distribution of shrubland patches (instead of a uniformly-aged shrubland patch)	Mid-term (~10 years)	Target acreage burned yearly
Restore grasslands through invasive species management and reintroduction of native species	No introduction of further invasive species Periodic use of fire and grazing for ongoing management	Mid-term	% cover of native species In grasslands
Develop landscape management plans that address all habitat types within the project area	Completion of assessment Creation of landscape management plan Public involvement	Near-term	
Reduce/manage conifer encroachment	No conifer encroachment in meadows	Mid-term	% conifer cover in grasslands
Thresholds that would indicate intervention/additional action is needed (what/when/how to respond): • Another severe fire that results in type conversion • Lack of funding/resources			

Adaptation Implementation Plan for the East Fork Scott River Meadow/Floodplain Complex

SECTION 1. BACKGROUND

PROJECT SITE: East Fork Scott River meadow/floodpain complex (two stream systems north of Kangaroo Lake – Cabin Meadow Creek and Rock Fence Creek)

- High elevation site, somewhat disturbed
- Receives storms from the valley, has been shown to have relatively high water storage and resilience over the past few years
- Real project site for the Scott River Watershed Council, USFW, and other partners

Value: High	**Current Condition:** Moderate to Poor	**Future Suitability:** Probably Unsuitable	**Potential Approach:** Resistance/Resilience; Direct/Respond; Acceptance

Overarching management goal: Restore high-elevation groundwater-dependent meadow and fen habitats (e.g., increase water residence time), promote resilience to wildfire, increase ecosystem functioning to maximum capacity (get the entire catchment system working together), demonstrate that it is possible to do catchment-level rather than site-level restoration

Key climate-related vulnerabilities to be addressed:

- Snow to rain conversion (significant amount of change, leads to issues with infrastructure and culverts)
- Increased wildfire risk
- High tree mortality rates
- Drying of meadow vegetation and encroachment by upland vegetation

Potential barriers to meeting management goal:

- Camping in floodplain, trailhead access roads fairly high up the meadows – Forest Service committed to maintain the roads
- Grazing
- Differing perspectives on what needs to be done

Potential conflicts or unintended consequences with non-target ecosystems/species, human communities, and/or other management goals:

- Conflicts with other management goals
- Damage to remnant meadow land habitat
- Road realignment/change (potential to cause negative unintended consequences)
- Approach requires adaptive management and follow-up – potential consequence is if people lose interest or this becomes a lower priority and could become abandoned

SECTION 2. IMPLEMENTATION STEPS

Adaptation Actions	Timeline	Lead & Potential Partners	Implementation Costs	Existing/Needed Resources
Develop comprehensive plan using information from monitoring and baseline studies to support management decisions	Near-term (first step)	*Lead:* Scott River Watershed Council *Partners:* Klamath National Forest, lease holders	*Initial:* $ (low to unknown) *Maintenance:* $$? (unknown, but may be increased costs associated with management of cows)	Relationships/partnerships *Needed:* People power, supplies, information, ingenuity
Develop and implement an adaptive management and monitoring plan for cattle grazing that focuses on achieving desired ecological outcomes with triggers for management actions	Near-term	*Lead:* Scott River Watershed Council *Partners:* Forest Service (Klamath NF), private consultant, other future unknown partners	*Initial:* $$ *Maintenance:* No real maintenance costs once plan is in place	*Existing:* Environmental NEPA analysis, Forest Service preliminary work *Needed:* On-the-ground studies, data analysis, and additional planning resources
Place large woody debris and brush to slow or stop channelization in degraded streams, & reconnect floodplain	Near-term (but must be done after first two actions)	*Lead:* Scott River Watershed Council *Partners:* Forest Service (Klamath NF), private consultant, other future unknown partners	*Initial:* $ (low) *Maintenance:* $ (low)	*Existing:* On-site materials *Needed:* Plans to be developed, community participation

SECTION 3. MONITORING & EVALUTION

Adaptation Actions	Desired Outcomes/Restoration Targets	Timeframe	Metrics to Measure Outcomes/Targets
Develop comprehensive plan using information from monitoring and baseline studies to support management decisions	Comprehensive stakeholder management plan for the two catchment systems Clear understanding of existing conditions and source problems that need to be addressed	Near-term	Flow/channel conditions analysis Environmental analysis and permitting completed Sensitive species / biological surveys (eDNA)
Develop and implement an adaptive management and monitoring plan for cattle grazing that focuses on achieving desired ecological outcomes with triggers for management actions	Grazing regime that does not negatively impact ecological values/resources	Near- to mid-term	Plant recovery metrics (developed by the Forest Service)
Place large woody debris and brush to slow or stop channelization in degraded streams, & reconnect floodplain	Increased wetted area and channel complexity Raised groundwater table Expansion of fen/wet meadow habitat Increased carbon sequestration		NDVI (before/after comparison, GIS analysis) # of confluences and difluences Groundwater wells measurement Soil cores Before/after physical surveys Channel evolution surveys to determine if sediment is being deposited in the right place

Thresholds that would indicate intervention/additional action is needed (what/when/how to respond):

- Grazing action – protocols show continued negative levels of impact, plan would need to be altered
- Woody debris option – is debris is degraded or dislodged (example, winter storm), would need to add more to keep in place (a trigger for positive further intervention, a place where additional actions may be needed)
- Ongoing evaluation and adaptive management is an expected part of the process

SECTION 4. FUNDING & COMMUNICATIONS

Funding mechanisms/options:

- State wildlife conservation board – flow enhancement grant
- Prop 1
- In-kind support from the Forest Service Southwest Research Station/Klamath NF
- General – gov. grants (CA Dept. of Fish and Wildlife, etc.)

Communication/public outreach plan:

- Volunteer and community-based outreach during implantation
- Kiosk to explain actions
- Watershed council youth summer employment and environmental education program – spreading information to families, building a conservation culture
- Field tours, speaking at professional and community events

Adaptation Implementation Plan for the North Spit Humboldt Bay

SECTION 1. BACKGROUND

PROJECT SITE: North Spit Humboldt Bay			
Value: High	**Current Condition:** Moderate	**Future Suitability:** Suitable (dependent on project success)	**Potential Approach:** Resistance/Resilience
Overarching management goal: Restoration of a dynamic geomorphic system resilient to SLR & storms, increased habitat value for native flora and fauna, protection/enhancement of archeological sites and cultural uses (e.g., culturally-valued plants, ceremonial uses), support of continued recreational use, increased aesthetic value			
Key climate-related vulnerabilities to be addressed: • Sea level rise and storm surge • Shifts in the timing of native plant response to disturbance, increased susceptibility to invasives • Reduced soil moisture, drought, wildfire (less of a concern)			
Potential barriers to meeting management goal: • Funding, public support (improving), infrastructure function (roads, utilities), industrial and residential development • Subsidence on bay side • Assumption that beaches are pro-grading (may not succeed if this reverses)			
Potential conflicts or unintended consequences with non-target ecosystems/species, human communities, and/or other management goals: • Coordination needed between federal agencies and private, local government, and NGO land owners • Sensitivity and collaboration needed due to the presence of archeological sites(Wiyot tribe, Blue Lake Rancheria, Bear River Band Rohnerville Rancheria)			

SECTION 2. IMPLEMENTATION STEPS

Adaptation Actions	Timeline	Lead & Potential Partners	Implementation Costs	Existing/Needed Resources
Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes > Leverage current pro-grading beach)	Near-term (will need ongoing maintenance)	*Lead:* Coalition (BLM, USFWS, Tribes, Friends of the Dunes, agencies, city/city county, landowners, etc.) will be required as area is mixed ownership, but helpful if can be put under one project umbrella for permitting/review – possibly under the lead funder *Partners:* CA Dept of Fish & Wildlife, CA Coastal Commission	*Initial:* Depends on methodologies - manual removal is more costly than burning/herbicide *Maintenance:* Annual retreatment may be needed	*Existing:* Coalition model in use already, and have volunteers, data on elevation (may need more) and relative sea level rise, have plant survey data and demonstrated successful invasives removal in the region (e.g., the Humboldt Coastal Resilience Project currently underway by USFWS) *Needed:* Funding (none already designated), more volunteers, permits/review, additional specific elevational data
Set up an early detection-rapid response program to prevent the establishment of invasive species on remnant native-dominated dune systems				
Increase public awareness of invasive species removal efforts in dune habitats and their role in reducing climate vulnerability	Near-term implementation, but ongoing with visitors and new residents	*Lead:* Project coalition subcommittee - docents/interpretation and outreach folks) *Partners:* Nonprofits & agencies	*Initial:* Costs related to staff time (seasonal docents), printed materials, signs – may be able to squeeze into existing budgets	*Existing:* Location with a high public profile and existing opportunities – Ocean Day (South Spit), Public Lands Day, sand sculpture events, kinetic sculpture race day

Protect sensitive dune habitats still dominated by native vegetation from recreational impacts				
Collaborate with tribes regarding cultural and archeological sensitivities and needs	Near-term	*Lead:* Organically-created coalition would be good so all meeting together (like the past Strategic Partnership Coalition) *Partners:* Wiyot tribe, Blue Lake Rancheria, Bear River Band Rohnerville Rancheria; Friends of the Dunes	*Initial:* Staff time *Maintenance:* Staff time	*Existing:* Staff time already exists and collaboration is prioritized *Needed:* Rotating meeting responsibilities
Redirect bay dredge material to augment sediment source (place it nearby in literal cell as an expanded sediment source, or place directly where needed)	Near-term Mid- to long-term if ongoing	*Lead:* Army Corps *Partners:* Humboldt Bay Initiative and other restoration efforts	*Initial:* Already being explored as option but not yet implemented *Maintenance:*	*Existing:* Army Corps already considering *Needed:* Research to test effectiveness (need funding for research)

SECTION 3. MONITORING & EVALUTION

Adaptation Actions	Desired Outcomes/Restoration Targets	Timeframe	Metrics to Measure Outcomes/Targets
Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	Eradication of invasives Restoration of natural dune processes and increased system resilience to SLR and storm surge	Near-term for initial treatment Mid- to long-term for dune processes	Plant surveys that include pre and post restoration monitoring of natives and invasives Dune topographic surveys (as part of pre/post plant surveys) to measure geomorphologic changes
Collaborate with tribes regarding cultural and archeological sensitivities and needs	Presence of tribal community trust and collaboration built during the process Tribal concerns incorporated into restoration project No dissemination of sensitive protected information (has been a problem in the past) Strong active involvement in the coalition between partners and tribes Mentorships for tribal students and community members to build capacity for long-term involvement	Near- to long-term	Tribal staff hired for involvement in restoration Mentorships created (e.g., for Humboldt State University student training and research)

Thresholds that would indicate intervention/additional action is needed (what/when/how to respond):

- If topographic surveys showed that dynamic dune system were not keeping up with SLR → shift more to resistance approaches (e.g., directly depositing dredge materials on spit), could also consider managed retreat
- Critical to be aware of protected and sensitive tribal information and inappropriate sharing

SECTION 4. FUNDING & COMMUNICATIONS

Funding mechanisms/options:

- Likely not a single source – lots of funding options could and would need to be tapped
- Consider agency matching funds, State Coastal Conservancy funding, emerging FEMA Pre-Disaster Mitigation grant and/or Federal infrastructure bill

Communication/public outreach plan:

- Coalition member communication strengths
- Do public outreach during existing events (e.g., Ocean Day, Public Lands Day, Sand Sculpture Day, Kinetic Sculpture Race Day) – works well due to high-profile location

Adaptation Implementation Plan for Black Oak and Tanoak Stands on Yurok Tribal Lands

SECTION 1. BACKGROUND

PROJECT SITE: Black oak/tanoak stands on Yurok tribal lands (Humboldt/Del Norte Counties)			
Value: High	**Current Condition:** Moderate	**Future Suitability:** Climatically suitable	**Potential Approach:** Resistance/Resilience
Overarching management goal: Restore historical conditions of black oak/tanoak woodlands through cultural management to improve ecosystem health and resilience (requires ongoing management/maintenance of cultural practices that maintain the system integrity, includes focus on understory as well as overstory)			
Key climate-related vulnerabilities to be addressed: • Drought (increased water stress in encroached stands) • Wildfire (increased risk of high-severity fire in dense encroached stands) • SOD (restored stands make them less hospitable for the pathogen and removing fire-intolerant hosts – pepperwood, tanoak, live oak, etc.)			
Potential barriers to meeting management goal: • Sudden oak death (SOD) is a major concern in the region • Cross-jurisdictional management – need to have treatment that is commensurate with need • Limited workforce training/capacity – don't have the workforce to implement with skill/specificity needed (challenge for tribes, USFS, others) • Liability/permits for burning/air quality/NEPA – complex due to jurisdictional issues (AB642, SB332, some say it only applies to fee and trust lands though they don't – these would be a great tool) • Difficult to figure out what to do with in-between trees (too small for commercial, too big for easy manual removal)			
Potential conflicts or unintended consequences with non-target ecosystems/species, human communities, and/or other management goals: • Potential concern for invasives establishment in newly cleared/burned areas as canopy is reopened (Himalayan blackberry, scotch broom, French broom, star thistle)			

SECTION 2. IMPLEMENTATION STEPS

Adaptation Actions	Timeline	Lead & Potential Partners	Implementation Costs	Existing/Needed Resources
Identify priority areas to treat, and develop prescription to implement the treatment (e.g., manual vs. mechanical, what you'll be removing and what will remain, season of burning/presence of endangered species, how treatments impact vulnerability) > Need to consider regulatory requirements and tribal sovereignty > Need to consider invasives that may come in once the canopy is opened up				
Remove understory and piercing conifers via a combination of manual, mastication, mechanical thinning to reduce fuel loads, SOD host species, and overtopping conifers that decrease oak resilience > Prioritize area directly within and around legacy trees, can come back later and expand treatments in surrounding forest matrix > Site-specific considerations around which trees to leave and how multi-stemmed trees are thinned – consider acorn size/mast size in addition to others		*Partners:* The state (has been contributing a lot of funds to climate resilience)		*Needed:* Workforce, the right kind of logging equipment to do the job (feller-bunchers and other specialized equipment that have GIS/remote capability to do work with great sensitivity and little damage in small areas), burning/air quality permits General capacity is a need for the tribe – road access, etc. (no tax base so need grants/funding)

Burn material that was removed (pile burning) > Consider small, snakey piles				
Broadcast burning > Through Prescribed Fire Training Exchanges (TREX) program		*Lead:* Yurok *Partners:* Tribal (multiple tribes – Karuk, Hoopa, also out of state or other parts of the state), state, federal, non-profit (TNC), Cultural Fire Management Council (Yurok-centric non-profit of tribal members, works with TNC to put fire on the ground)	*Initial:* $250-400/acre, depending on factors like crew, topography, condition *Maintenance:* Significantly less	*Existing:* Funding from TNC (likely)
Maintain sites through ongoing cultural burning over time		*Lead:* Yurok	*Initial:* Biggest investment in the first 10 years, after that maintenance becomes easier	
Conduct workforce training				
Outreach to get people connected to the landscape (e.g., families that maintain the groves, people in the community) > Focus on empowering people to interact with the environment and become part of the process				

SECTION 3. MONITORING & EVALUTION

Adaptation Actions	Desired Outcomes/Restoration Targets	Timeframe	Metrics to Measure Outcomes/Targets
Identify priority areas to treat, and develop prescription to implement the treatment (e.g., manual vs. mechanical, what you'll be removing and what will remain, season of burning/presence of endangered species, how treatments impact vulnerability)	A good plan that considers everything important		Plant surveys that include pre and post restoration monitoring of natives and invasives Dune topographic surveys (as part of pre/post plant surveys) to measure geomorphologic changes
Remove understory and piercing conifers via a combination of manual, mastication, mechanical thinning to reduce fuel loads, SOD host species, and overtopping conifers that decrease oak resilience	Reduced surface and ladder fuels Black oak/tanoak dominance with more open canopy and understory and fewer trees Full-crowned black oak and tanoak trees with open-grown form and ideally single trunks Restoration of legacy stand and tree structure Understory includes huckleberry, *ceanothus integerrimus*, serviceberry, elderberry, tanoak mushroom and mycorrhizal fungi Productive black/tanoak orchard Healthy, resilient forest	Near-term for surface and ladder fuels Mid-term for everything else	Fuel load – estimate tons/acre, follow up (or for research) quantify using browns transects and destructive sampling Cover of invasives Visual estimates of stand structure and composition Species assemblage (understory composition) Proportion of good acorns
Burn material that was removed (pile burning)			
Broadcast burning			
Maintain sites through ongoing cultural burning over time			

Conduct workforce training	Increased availability of skilled workforce Increased capacity for implementation		
Outreach to get people connected to the landscape (e.g., families that maintain the groves, people in the community)			

Thresholds that would indicate intervention/additional action is needed (what/when/how to respond):

- Increased presence of invasives – would need to treat, evaluate need for planting
- Surface fuel loading – have to ensure there isn't too much post-thinning slash on the ground
- Have to be aware of who is implementing the project and how it is being done – may need to step in if implementation is not meeting intent and take in-process corrective action (e.g., may need to burn cooler)

SECTION 4. FUNDING & COMMUNICATIONS

Communication/public outreach plan:

- Idea of the ongoing process, not one-and-done – long-term results (over many generations), takes maintenance and commitment
- Importance of fire – the role of fire in these ecosystems (fire as tool!)
- "Healthy environment, healthy people"
- Show people why this is important, even if they aren't spending time in these areas – breaking up fire is important, reduces fire risk across larger areas

Adaptation Implementation Plan for the Indian Creek Watershed of the Mid-Klamath

SECTION 1. BACKGROUND

PROJECT SITE: Indian Creek watershed of the Mid-Klamath			
Value: High	**Current Condition:** Poor	**Future Suitability:** Unknown	**Potential Approach:** Any
Overarching management goal: Riparian restoration to improve watershed health, reduce erosion, and promote species and hydrological connectivity			
Key climate-related vulnerabilities to be addressed: • Climate-driven changes in fire regimes (particularly increased frequency of high-severity fires and extreme fire behavior) • Warmer temperatures and drought that cause water quality changes (e.g., increased temperatures and turbidity), loss of riparian vegetation, and increased fire risk • Extreme precipitation that causes erosion			
Potential barriers to meeting management goal: • Very large, very degraded area • Post-fire emergency actions currently allowed but it is not clear for how long that will last • Inadequate funding for the scale of the project ($28,000 won't cover watershed)			
Potential conflicts or unintended consequences with non-target ecosystems/species, human communities, and/or other management goals: • People have different approaches to fire response (extinguish immediately vs. use managed wildfire for ecological benefit) • Lack of recreation access • Water users downstream may see impacts to water quality • Debate over how to manage fuel load (e.g., salvage logging, burn, maintain)			

SECTION 2. IMPLEMENTATION STEPS

Adaptation Actions	Timeline	Lead & Potential Partners	Implementation Costs	Existing/Needed Resources
Accept changes with business-as-usual management (e.g., fire suppression) in select locations > May be done across entire burned region, or on specific sites that are low-priority sites or hard to access		*Lead:* Gaia/mother nature, USFS, Siskiyou County *Partners:* NGOs, private landowners, local community, USFS, water resource control board, USFWS/CalWild	*Initial:* No additional cost because this does not involve implementing a new action, but they may be costs associated with "downstream" impacts (e.g., water quality, recreation, cultural resources and subsistence harvest)	*Existing:* We have everything we need to do this *Needed:*
Prevent the introduction of invasive species and remove controllable invasives from high-risk locations (e.g., edges) and important locations > Could include equipment washing to ensure non-transfer of biological materials between sites, physical removal (ideally non-chemical)		*Lead:* Klamath Alliance for Regional Invasive Species Management *Partners:* USFS, County, NGOs, private land owners	*Initial:* $ for prioritization and prevention actions, survey/monitoring, removal *Maintenance:* $$$ (annual cost is low but would need to monitor with regular surveys and likely removal on a regular basis, so costs add up over time)	*Existing:* Baseline surveys (incomplete), geodatabase info, Burned Area Emergency Rehabilitation (BAER) funding, expertise and knowledge on how to undertake the work, general support for the need for this type of action *Needed:* Staff time, additional funding, policy change (to make BAER funding available for more than 1 year), community training (ID of prioritized species to crowdsource surveys)

Support of vegetation type conversion from conifer-dominated forest to shrubby oak woodland that was present prior to fire exclusion/suppression (with or without fuel load reduction)		*Lead:* USFS *Partners:* USDA Climate Hub, tribes, TNC, Western Klamath Restoration Partnership	*Initial:* Low ($) for planting, enclosures, plan development, fire management (individual tree protection) *Maintenance:* Follow up with manual/chainsaw treatment, burning within 5-7 years, (less expensive than active management, more expensive than acceptance with no management)	*Existing:* USDA Climate Hub guidance on vegetation type conversion, general support (from tribes, some sectors), existing agreements for burning on the Klamath (e.g., TNC, interagency agreements) *Needed:* Broad social acceptance/public buy-in
Alter fire management regime to prioritize the restoration of pre-settlement fire regimes > Take current composition and future climate conditions into account, as well as cultural burning		*Lead:* USFS, Tribes, CalFire *Partners:* County, private landowners, research (OSU, USFS PNW/SW Research Stations)	*Initial:* $$$ for modeling/fire plan development, fire management techniques *Maintenance:* Reduced ongoing costs for managed wildfire compared to the status quo (reduced costs of non-suppression during the shoulder season, though there may be some cost associated with need to protect sensitive areas) Higher ongoing costs for intentional fire (e.g., prescribed fire, cultural burning) due to need for NEPA documents/resources	*Needed:* Broad social acceptance/public buy-in, evaluation of burn control features, fireline geodatabase, manager agreement

Reintroduction of native riparian and aquatic species	This action may be later than the start of the others – will likely require some habitat stabilization before it would be deemed effective	*Lead:* USFS *Partners:* NGOs, private landowners, county, tribes, USFS, USFWS/CalWild, TNC	*Initial:* $$$ for fish (ID species source, pathology and genetic checks, transportation, NEPA); $ for planting/seeding riparian species, $$ for riparian site selection/project planning, staff time, transport, purchase, and possible NEPA *Maintenance:* $ (would not water planted areas at this scale of implementation), but monitoring and repeated measures may increase expenses	*Existing:* Forbs and grasses available, existing experience and infrastructure for moving both fish and plants *Needed:* Shortage of disease -esistant conifer species (most genetic stock burned in recent fire); source for fish

SECTION 3. MONITORING & EVALUTION

Adaptation Actions	Desired Outcomes/Restoration Targets	Timeframe	Metrics to Measure Outcomes/Targets
Support of vegetation type conversion from conifer-dominant forest to shrubby oak woodland, with or without fuel load reduction (return to what was there prior to fire suppression)	Riparian shading to maintain water temperatures and limit sedimentation Soil stabilization Healthy food webs and ecosystems Vegetation conversion to a system that can better withstand future climate change impacts (fire, drought, extreme precip events) Cost effective/less time-intensive management regimes	Mid-term (soil stabilization, some shading) Long-term (all other outcomes)	Canopy cover and composition Sediment load in freshwater system Stream bank condition Presence/absence of species (e.g., benthic inverts, fish, birds, aquatic veg, microbes, amphibians) Post-fire condition following the next event Water quality (temperature, turbidity)

Thresholds that would indicate intervention/additional action is needed (what/when/how to respond):

- Mass wasting – would need to use soil stabilization interventions
- Critical species failure – remove invasive species or increase active management of the target species (reintroduction)
- High water temperatures – actively plant in targeted locations to increase shading, re-evaluate the suitability of the system for target goals, use prescribed fire as “Klamath shade cloth” (a.k.a., smokey skies)
- Fuel loading exceeds acceptable threshold for low- to moderate-intensity fires –active fuel removal

SECTION 4. FUNDING & COMMUNICATIONS

Funding mechanisms/options:

- Collaborative Forest Landscape Restoration (USFS funding)
- BAER funding
- Resource Advisory Council (RAC) funding

Communication/public outreach plan:

- Increase community understanding of forests that are suitable for the future (and the past changes that have already transpired) by hosting community conversations through Facebook Live events (invite community, ask tribal and academic leaders to lead discussions), social media postings (Facebook is a popular tool in this community), pitching stories to local newspaper
- NEPA analysis with public comment period
- Host a symposium introducing new post-fire restoration framework to evaluate where on the landscape future conditions will do what
- Promote a common understanding/vision among internal management agencies
- Host community work days, volunteer science (e.g., invasive species spotting apps), project field trips for projects to increase engagement
- Collaborate with schools (including planting in relation to terrestrial or aquatic studies)

Literature Cited

Glick P, Stein BA, Edelson NA. 2011. Scanning the conservation horizon: A guide to climate change vulnerability assessment. National Wildlife Federation, Washington, D.C.

Gregg RM. 2021. Hakalau Region Climate-Informed Restoration Technical Resource Document. EcoAdapt, Bainbridge Island, WA.

Gregg RM, Kershner J. 2019. Extremes to ex-streams: ecological drought adaptation in a changing climate. EcoAdapt, Bainbridge Island, WA.

Kershner JM, Woodward A, Torregrosa A. 2020. Integrating climate change considerations into natural resource planning—An implementation guide. U.S. Geological Survey Techniques and Methods, Book 6, Chap. C2. U.S. Geological Survey, Reston, VA. Available from https://doi.org/10.3133/tm6C2.

Schuurman GW et al. 2021. Navigating ecological transformation: Resist–Accept–Direct as a path to a new resource management paradigm. BioScience:biab067.

Appendix A. Workshop Participants, Affiliations, and Breakout Group Assignments

Redding Workshop (November 15–16, 2021)

Participant Name	Affiliation	Breakout Group
Betsy Stapleton	Scott River Watershed Council	Freshwater
Brad Rust	U.S. Forest Service	Freshwater
Brooke Thompson	Bureau of Land Management	Forest/Woodland
Chad Roberts	FireScape, Tuleyome, other NGOs	Grassland/Shrubland
Christal Johnson	U.S. Forest Service	Forest/Woodland
Christine Mai	U.S. Forest Service	Grassland/Shrubland
Emilie Blevins	Xerces Society for Invertebrate Conservation	Freshwater
Gregory Wolfin	Pit River Tribe	Grassland/Shrubland
Japhia Huhndorf	U.S. Forest Service	Grassland/Shrubland
Karen Pope	U.S. Forest Service	Freshwater
Lara Buluc	U.S. Forest Service	Forest/Woodland
Laura Brodhead	Bureau of Land Management	Forest/Woodland

Eureka/Arcata Workshop (November 17–18, 2021)

Participant Name	Affiliation	Breakout Group
Andrea Pickart	U.S. Fish & Wildlife Service	Coastal
Arnaldo Ferreira	U.S. Forest Service	Forest/Woodland
Carol Spinos	U.S. Forest Service	Forest/Woodland
Frank Lake	U.S. Forest Service	Forest/Woodland
Gabrielle Bohlman	U.S. Forest Service	Forest/Woodland
Gregory Schrott	U.S. Fish & Wildlife Service	Freshwater
Jeremy Marshall	U.S. Forest Service	Forest/Woodland
Jesse Irwin	Bureau of Land Management	Coastal
Joseph Hostler	Yurok Tribe	Forest/Woodland
Justin Windsor	Bureau of Land Management	Coastal
Laurel Goldsmith	U.S. Fish & Wildlife Service	Coastal

Participant Name	Affiliation	Breakout Group
Lisa Hoover	U.S. Forest Service	Forest/Woodland
Logan Graham	U.S. Forest Service	Freshwater
Luna Latimer	Mid-Klamath Watershed Council	Freshwater
Marissa Vossmer	Bureau of Land Management	Forest/Woodland
Russell Namitz	Bureau of Land Management	Coastal
Sarah Sawyer	U.S. Forest Service	Forest/Woodland
Sharyl Kinnear-Ferris	Bureau of Land Management	Coastal
Tracy Katelman	ForEverGreen Forestry	Forest/Woodland

Appendix B. Adaptation Implementation Plan Guidelines

Evaluation of Priority Sites

Considering the value (e.g., ecological, cultural, socioeconomic), current ecological condition, and likely future suitability of sites for management and restoration can inform the selection of sites and corresponding adaptation approaches that balance current priorities with realistic future expectations for management and use of limited resources.

- **Site**: Potential sites considered for adaptation implementation planning activity
- **Value, Current Condition,** and **Future Suitability**: Based on rankings and guiding questions presented in Table 2.
- **Critical Needs**: Brief summary of critical needs or management goals of the proposed site (e.g., invasives removal, post-fire restoration)
- **Advantages** and **Challenges**: Primary advantages and/or challenges for climate-informed management activities at that site. For instance, an advantage might include high native plant cover on the site or availability of high-resolution mapping or existing monitoring programs. Challenges could include things like regulatory restrictions on management activities or limited access to the site.

Adaptation Implementation Plan

SECTION 1. BACKGROUND

- **Selected Project Site**
- **Value, Current Condition,** and **Future Suitability**: Rankings carried over from Evaluation of Priority Sites activity
- **Potential Approach**: Based on the matrix in Table 5, which is designed to help clarify management goals and select an adaptation approach for the group to consider when mapping out specific adaptation actions
- **Overarching Management Goal**: E.g., increase habitat connectivity, manage fuels to reduce wildfire risk, manage invasives and increase native plant cover
- **Key Climate-related Vulnerabilities**: Vulnerabilities to be addressed by this project, which may include climate stressors, climate-driven changes in disturbance regimes, interactions between climate changes and non-climate stressors, and adaptive capacity factors that will enhance the ability of the resource to cope with or respond to climate change (e.g., genetic diversity, support for climate-informed management)
- **Potential Barriers to Meeting Management Goal** and **Potential Conflicts or Unintended Consequences**: Potential barriers to meeting the management goal and/or conflicts with other species, habitats, ecosystem services, or human communities that may arise as part of the project

SECTION 2. IMPLEMENTATION STEPS

- **Adaptation Actions**: Outline of 3–5 adaptation action steps (i.e., specific, concrete tasks) that would be implemented as part of this project

- **Timeline**: The ideal timeline when initial implementation of this action would occur and/or notes on time-dependent factors (e.g., invasives removal must occur prior to adaptation actions focused on planting)
- **Lead & Potential Partners**: Lead department, agency, or organization and potential partners for each adaptation action
- **Implementation Costs**: The cost of implementing each action step, including initial investment and ongoing maintenance (consider whether climate change may increase the initial cost or require more frequent maintenance)
- **Existing/Needed Resources**: Other resources that would be required for implementation, including things like staff capacity, permits and approvals, and data or technical capacity

SECTION 3. MONITORING & EVALUATION

- **Desired Outcomes/Restoration Targets**: Specific desired outcomes and/or restoration targets for this project. If you were successful in your effort, what would that look like? For example, increased native seed source, flow regime is restored to the habitat within 10 years, multiple partners and stakeholders are engaged in the effort, and costs associated with flooding are reduced.
- **Timeframe**: Target timeframe for achievement of the desired outcomes, including near-term (1–5 years), mid-term (5–20 years), and long-term 20–50+ years.
- **Metrics to Measure Outcomes/Targets**: Identification of specific metrics for each outcome that could be used to monitor change and progress toward the desired outcome(s). Notes may include tools/methods of measurement, data sources to reference, or other specifics.
- **Thresholds Indicating Intervention/Additional Action is Needed**: Management thresholds can be thought of as the point where change is heading towards undesirable outcomes and intervention may be needed to ensure that the project gets back on track or does not result in further harm. What is the threshold and necessary next steps/time frame for intervention? What are potential adaptive responses? These may include placing the project on hold until further studies/monitoring can be conducting, modifying the management actions already occurring, or implementing new actions.

SECTION 4. FUNDING & COMMUNICATIONS

- **Funding Mechanisms/Options**: Potential funding sources or mechanisms, which may include government support, foundation grants, private funding sources, and in-kind or volunteer support. Consider whether there are existing funding structures that this project could take advantage of.
- **Communication/Public Outreach Plan**: Potential strategies for communications and public outreach about this project. What is the most interesting story or important message? Who is the primary audience that needs to hear it? Consider whether there are existing communications strategies or campaigns that this project could take advantage of.