KARUK

Agroecosystem Resilience and Cultural Foods and Fibers Revitalization Initiative: *xúus nu'éethti* — we are caring for it

Karuk Tribe - UC Berkeley Collaborative

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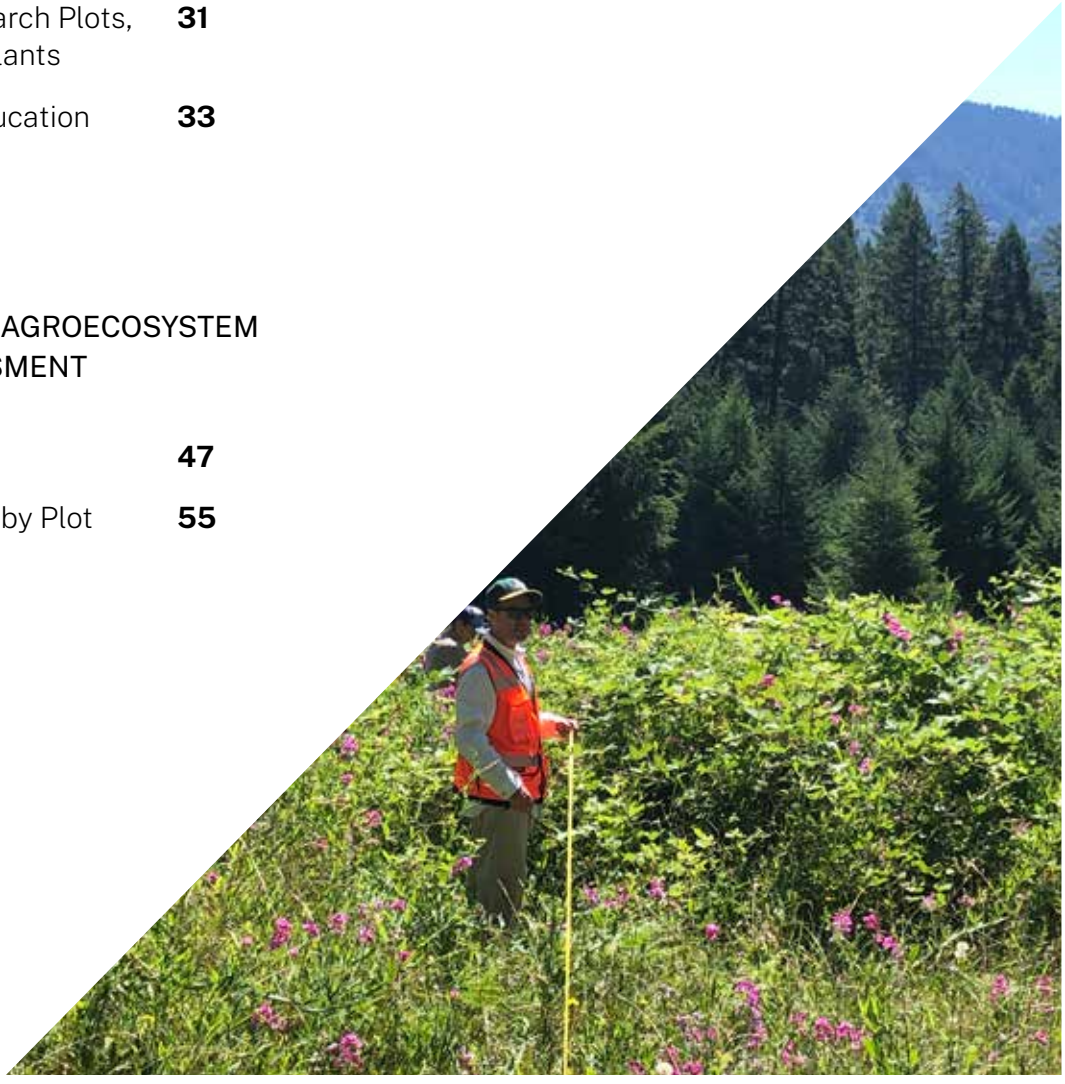
2023

CONTENTS



ABOUT THIS REPORT

This report shares the results from a three-year research and extension project jointly led by the Karuk Tribe Department of Natural Resources (KDNR) and UC Berkeley researchers under the auspices of the Karuk Tribe-UC Berkeley Collaborative (KBC). The project aimed to (a) increase collective understanding of the condition and quality of culturally significant food and fiber species and the habitats in which they grow, in Karuk Aboriginal Territory (Figure 1.1) and (b) provide recommendations for monitoring and management to enhance resilience of these cultural agroecosystems under changing climate conditions. Over the course of three years, the project team codesigned and implemented field-based research integrating Indigenous and western science, cocreated innovative decision support and monitoring tools and technologies to support the long-term monitoring and management of these areas, and developed and implemented K–12 STEM curriculum and youth programming centered on climate change and biodiversity.

Core team members responsible for leading and coordinating the research, education and extension elements of the project include (listed alphabetically): Shawn Bourque, Marit Doshi, Sean Hogan, Frank Lake, Andy Lyons, Kathy McCovey, Leaf Hillman, Lisa Morehead-Hillman, Megan Mucioki, Vikki Preston, Daniel Sarna-Wojcicki, Jennifer Sowerwine, Frankie Tripp, and Christopher Weinstein.

We acknowledge the following individuals and organizations who contributed their knowledge and expertise in different phases of the project through advising, participating in research and/or field work, leading extension modules or class instruction, and/or contributing to the report (listed alphabetically): Phil Albers, Thomas Carlson, Melissa Eitzel Solera, Edith Friedman, Annelia Hillman, Chook-Chook Hillman, Alexander Keith (Designer, Creative Lab), Royale Pinassi, Wiyaka Previte, Colleen Rossier, Heather Rickard, Ben Saxon, Isabella Schreiber (Creative Lab), Toz Soto, Bari Talley, Analisa Tripp, Emilio Tripp, Bill Tripp, Sylvia Van Royen, Olivia Rose Williams, and Cleo Wölfle-Hazard; UC Berkeley interns Martin Banuelos, Aliya Haas Blinman, Elizabeth Carlton, Reid Harwood, Bryce Hutchins, Lena Kondrashova and Cori Nelson; members of the Karuk community and residents of Karuk Aboriginal Territory; and staff of UC Agriculture and Natural Resources Informatics and GIS (IGIS), Western Klamath Restoration Partnership (WKRP) and of the University & Jepson Herbarium of the University of California at Berkeley.

We want to call special attention to the following cultural practitioners whose Indigenous scientific knowledge, expertise, guidance and wisdom were invaluable to the project, including core team members Frank Lake, Kathy McCovey, Leaf Hillman, Lisa Morehead-Hillman, Vikki Preston, and Frankie Tripp, as well as Phil Albers, Poppy George, Adrian Gilkison, Annelia Hillman, Chook-Chook Hillman, Verna Reese, Ben Saxton, Analisa Tripp, Bill Tripp, and Emilio Tripp.

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For more information about the Karuk Tribe-UC Berkeley Collaborative, please visit the following website: https://nature.berkeley.edu/karuk-collaborative/

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Please consider donating to the Karuk Endowment for Eco-cultural Revitalization to support sustained stewardship and revitalization of Karuk lands, ecosystems and cultural food systems by the Karuk people.

EXECUTIVE SUMMARY

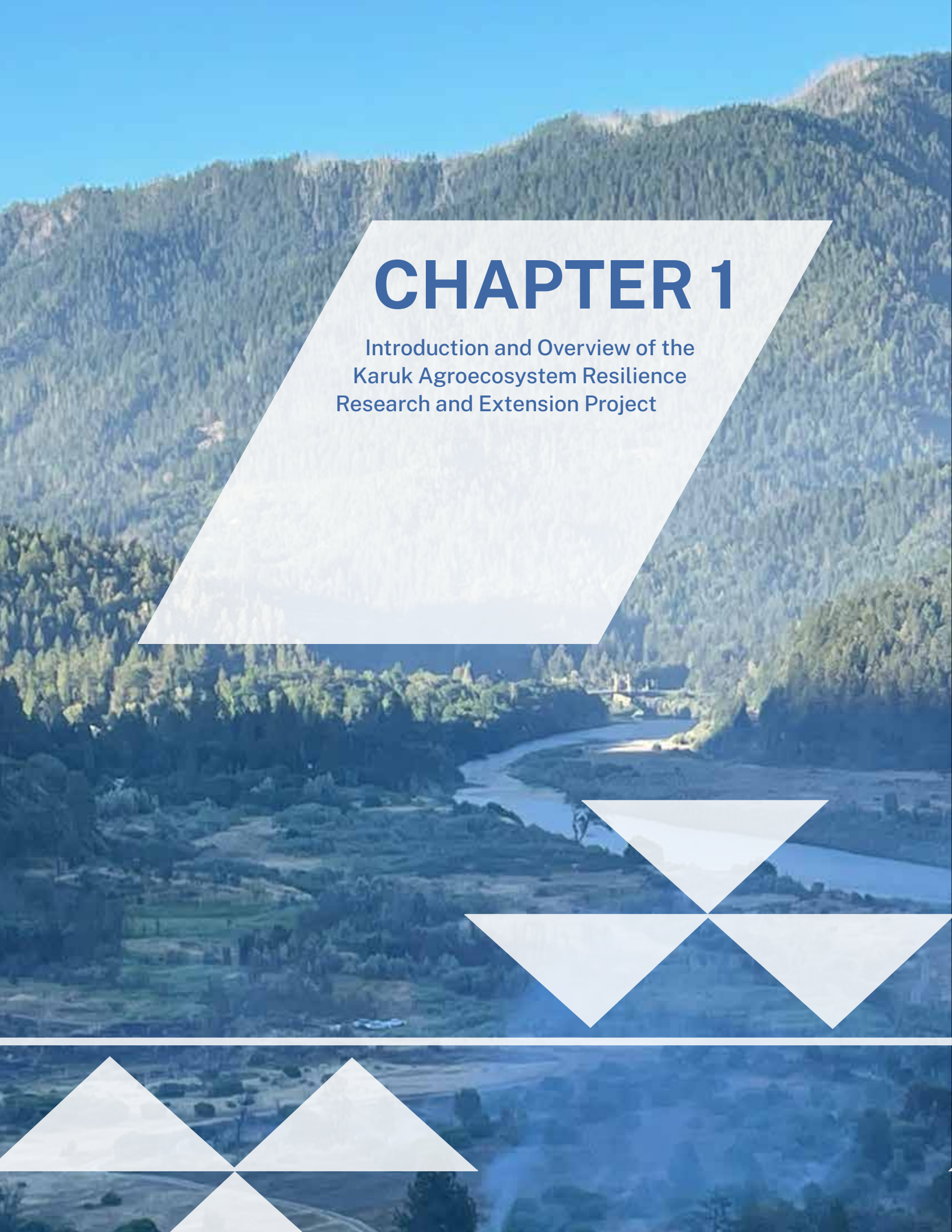
To support the Karuk Tribe in achieving their climate adaptation and ecocultural revitalization goals, the Karuk Tribe-UC Berkeley Collaborative launched the USDA-AFRI funded "Karuk Agroecosystem Resilience and Cultural Foods and Fibers Revitalization Initiative: xúus nu'éethti –we are caring for it" from 2018-2022. This report provides an overview of our collaborative research and extension project, including our approach, methods, a summary of general findings, and management and monitoring recommendations. In partnership with the Karuk Department of Natural Resources, this project integrated Indigenous and Western science perspectives to assess climate change impacts on cultural use species and associated habitats, and developed strategies and tools for long term monitoring. We provide an overview of the methods and results from our main research objective, the "Agroecosystem Condition Assessment (ACA)", in which we assessed the baseline habitat conditions of eight 60x60m plots within culturally significant areas, 27 smaller focal patches that contain culturally significant focal species, and 20 focal plants, prioritized by KDNR staff, distributed throughout our plots and patches. Based on research findings informed by the deep insights of Karuk elders and cultural practitioners, we make recommendations for restoring key habitats and revitalizing culturally significant species to enhance agroecological resilience in Karuk Aboriginal lands. Our sincere hope is that this report serves as an example of how university and federal agency researchers can partner with California Tribes to lift up Indigenous knowledge, which can help us better understand and develop solutions to the climate crisis and its effects on California's landscapes and biodiversity, especially on species of cultural significance to Indigenous communities.

The report is organized in four chapters: 1. Introduction/project overview, 2. Plot data, 3. Focal plant data, and 4. Management and monitoring recommendations from Karuk cultural practitioners and Tribal managers. While detailed assessment is given for each of the eight plots, generally plots in Karuk gathering areas ranged from more open, meadowlike areas (*Táasich and Tishánik*) to closed forest (*Ikxariyátuuyship*, Upper Sims, and Patterson). Douglas fir (*Pseudotsuga menziesii, ithárip*) and Ponderosa pine (*Pinus ponderosa, ishvírip*) predominantly accounted for the upper canopy in all plots, with a more diverse range of hardwoods accounting for the understory, as well as a diverse array of shrub and herbaceous plants below. The overall quality and condition of the majority of the focal species found in our plots and patches suggested a need for active cultural management to increase the consistency and quality of harvests. During the 2019 and 2020 harvest seasons, 18 out of 31 (58%) focal plant areas had failed harvests or no reproduction at all. Many others had very limited

harvest or highly variable harvest across the two years. The data collected suggest an urgent need for intervention management to enhance cultural use quality, as well as close monitoring of species experiencing climate stress. Based on guidance from KDNR staff, Karuk cultural practitioners and Tribal community members, we provide specific management and monitoring actions that will enhance the resilience of cultural focal species and habitats in ACA plots, patches, and riparian areas to climate change, climate variability and management threats. We also recommend broader management, policy, research and institutional actions to support the resilience of Karuk cultural agroecosystems and cultural food and fiber species to climate change-related threats and stressors across Karuk Aboriginal Territory, aimed at strengthening Indigenous food sovereignty now and into the future. A summary of key recommendations include:

- Support Karuk Tribal natural resource, data and knowledge sovereignty through appropriate engagement and Tribal oversight.
- Invest in Tribal management infrastructure and workforce development to support culturally appropriate, place-based job opportunities for Tribal members and descendants.
- Support co-management and family-based stewardship of cultural use plants and habitats on Karuk Aboriginal lands currently administered and occupied by private landowners and the US Forest Service.
- Invest in and support the re-acquisition of Karuk Aboriginal lands to build back the Tribal land base and restore habitats and ecosystems.
- Fund research, monitoring, and educational opportunities that can support youth leadership development, job creation, agroecosystem resilience, and food sovereignty in Karuk Aboriginal Territory.

For more detailed recommendations, please refer to Chapter 4.



CHAPTER 1

Introduction and Overview of the Karuk Agroecosystem Resilience Research and Extension Project

1.1 INTRODUCTION

The Klamath River Basin historically supported diverse and abundant cultural agroecosystems stewarded by Indigenous communities through elaborate land management and ceremonial practices. The cumulative impacts of colonization over the past century have resulted in widespread degradation of terrestrial and aquatic habitats and a decline in the quality, accessibility and availability of cultural use plants, which include Native food, fiber and medicinal plant species that are vital to the health and well-being of Karuk people.

BOX 1.1 Definitions of cultural use plants, species and resources

The term "cultural use plants" is used throughout this report synonymously with Native food, fiber and medicinal plant species. The broad definition of 'cultural use species' includes wildlife and fungi harvested for their food, regalia material and spiritual value. The term "cultural resources" extends to water, fire, air, land and Spirit or First People.

Increased climate variability poses further threats to the unique biocultural diversity and agroecosystem resilience within Karuk Aboriginal Territory, which is located in the Klamath River Basin, in what is now the western United States, in southwestern Oregon and northwestern California. In the face of these intersecting threats and challenges, the Karuk Tribe Department of Natural Resources (KDNR) is working to support Karuk people in reinstating cultural land management practices that revitalize Indigenous cultural agroecosystems across the landscape of their Aboriginal Territory (Figure 1.1)

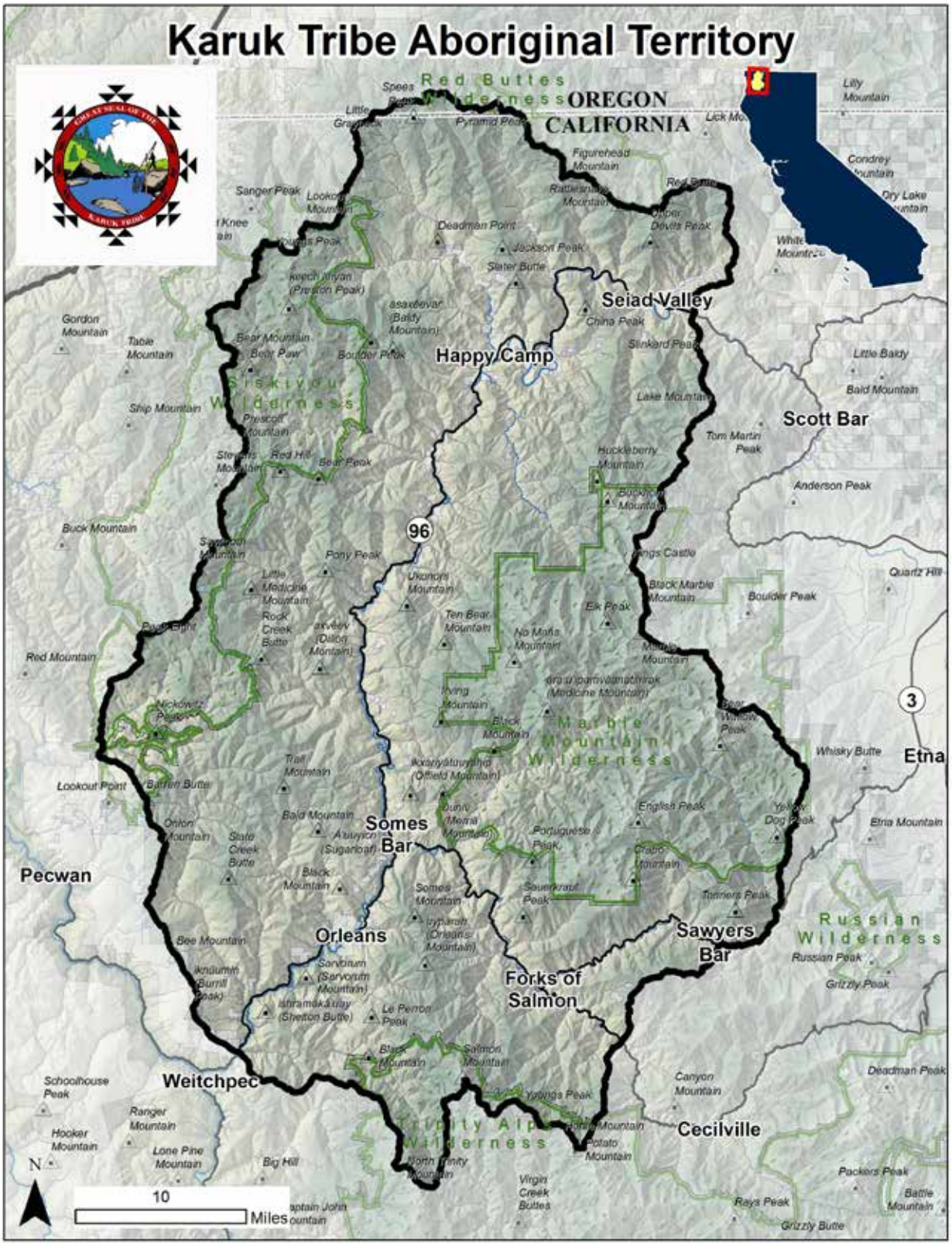


FIGURE 1.1: Karuk Aboriginal Territory in the Klamath River Basin of Northern California.

Map Source: Jill Beckman in *Sarna-Wojcicki, Daniel, Jennifer Sowerwine, Lisa Hillman, Leaf Hillman, and Bill Tripp. "Decentring watersheds and decolonising watershed governance: Towards an ecocultural politics of scale in the Klamath Basin." Water Alternatives 12, no. 1 (2019): 241–266."*

To support the Tribe in achieving their climate adaptation and eco-cultural revitalization goals, the Karuk Tribe-UC Berkeley Collaborative launched the USDA-AFRI funded[1] "Karuk Agroecosystem Resilience and Cultural Foods and Fibers Revitalization Initiative: *xúus nu'éethti –we are caring for it*" from 2018–2022. The long term goal of this four-year research and extension project is to promote and enhance the resilience of cultural agroecosystems within Karuk Aboriginal Territory under variable land management and climatic conditions. In partnership with KDNR, this project integrated Indigenous and Western science perspectives to assess climate change impacts on cultural use species and associated habitats, and developed strategies and tools for long term monitoring. Based on research findings informed by the deep insights of Karuk elders and cultural practitioners, we make recommendations for restoring key habitats and revitalizing culturally significant species to enhance agroecological resilience in Karuk Aboriginal lands.

Project Team preparing to establish ACA plots and conduct baseline assessments, April 2019.
Photo credit: Jennifer Sowerwine.

1 USDA-NIFA-AFRI project #2018-68002-27916. This project was funded by the USDA-NIFA-AFRI Resilient Agroecosystems in a Changing Climate Challenge Area grant program. Our research followed both UC Berkeley's IRB protocol for the protection of human research subjects, as well as the Karuk Tribe's Practicing Pikyav research protocol. In alignment with the Tribe's principle of knowledge sovereignty, all original data sets, photographs, audio and video recordings are held in the Karuk Tribe's secure repository.

This report provides an overview of our collaborative and participatory research approach and methods, a summary of general findings, and recommendations for long term management and monitoring for cultural agroecosystem resilience in Karuk Aboriginal Territory. Our sincere hope is that this report serves as an example of how university and federal agency researchers can partner with California Tribes to lift up Indigenous knowledge, which can help us better understand and develop solutions to the climate crisis and its effects on California's landscapes and biodiversity, especially on species of cultural significance to Indigenous communities. This report presents a synthesis and summary of a more detailed confidential internal report submitted to KDNR and Karuk community partners. In this public report, we have worked with KDNR oversight bodies and data stewards to redact all culturally sensitive and spatially-explicit information and data in order to uphold Karuk research and data sovereignty protocols.

We provide an overview of the methods and results from our main research objective, the "Agroecosystem Condition Assessment (ACA)" in which we assessed the baseline habitat conditions of eight 60x60m plots[2] within culturally significant areas, 27 smaller focal patches that contain culturally significant focal species, and 20 focal plants, prioritized by KDNR staff, distributed throughout our plots and patches. The goal of the ACA was to describe the historical and contemporary patterns of agroecological diversity, including the distribution, abundance and quality of cultural use plants, and the impacts of changing land management practices and climatic variation over time on cultural resources. More broadly, the assessment identified the social and ecological factors that contributed to the resilience of Karuk agroecosystems over time.

This report also synthesizes the results of other primary research objectives related to better understanding the distribution of key focal species across Karuk aboriginal territory using historical voucher specimens, as well as habitat change over time using long term land use-land cover and ecological change detection models. We summarize other monitoring, extension and education activities conducted under this initiative to illustrate how linked research and extension programs can help build long term adaptive capacity and resilience in the community. Ultimately, this report aims to provide a holistic understanding of historic and contemporary cultural land use, settler-colonial land management impacts on cultural use species, contemporary climate change threats, and management strategies for promoting the resilience of 20+ cultural use plant species within cultural use areas. Next steps are already underway as the Karuk Tribe secured funding in 2021 to establish additional plots and focal patches for long term monitoring. We envision repeating surveys in 5 to 10-year intervals to monitor changes in habitat condition and cultural plant vitality in response to management for improvement and changing climate conditions.

2 Táasich, Kámmaahriv, Tishánik, Lower Sims, Upper Sims, Ikxariyátuuyship, Owl Mine, and Patterson.

The report is organized into four chapters:

Chapter One: Overview

Chapter one presents an overview of the research goals, context, rationale and methods of the project as well as a summary of the study plots and focal plants identified by the Karuk Tribe as priority for long term cultural stewardship and monitoring. We also include a summary of extension and education activities as part of the *xúus nu'éethti* project, supporting the KDNR and Tribal youth in their efforts to effect long-term monitoring for resilience.

Chapter Two: Plot Data

Chapter two presents results from our baseline habitat assessment and seasonal assessments of our eight study plots. Detailed information about each plot includes 1) general plot description including terrain, list of focal plants, habitat types, and geology/soils; 2) land use history compiled from archival documents and oral history interviews; 3) land cover change summaries; 4) vegetation description (from baseline, seasonal and harvest surveys) including percent cover of trees, shrubs and herbs, and focal plant harvest, quality and productivity; 5) animal activity; 6) wetland-riparian survey data; and 7) images of plots and focal plants.

Chapter Three: Focal Plant Data

Chapter three presents our observations and assessment of 20 cultural use plant species, prioritized by KDNR for long-term monitoring, in our plots and patches. For each species, we summarize biological requirements, vulnerabilities and resilience, observations of phenology, climate stress, disease and threat from invasive species, as well as harvest data from cultural practitioners. Data also includes a summary of findings from analysis of historical voucher specimens of cultural use plant species collected within Karuk Aboriginal Territory, aggregated from herbaria in the California Consortium of Herbaria.

Chapter Four: Management and Monitoring

Chapter four presents recommendations for our eight study plots and focal plants. Recommendations for management and monitoring activities are based on information gathered from related scientific articles as well as through interviews with cultural practitioners at our ACA research plots, patches and in other settings such as workshops, one-on-one interviews and focus groups.

1.2 RESEARCH QUESTIONS

Our project includes both short term and long term research questions (see Box 1.2). In the short term, we investigated the historical and contemporary patterns of agroecological diversity, including the distribution and abundance of cultural use plants, and the impacts of changing land management practices and climatic variation on these foods and fibers. We explored the social and ecological factors that contribute to the resilience of Karuk agroecosystems, component cultural use species, and associated habitats in view of these changes. In the long term, our goal is for the plots and patches we established to serve as long term monitoring sites and living classrooms where KDNR and the Karuk community can have continued access to gather and measure changes in habitat and focal plant quality and condition resulting from Tribal land management and climate change over time. We hope this data will support land management decisions that will improve the viability, productivity and resilience of these cultural use plants and habitats, thereby enhancing food sovereignty. We also make general recommendations, based on research and extension activities, to support ongoing intergenerational learning, knowledge exchange and demonstration of Karuk cultural agroecosystem resilience and ecosystem stewardship in Karuk Aboriginal Territory.

BOX 1.2 Overarching research questions

Short Term

- What is the current condition, accessibility and quality of culturally significant habitats and focal plants within Karuk Aboriginal Territory?
- What are the historical and contemporary stressors affecting the health and vitality of culturally significant habitats and focal plants (land uses, climatic and environmental — e.g. diseases & pests)?
- How might these areas be managed to enhance productivity and quality of cultural and biological systems under changing climate conditions?
- What ecosystem or species indicators of health should we be monitoring for over time?

Long Term

- In response to climate change and non-Tribal land management regimes, how are culturally significant habitats and plants changing over time (in terms of quality, accessibility, use, availability (number), abundance (yield), stressors, and phenology)?

During the 2019-2020 study period, our research focused on the short term questions outlined in Box 1.3, which included conducting baseline habitat and focal species assessments.

BOX 1.3 Specific short term research questions

Vegetation diversity, composition and structure

- What is the species richness of cultural use plants?
- What is the plant community structure of wetland areas?
- What is the population size of cultural use plants in each plot?

Availability/density and quality of cultural use plants What is the quality of cultural use foods and fibers?

- What is the quality of cultural use plants?
- What is the availability of cultural use plants?

Foraging efficiency

- How long does it take to physically access these sites?
- How abundant are the cultural use plants at these sites in terms of both quantity and quality of the populations?
- How long does it take to harvest the desired amount of cultural use plants?

Climate and environmental stressors

- Are cultural food, fiber and medicinal plants showing signs of climate or environmental stress (heat and water stress, stress from shade or overcrowding, flooding, severe fire or lack thereof, etc.)? If yes, what are the observable indicators?

Pathogens, disease, and invasive plants

- What disease/pest/pathogens and invasive plants are present?

Historical voucher specimens

- Is there a presence/absence of historical voucher specimens and/or do new specimens need to be collected to add to the existing herbaria?

- What collection of new specimens was made?

Habitat quality

- Is there any evidence of habitat use by culturally significant animals, (e.g. are there cavities in Black Oak used by Pacific fishers (*tatkunuhpíithvar, Martes pennanti*)?

- Is the habitat suitable for relevant cultural use focal species?

Wetlands and riparian areas

- What are the current ecological and hydrologic conditions of the wetlands, riparian areas and bodies of water associated with these sites?

- What is the abundance and quality of focal species and cultural use species in wetlands and riparian areas associated with ACA plots and patches?

We anticipate monitoring these eight plots over the long term in seasonal, annual and 5-and 10-year increments, to track changes in vegetation diversity, foraging efficiency and use. In addition, we will track the quality and abundance of cultural foods and fibers, climate and environmental stressors such as diseases and invasive pathogens, and changes in wetland quality and function, under changing climate conditions and land management treatments (see Box 1.4).

BOX 1.4 Specific long term research questions

Vegetation diversity, composition and structure

- Is the species richness of cultural use plants changing over time?
- Are the population sizes of cultural use plants changing over time in response to short, medium, and long-term climate variability, and treatments/Tribal management?
- How is the overall composition and structure of vegetation changing over time?

Foraging efficiency

- How has access to site, density/quality, and time to harvest changed in response to Tribal management?

Quality and quantity of cultural foods

- How is the quality and availability/density of cultural foods and fibers changing over time in response to short, medium, and long-term climate variability, treatments/Tribal management)?

Climate and environmental stressors

- Are climate and environmental stressors in cultural use plants increasing/decreasing/the same over time?
- Are there phenological changes? (I.e. Are plants flowering and fruiting earlier? Are seasonal harvesting times consistently changing?)

Pathogens, disease, and invasive plants

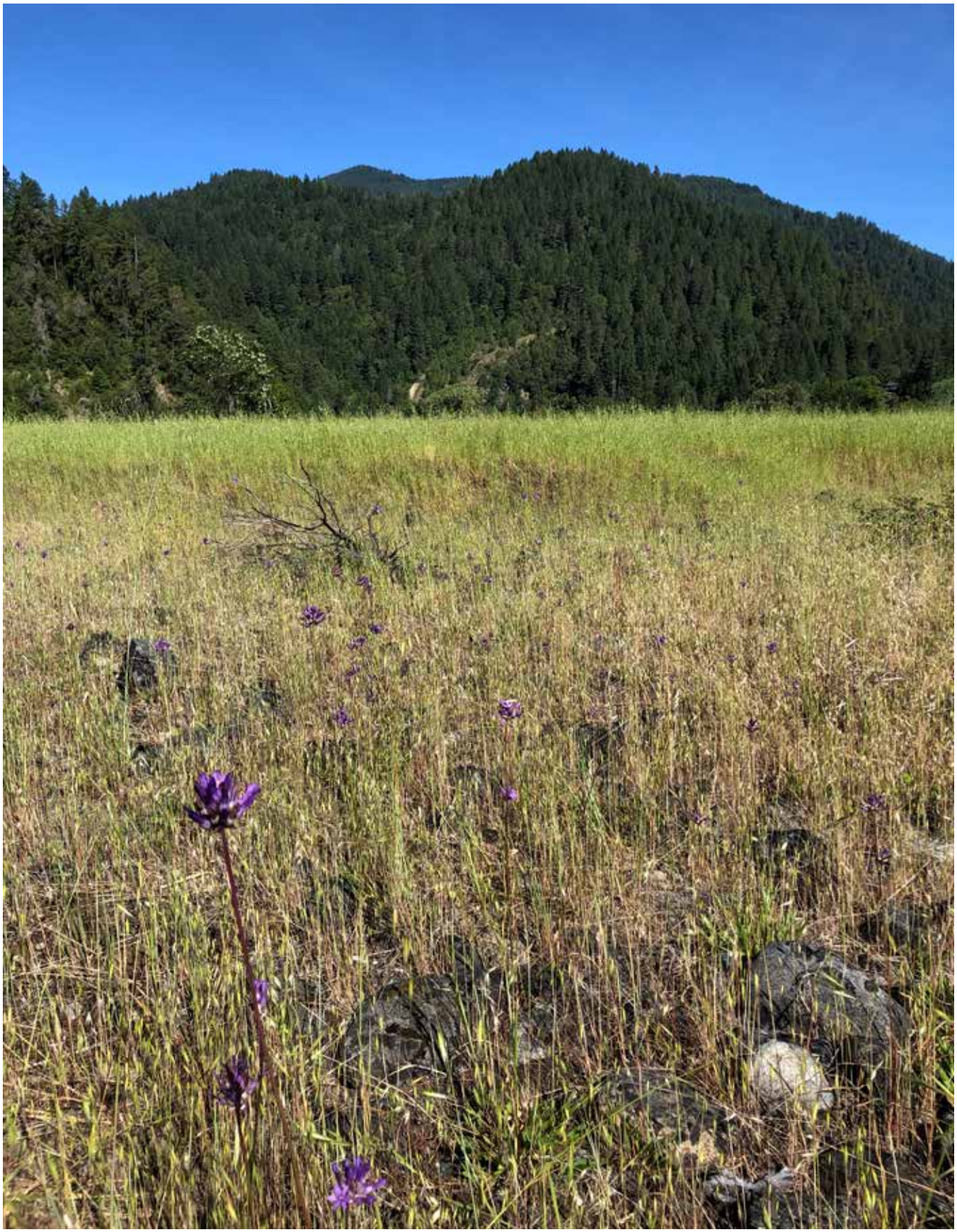
- How is the presence/absence of invasive plant species changing over time? How is their population size changing?
- How is the presence/absence of disease/pests/pathogens and vectors changing?

Habitat use

- How are indicators of habitat condition and use changing over time (seasonal, year-to-year, longer term variability, long term changes in frequencies, timing and location of uses)?

Wetlands and riparian areas

- How are indicators of the condition of wetlands, riparian areas and the habitats and cultural uses they support changing over time in response to short, medium and long-term climate variability?
- How do long term changes in the timing and amount of precipitation, streamflow and flood regimes, and snowfall amounts/timing of snowmelt impact the quantity and quality of cultural use species in wetlands and riparian areas?
- How do anthropogenic impacts (e.g. mining, logging, fire exclusion and road building) and restoration activities (e.g. off-channel/floodplain habitat rehabilitation, dam removal, road decommissioning) impact the quantity and quality of cultural use species in wetlands and riparian areas?



Blue dicks (*táyiith*, Dichelostemma capitatum ssp. capitatum) grow on a floodplain terrace above the Klamath River at *Tishánik*. Photo credit: Jennifer Sowerwine.

1.3 RATIONALE

Karuk agroecosystems encompass cultural use plants, habitats and associated ecosystem processes. These cultural agroecosystems have been stewarded by Indigenous communities through elaborate land management and ceremonial practices since time immemorial (Karuk Tribe Department of Natural Resources 2010; Karuk Tribe 2019; Salter 2003). Using cultural fire, pruning, coppicing, selective harvesting, and other cultural management techniques, Karuk people have maintained a landscape mosaic of diverse terrestrial, wetland and aquatic habitat conditions that support a plethora of nutritious cultural foods such as tanoak acorns (*Notholithocarpus densiflorus*), Indian potato (*Brodiaea coronaria*) and Roosevelt elk (*Cervus elaphus roosevelti*); medicinal plants, such as California mugwort (*Artemisia douglasiana*) and prince's pine (*Chimaphila umbellata*); and fibers such as beargrass (*Xerophyllum tenax*) and hazel stick (*Corylus cornuta ssp. californica*)(See also Table 1.2 below and Norgaard et al. 2011; Salter 2003). Abundant fisheries and healthy forest ecosystems in the Klamath River Basin supported community health through nutrition and food security for thousands of years (Hormel & Norgaard 2009; Mucioki et al. 2018; Sowerwine et al. 2019). However, the cumulative impacts of colonization, mining, logging, fire suppression, agriculture, and road building over the past century have resulted in widespread degradation of terrestrial and aquatic habitat and a decline in quality, accessibility and availability of cultural use plants that are vital to the health and well-being of Karuk people (Karuk Tribe 2019; Norgaard 2005).

In addition to cumulative environmental degradation, climate variability challenges agroecosystem resilience and poses potential threats to the unique biodiversity of Karuk Aboriginal Territory (Karuk Tribe 2019; Lynn et al. 2013; Olson et al. 2012; Voggesser et al. 2013). The Klamath River Basin has experienced prolonged drought, increased temperature, precipitation variability, decreased snowpack, and increased incidence of wildfire in the past decade, trends that are only expected to amplify through the end of the century (Grantham et al. 2018). Regional climate projections predict rising average temperatures, shifting precipitation patterns, reduced snowpack and earlier snow melt, more severe droughts and floods, increased variability in stream flows, reduced soil moisture, pest outbreaks, shifts in wildfire frequency, intensity and severity and changes in plant assemblages and wildlife habitats across all elevation levels (Butz et al. 2015; Dalton & Mote 2013; Karuk Tribe 2016).

The "Karuk Climate Vulnerability Assessment" projected that the annual average temperature will increase by almost eight degrees in the territory by the end of the 21st century (Karuk Tribe 2019). Additionally, in the same timeframe, 53 more days of extreme heat (days over 86 degrees Fahrenheit) are predicted as well as an increase in maximum average summer temperatures by almost 10 degrees Fahrenheit (Karuk Tribe 2019). Total annual precipitation is projected to increase slightly (1.2 inches by end of century) (Karuk Tribe 2016), but precipitation is expected to be more variable and delivered in more intense storms (Grantham et al. 2018). The chance of intense drought for longer periods of time is likely given these temperature predictions, despite no projected decrease in precipitation (Grantham et al. 2018). Similarly, soil moisture is projected to decrease 1.9 inches between July and September from the historical value (1971-2000) in the territory, and wildfire risk will increase along with area burned (Grantham et al. 2018). In the Klamath River Basin, 37-65% of snowpack will be lost by mid-century and 73-90% by century's end (Barr et al. 2010), with less overall precipitation falling as snow (Butz et al. 2015). Changes in plant spatial distributions and temporal cycles are expected to have the most immediate consequences to Native Americans' access to cultural use plants and related benefits. Cultural use plants are expected to face multiple intersecting threats such as drought and catastrophic fire, range and elevation shifts, increased pests or pathogens (e.g. *Phytophthora ramorum*, which causes Sudden Oak Death), encroaching invasive species, shifting harvest cycles, and decreased quality and quantity of harvested parts (Fisher & Ziaja 2018). Additionally, forest types in the territory are expected to shift from evergreen conifer forests to Douglas fir-tanoak forest and tanoak-madrone-oak forest under future climate scenarios (Lenihan et al. 2003, 2008 as cited in Butz et al. 2015). Water temperature of freshwater habitats will increase and water flows will be altered, with less flow volume during the dry season (Asarian et al. 2019 as cited in Karuk Tribe 2016; Grantham et al. 2018). Cold water dependent cultural fish species are especially vulnerable to temperature and flow changes in their habitat, with salmon species ranked as particularly vulnerable (Grantham et al. 2018). Considering the environmental and cultural impacts of future climate variability scenarios, the "Karuk Climate Change Vulnerability Assessment" found: "Climate change poses a threat not only to the Klamath ecosystem, but to Karuk culture which is intimately intertwined with the presence, use and management of cultural use species" (Karuk Tribe 2016, pp. 23, 200).

Despite these challenges, the Karuk Tribe Department of Natural Resources is working to reinstate cultural land management practices to revitalize Indigenous cultural agroecosystems across the landscape of their Aboriginal Territory (Hormel & Norgaard 2009; Karuk Tribe 2010, 2019). The title of our project, "*xúus nu'éetht*i — *we are caring for it*," reflects the continuing commitment and responsibility of the Karuk Tribe to restore, protect and enhance the co-inhabitants of its Aboriginal Territory whom they know to be their relations – the plants, animals, fish, bodies of water and landscapes. Karuk management ethics are imbued with the concept of reciprocity, meaning that to be Karuk, one must care for the land's cultural food, fiber and medicinal plant resources, ecosystem functions and

species' habitat in order to continue to receive their gifts and benefits for future generations.

This project built on a decade-long partnership between the Karuk Tribe and the University of California at Berkeley (Karuk Tribe-UC Berkeley Collaborative 2017) and the results of the five-year collaborative Klamath Basin Tribal Food Security Project (AFRI Food Security Grant #2012-68004-20018; 2012-2017). Through the Food Security initiative, UC Berkeley and the Karuk, Yurok and Klamath Tribes worked together to understand and enhance community food security through community-engaged applied research and extension. A household survey conducted as part of this project found high rates of poverty, food insecurity, dependence on food assistance, and severely limited availability of and access to cultural foods among Karuk Tribal households, as well as a strong demand to revitalize cultural food systems (Box 1.5) (Sowerwine et al. 2019).

BOX 1.5 Trends of food insecurity reported by Native households in 2018

- 92% of all households are food insecure
- 52% of households have very low food security
- 64% rely on food assistance
- 84% still worried about or ran out of food
- 7% of all households are native foods secure
- 70% never or rarely get all desired native foods
- 83% consumed native foods in the past year
- 99% want access to more native foods

This research demonstrated the important connections between access to native foods and household food security (Sowerwine et al. 2019). Twenty-one percent of food assistance users reported relying on food assistance because native foods are not available, and nearly 40% of households reported relying on fishing, hunting, gathering and home-canned foods to minimize food insecurity, underscoring both the importance and shortcomings of food assistance and the value of native foods for household nutrition and food security. To articulate the importance of access to native foods to food security, the authors defined the concept of ***native foods security*** as "having physical,

economic, social and legal access to all desired native foods in the appropriate quality and quantity throughout the year, and the continuity of the cultural institutions that sustain them including indigenous knowledge, social support networks, and cultural resource stewardship" (Sowerwine et al. 2019, p. 602).

Only 7% of all households reported being native foods secure (i.e. always having access to desired native foods), whereas nearly 70% of all households never or rarely had access to all desired native foods throughout the year. Although quantity and quality of and access to some native foods may limit frequency of consumption, 82.95% of survey respondents reported consuming native foods in the prior year. There was a very strong desire for more native foods in the Karuk community, with 99.56% of respondents wanting access to more native foods. The strongest barriers cited by Tribal households to accessing cultural use species were: laws and regulations inhibiting access, limited availability, and degradation of habitats associated with cultural foods. Furthermore, 70% of Tribal households in the Klamath Basin identified climate change as a barrier to having enough cultural foods, with over 20% of respondents saying it was a strong barrier (Sowerwine et al. 2019). Results from this research, along with other studies (e.g. Karuk Tribe 2016, 2019; Lake et al. 2018; Norgaard 2005), demonstrated a clear need for improved land management to enhance the availability, quality, accessibility and use of cultural foods and fibers by the Karuk Tribal community, and to protect cultural foods and fibers from threats and vulnerabilities presented by climate variability including invasive pests and pathogens.

This project also built upon and advanced a number of other KDNR initiatives related to climate change research and adaptation planning, wildfire management, ecosystem restoration and cultural revitalization. In 2016, KDNR published its "Karuk Tribe Climate Vulnerability Assessment," which focused specifically on climate-related wildfire risk and resilience. In 2019, KDNR followed with the "Karuk Climate Adaptation Plan," which provided guidelines for Tribal community climate adaptation, including recommendations for key focal species and habitat monitoring. KDNR is also engaged in strategic fuels treatments that protect community infrastructure, reduce wildfire risk and enhance the resilience of wildlife habitats and cultural use species. KDNR is a co-leader of the Western Klamath Restoration Partnership (WKRP), a consortium of Tribal, federal, state and non-governmental organizations, industry and landowners committed to collaboratively managing fire to maintain resilient Klamath ecosystems, communities and economies.[3] The WKRP combines cutting-edge fire ecology and forest management techniques with Karuk Indigenous Traditional Ecological Knowledge (ITEK) and management practices to pilot the implementation and monitoring of prescribed burning and fuels treatments designed to benefit cultural foods and fibers and wildlife habitat and improve community wildfire protection.

3 WKRP website: https://www.wkrp.network

1.4 METHODS

INTEGRATING KARUK INDIGENOUS TRADITIONAL ECOLOGICAL KNOWLEDGE AND WESTERN SCIENTIFIC APPROACHES

The Agroecosystem Condition Assessment (ACA) development was a collaborative effort between UC Berkeley researchers, a research ecologist with the USDA Forest Service, KDNR staff, cultural practitioners, and cultural resource managers. In the ACA, research methods to assess habitat and focal plant quality and abundance include both standardized western scientific methods and Indigenous scientific perspectives. Over the course of a year, we developed methods to integrate Karuk Indigenous Traditional Ecological Knowledge and priorities into the research methods, building on Food Grove Assessments begun during the Klamath Basin Tribal Food Security Project. Data collection in the field always included at least one Karuk cultural practitioner to lead the evaluation of climate stress and disease on particular plants, and to assess cultural land use, settler-colonial land use, gathering potential at the site, timing and process of harvesting from focal plants, and animal activity. In addition to data collected on paper and digital forms, cultural practitioner narration was recorded on audio and video during field visits. Visuals were documented through standard and 360-degree photos, all stored securely on the KDNR server.

SITE SELECTION PROCESS

Working with KDNR colleagues, the team developed and iterated a set of criteria that we utilized to identify and select sites.

BOX 1.6 Site selection criteria for research sites.

- Culturally significant sites with diverse food, fiber, regalia and/or medicinal plants, and/or historical village or gathering sites, reflecting a “cultural transect” or gradient in elevations, habitat types and seasonal cultural use areas from the river corridor to the higher elevation gathering areas.

- Inclusive of habitat delineations included in Karuk Tribe Climate Vulnerability Assessment.
- Inclusive of a range of biophysical setting/existing vegetation type (LandFire[4]) and habitat types.
- Range of elevations (low (< 1500 ft), middle (1500-2500 ft), and high (>2500 ft)).
- Accessible to researchers and cultural practitioners.
- Culturally appropriate for research activities and seasonal visits.
- Inclusive of wetland or riparian features associated with different types of bodies of water (at least half of sites).
- Sites of historical voucher specimen collection.
- Overlap and coordination with other KDNR and partner data collection efforts.
- Active management by KDNR or tribal members, or identified Tribal priority for management.

RACCCA team at Karuk DNR headquarters, preparing to go out in the field. Photo credit: Jennifer Sowerwine.

4 LANDFIRE is a platform of landscape scale geo-spatial products used by the wildland fire management programs of the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior to support cross-boundary planning, management, and operations (see https://landfire.gov/about.php)

Karuk cultural practitioners and resource managers selected culturally significant locations with a history of gathering and management of focal species for the establishment of plots and patches. We gave preference to historical and contemporary gathering areas that are accessible by road, vulnerable to environmental change and landscape mismanagement, and slated for prescribed fire and other fuels treatments through WKRP projects, including the Somes Bar Integrated Fire Management Project and *Ikxariyátuuyship* initiative (see glossary for project descriptions). Secondly, we selected regions to roughly represent Karuk seasonal gathering cycles along an elevational gradient from low to high country, with representation of plots in low (< 1500 ft), middle (1500-2500 ft), and high (>2500 ft) elevations. Our aim was to emulate traditional gathering cycles emanating out from villages along the river to areas higher up throughout the seasons. Plots in each region were established keeping in mind the structural uniformity of the area[5] while striving to capture a range of focal plants and a diversity of wetlands or water body types (i.e. streams, ponds, rivers, etc.).

AGROECOSYSTEM CONDITION ASSESSMENT SURVEYS

The Agroecosystem Condition Assessment (ACA)[6] methodology consists of seven components: baseline plot assessment, sketch and digital map, wetland-riparian survey, seasonal survey, harvest survey, post-harvest survey, and external patch assessment. At the time of plot and patch establishment, a baseline habitat condition assessment is conducted, including an evaluation of biophysical attributes, recording of land use history, estimation of tree canopy closure and vegetation cover, evidence of animal activity, and an appraisal of stress and disease, among other tasks (see Box 1.7). Seasonal, harvest and post-harvest assessments are carried out at different intervals throughout the year to assess focal plant phenology, stress, yield and quality. Seasonal and harvest visits can be repeated at various intervals over time for long-term monitoring of study areas (see Table 1.1 for a summary of our ACA data collected). Wetland-riparian surveys to assess the status and condition of bodies of water and associated vegetation are conducted once for baseline assessments and once per year for wet/dry mapping (Woelfle-Erskine 2017; Woelfle-Erskine et al. 2017).

For each ACA assessment, a Survey 1-2-3 tool was developed and installed on KDNR iPads for ease of data collection and secure storage on the KDNR server.

5 According to the California Native Plant Society (2007) relevé protocol: "A stand (or plot) is defined by two main unifying characteristics: 1) It has compositional integrity. Throughout the site the combination of species is similar and 2) It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species throughout."

6 Here we provide a succinct overview of our methods. A more detailed step-by-step guide is available in our ACA Protocol, housed at the Karuk Department of Natural Resources.

Project team members discuss ACA methods in preparation for establishing an ACA survey plot.
Photo credit: Daniel Sarna-Wojcicki.

BOX 1.7 ACA survey data collected.

- Sketched plot map (focal plant/patch locations, direction, general vegetation cover)
- Site accessibility and vegetation density
- Weather and air quality
- Slope, aspect, and position
- Land use and management history

- Most abundant trees (and seedlings/saplings), shrubs, herbs, and dead trees or shrubs
- Soil type, soil moisture, and fuel depth
- Animal activity by species (scat, browse, tracks, burrows, etc.)
- General canopy closure using concave densiometer
- Canopy cover by species of shrub and trees along a transect using line intercept method
- Four 360° photos at subplot center at plot establishment
- Herbaceous cover and nested rooted frequency of forbs in a 50 cm x 50 cm quadrat placed at equal intervals along a transect
- Phenology, climate stressors, and disease of plants
- Diameter at Breast Height (DBH) and height of trees
- Size and number of focal plants in the patch or plot
- Sudden Oak Death risk
- Harvest evaluation of focal plants (with cultural practitioner)
- CRAM[7] assessment of bodies of water present
- Voucher specimen collection of focal plants (for Karuk Herbarium)

7 CRAM stands for California Rapid Assessment Method for assessing and monitoring the ecological conditions of wetlands throughout California. It is designed to evaluate the condition of the wetland based on its landscape setting, hydrology, physical structure and biological structure. The methodology is standardized for over seven types of wetlands, so ecological conditions can be compared at local, regional and statewide landscape scales (https://www.cramwetlands.org).

TABLE 1.1 Overview of Survey Components for the Agroecosystem Condition Assessment

Form/survey	Frequency of completion	Summary of content
Plot establishment	Completed when the plot is first established in the spring and thereafter at 5-year intervals.	General description of plot and vegetation, animal activity, focal plant inventory and observations of other plants, canopy closure and cover by species of shrub and trees, cover and nested frequency for herbs, 360° photos captured.
Photo, audio & video recordings	Completed during each visit to the plot or patch.	Interview & record observations of cultural practitioners of focal plant phenology, climate and/or disease stress and habitat condition.
360° Photos + Drone 360° images	360° photos completed during plot establishment and 3x throughout year 1 to observe seasonal changes.	360° photos from four subplot centers. Drone footage conducted at eligible plots.
Sketch map	Completed when the plot is first established and thereafter at 5-year intervals.	Grid on paper form to map the important plot features including focal plants, wetland areas, general terrain and vegetation, orientation of plot to surroundings, direction and orientation of plot sides.
Herbarium specimen collections	Completed during flowering/fruiting season.	Collections of cultural use plant species gathered, dried, frozen, mounted and labled for storage and use at KDNR herbarium.
Wetland-Riparian survey	CRAM survey completed in riparian areas associated with plots and patches. Key metrics taken at seasonal visits at least once per year during low flows.	Wetland-Riparian Surveys are based on the California Rapid Assessment Method for Wetlands (CWMW 2013) which assesses the ecological health and function of riparian and wetland areas using qualitative and quantitative indices of hydrology, geomorphology, plant community and habitat quality. Seasonal metrics focus on important indices of water availability in the dry season. As the CRAM method was developed with a state-wide focus and did not include Karuk Indigenous knowledge or address specific concerns about particular habitat features and conditions that support cultural use species, we also conducted wet-dry mapping and seasonal assessments of water levels in creeks and seeps, as well as focal patch and harvest surveys for cultural use plant species in wetlands and riparian areas associated with bodies of water in or near ACA plots (e.g. willow, yew and woodwardia).

Form/survey	Frequency of completion	Summary of content
Seasonal visit	Completed monthly from May — November or at least three times a season.	Climate and soil conditions, animal activity, plant phenology and stressors
Harvest	Completed at each patch and plot when focal plants are ready for harvest.	Assessment of harvest quality and quantity. Cultural practitioner assessment of harvest.
Post-harvest	Completed out of the field for each harvest.	Quantifying the harvest through volume or weight out of the field.
External patch assessment	Completed when the patch is first established in the spring and thereafter at 5-year intervals.	Assessment of general vegetation, animal activity, soil, plant phenology and stressors around the patch of focal plants.

Madrone berries at *Tishánik* ACA plot. Photo credit: Daniel Sarna-Wojcicki.

LONG TERM LAND USE, MANAGEMENT AND COVER CHANGE ASSESSMENT

Through interviews, focus groups and site visits with cultural practitioners with family and personal connections to the sites, we gathered data on the historical and contemporary use and management of the land, bodies of water and cultural use plant species. We also gathered information on settler-colonial land and water management in and around ACA plots. Qualitative data was recorded, transcribed, coded and analyzed in NVivo qualitative data management software. We analyzed archival mining, logging and land-use records covering 5 of the original plots and surrounding areas. To assess changes in land cover over time for each of those plots, the KDNR-UC Berkeley team and M.V. Eitzel Solera manually georegistered historical and contemporary aerial images (1944–2016) and manually classified the vegetation in each image for areas around each of the five plots (bare ground, road, woody, or herbaceous). To summarize land-cover change, we summed up the area occupied by each land cover type in each year, and plotted the change in proportion of each type over time for each site. We also rasterized the classifications (with a pixel size equal to the spatial resolution of the coarsest image for that site) for mapping, using alluvial plots that group pixels by class and trace the transitions of each pixel from one class to another over time.

HISTORICAL VOUCHER COLLECTION ANALYSIS

Voucher specimens are pressed and dried sections of plants,usually including flowers and fruits, which are mounted on heavy paper using methods and materials for long-term storage and preservation (some today are up to 200 years old). Along with plant material, data is collected describing plant features, phenology, habitat, location, etc., which is included with the mounted plant. We aggregated historical voucher specimen data collected in Karuk Aboriginal Territory (limited to specimens with GPS coordinates identifying location) from the Consortium of California Herbaria via the Consortium's online database. We summarized data on these voucher specimens using descriptive statistics: year of collection, species, collector, and location. We explored the data spatially by examining voucher specimens collected in or near our plots and patches, enriching specimen locations with additional information (e.g. cover, road density, etc.), and exploring the histories of voucher specimen collectors. We created species distribution models using bioclimatic variables to predict presence for four of our study species-beargrass, tanoak, iris, and evergreen huckleberry.

1.5 OVERVIEW OF RESEARCH PLOTS, PATCHES, AND FOCAL PLANTS

We established eight research plots, each 60 x 60 meters in area, and 27 research "focal patches" (smaller areas focused on one focal plant species) in culturally significant areas. Of the eight plots, we established five in 2019, and three in early 2020. Focal patches encompassed plant species that were either missing from or in different condition than those found in the plots. Patches were often adjacent to or in the same region as established plots. Karuk collaborators identified 20 cultural use plant species as "focal plant species" on which to center our assessments of plant health, phenology, seasonal stressors, and harvest (Table 1.2).

In this report, we use the term *focal plant* or *focal species* for this specific set of 20 plant species. Each focal plant species was present in at least two plots or patches with populations of focal species, representing both "good condition" and those that need more stewardship to increase their harvest potential.

Frank Lake and Kathy McCovey measure a legacy Tanoak tree. Photo credit: Jennifer Sowerwine.

TABLE 1.2 Focal Plants

Latin Name	Common Name	Karuk Name
Xerophyllum tenax	BEAR GRASS	**panyúrar**
Rubus ursinus	CALIFORNIA BLACKBERRY	**attaychúrip**
Rubus leucodermis	BLACKCAP	**paturúpveen'ippa**
Umbellularia californica	CALIFORNIA LAUREL	**páhiip**
Chrysolepis chrysophylla	GIANT CHINQUAPIN.	**sunyíththip**
Adiantum aleuticum	FIVE-FINGER FERN	**ikrittápkir**
Woodwardia fimbriata	CHAIN FERN	**típtiip**
Corylus cornuta ssp. californica	CALIFORNIA HAZEL	**súrip / áththip**
Vaccinium ovatum	EVERGREEN HUCKLEBERRY	**purith'íppan**
Iris purdyi, Iris tenax	ROPE OR STRING IRIS	**achviv'ápkaas**
Arctostaphylos patula	GREENLEAF MANZANITA	**pahav'íppa / fath'uruhsa'íppa**
Arctostaphylos manzanita	PARRY MANZANITA	**fáththip**
Tricholoma magnivelare	TANOAK MUSHROOM	**xáyviish**
Quercus kelloggii	BLACK OAK	**xánthiip**
Taxus brevifolia	PACIFIC YEW	**xuppáriish**
Dichelostemma capitatum ssp. capitatum	BLUE DICKS	**táyiith**
Pinus lambertiana	SUGAR PINE	**ússip**
Notholithocarpus densiflorus	TANOAK	**xunyêep**
Salix exigua	SANDBAR WILLOW	**pâarak**
Clinopodium douglasii	YERBA BUENA	**champínnishich**

1.6 EXTENSION AND EDUCATION ACTIVITIES

KDNR staff, Karuk cultural practitioners and UC Berkeley researchers co-designed and implemented the following extension and education activities. The overall goals of these activities were to build research and monitoring infrastructure and capacity in the Karuk community; support Karuk cultural use plant and agroecosystem monitoring and management; and build community capacity to support climate change adaptation initiatives into the future.

SEASONAL CALENDARING WORKSHOP

To better understand the impact of climate change on cultural use species, the project team conducted a participatory workshop with cultural practitioners. In the workshop, we discussed seasonal and temporal dimensions of cultural use species, including plant phenological changes, seasonal management and harvest indicators, harvest timing, seasonal hunting and fishing, and climate-related changes to these species' phenology and biorhythmic patterns. We collectively developed a seasonal calendar to reflect the timing of cultural use species management, harvest and processing activities. We explored creating a mobile application to allow cultural practitioners to capture timing and quality-related information and observations, which was later developed into the Karuk Tribe Citizen Science Tool through this grant (see below).

Seasonal Calendaring workshop participants discuss seasonal, phenological and biorhythmic dimensions of cultural plant stewardship, harvesting and processing, January 2019. Photo Credit: Daniel Sarna-Wojcicki.

KDNR staff and cultural practitioners discuss seasonal harvest timing during participatory workshop. Photo credit: Jennifer Sowerwine.

KARUK TRIBE CITIZEN SCIENCE TOOL

As a means of engaging tribal members in tracking and sharing observations about cultural use plants over the seasons, KDNR GIS specialists Christopher Weinstein and Sylvia Van Royen, along with UC Agriculture & Natural Resources IGIS specialist Andy Lyons, developed the "Karuk Tribe Citizen Science Tool." This idea came from a Karuk cultural practitioner during the Seasonal Calendar workshop mentioned above. The goal of this user-friendly mobile app is to enable KDNR staff, Karuk Tribal community members, other regional Indigenous cultural practitioners, and local community/citizen scientists to make and record unusual and significant observations about their surroundings. Data collected through the citizen science tool will populate a community-sourced dataset for KDNR on cultural resources and climate-change related patterns, and provide KDNR land managers with actionable information. Learnings from this data will also support educational resources for teachers and cultural practitioners to explore spatial and temporal patterns in cultural use species. The

app and submitted data are maintained by KDNR using ArcGIS Enterprise. To ensure proper use, and maintain individual privacy and Tribal sovereignty over data generated through the app, only KDNR administrators will have access to the full dataset.

DRONE, STORY MAPPING, AND 360° PHOTO WORKSHOPS

We offered training in innovative assessment, monitoring and communication tools through a series of workshops for project team members, KDNR staff, and youth. Andy Lyons and Sean Hogan, UCANR Informatics and GIS (IGIS) Statewide Program specialists, provided training and technical support in how to use mobile field data collection tools, 360 photography, story mapping, and drones. We learned to use 360° photography and discussed integrating this technology into our survey. Youth and adults gathered at the KDNR computer lab to learn how to create story maps using the ESRI ArcGIS online platform, creating visuals of the story "Coyote's Journey" through Karuk country. As our project progressed, we utilized these skills in the field during our ACA surveys, taking 360° photos at each site and creating sample immersive visualization tours for education and monitoring. We also conducted drone aerial imagery transects of select ACA sites for remote sensing-based vegetation monitoring, and are creating a story map of our project.

KDNR managers learn how to use 360° photography (pictured above) and test out virtual reality tours using Google Cardboard (pictured previous page). Photo credits: Megan Mucioki and Jennifer Sowerwine.

Andy Lyons explains drones to youth at RACCCA workshop, October, 2018. Photo credit: Jennifer Sowerwine.

Sean Hogan and Andy Lyons conduct a UAV vegetation transect to help monitor meadow encroachment at the *Táasich* ACA plot, October 2019. Photo credit: Jennifer Sowerwine.

KARUK CLIMATE DATA DASHBOARD AND ENTERPRISE SERVER

The acquisition, configuration, and deployment of a GIS server to host the Karuk Climate Data Dashboard has allowed KDNR to launch a secure centralized solution for collaborative data management. The implementation of ArcGIS Enterprise has also created the opportunity for field crews to collect data while reducing the need for in-office data entry. It provides greater internal project transparency by giving managers the ability to view program data spatially, through web maps and dashboards. This collaboration has enabled the next level of data access, storage and transparency for KDNR's data management efforts across its programs.

YOUTH CLIMATE CHANGE AND PLANT BIOLOGY CURRICULA AND FIELD TRIPS

Six lesson supplements were developed and geared to the relevant grade levels for classroom and field implementations by project team members Heather Rickard, Lisa Morehead-Hillman and

Megan Mucioki (see Box 1.8). Once approved by Tribal Council, the supplements were added to existing K–12 lessons focused on climate change and plant biology.

BOX 1.8 Climate change and plant biology lesson supplements for elementary, middle and high school students.

- "Plant Biology: Willow" for Grade 5.
- "Native Edible Berries" for Grade 8.
- "Investigating Biological Resilience in Mushrooms, Mosses, and Ferns" for Grades 3–6.
- "Secret Plant Scavenger Hunt/Nature Journaling" for K–4 and 5–8. To be led by elder and cultural practitioner.
- "Dendrochronology & Climate Change" for Grade 7. Using oral tradition and tree "cookie" cross sections, students investigate ways of understanding how weather changes over time.
- "Climate Justice & Climate Action" for Grade 7. Students hear from indigenous climate activists around the world who speak to the strengths of youth, then come up with their own solutions based on identified strengths.
- Herbarium workshop for K–8. Students learn about cultural use plants through the collection and mounting of voucher specimens.

As an example of lesson plan implementation, project team members Heather Rickard, Kathy McCovey, and Megan Mucioki led a lesson on "Investigating biological resilience in mushrooms, mosses, and ferns" with 3rd–6th graders at Orleans Elementary School. Students rotated among three stations focused on: desiccation tolerance in mosses, mushroom life cycle and spore prints, and implications of climate change on ferns used for weaving. At the moss station, students learned about moss's unique ability to persist years without water by comparing dried-up and saturated moss. At the mushroom station, students reviewed the mushroom life cycle, examining mushroom gills under a light microscope and setting up spore prints. At the fern station, cultural practitioner Kathy McCovey taught students about using ferns in basketry, showing live specimens of fibers used for weaving and beautiful basket caps.

As an example of a field trip, sixth graders from Orleans Elementary School joined Karuk Tribal Temporary Aid for Needy Families (TANF) Cultural Activities Coordinator Phil Albers, Jr., to learn about the Pacific yew (*Taxus brevifolia, xuppáriish*), a cultural use tree whose wood is used for bow making. Phil explained harvesting techniques and displayed two bows that he'd made. He also shared responsible care of yew trees, how to cure the wood after harvest, desirable habitat conditions and much more.

Phil Albers, Jr. teaches students from Orleans Elementary School about cultural uses and stewardship of Pacific yew and bow-making, March 2020. Photo credit: Megan Mucioki.

Above: Piloting a lesson on "Investigating biological resilience in mushrooms, mosses, and ferns" at Orleans Elementary School. Students examine spore-producing gills of locally collected mushrooms. Below: Cultural practitioner Kathy McCovey teaching students about different riparian-loving ferns used in Karuk basketry. Photo credits: Megan Mucioki and Heather Rickard.

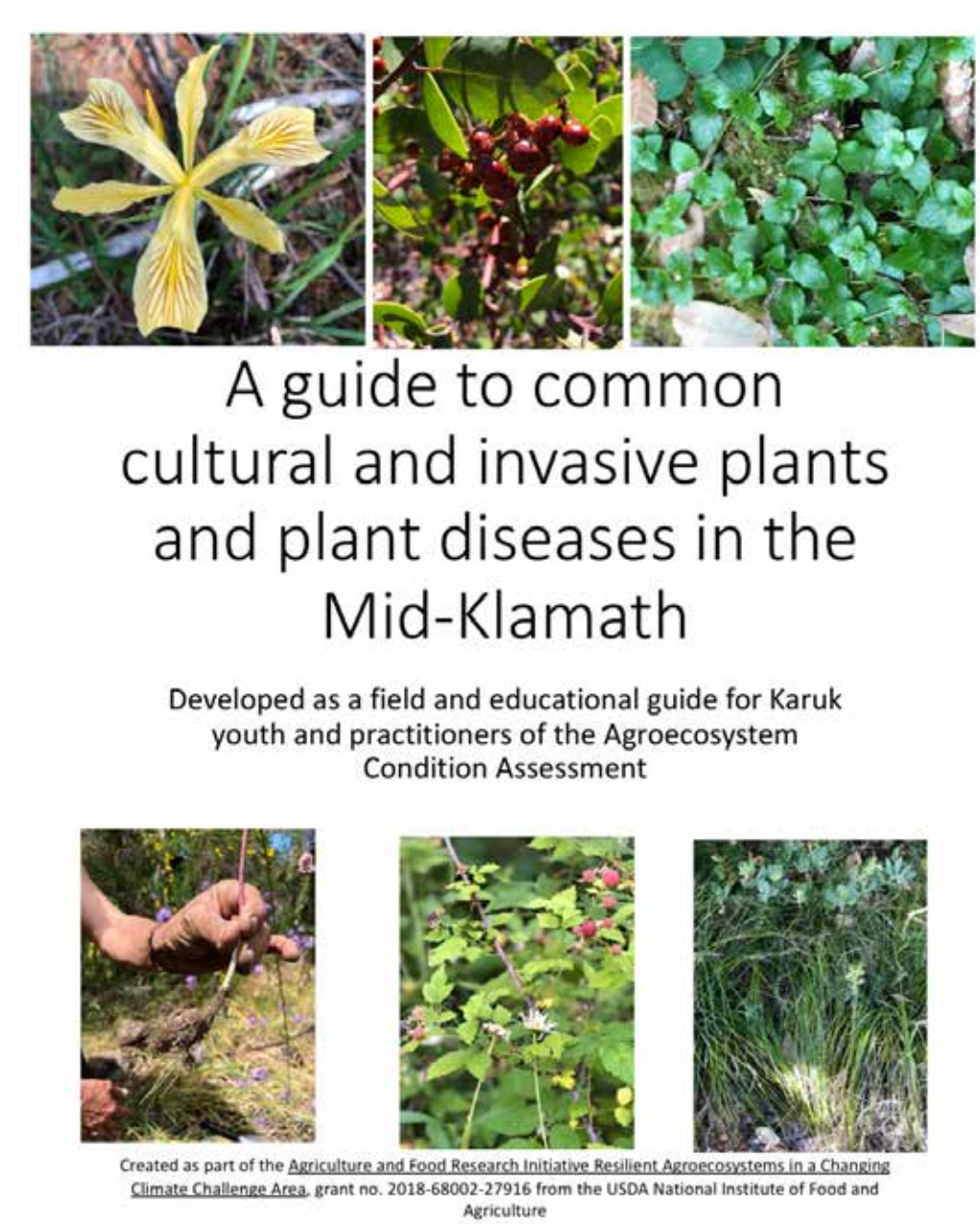
HERBARIUM WORKSHOP AND EXPANDING THE KARUK HERBARIUM

Project team members attended a two-day intensive workshop at the University & Jepson Herbaria at UC Berkeley to strengthen skills in collecting and preserving voucher specimens. Led by experts at the University & Jepson Herbaria, the workshop focused on bulky specimens, lichens, fungi, bryophytes (mosses), and algae/seaweeds. Team members applied their new skills to diversify the Karuk native plant collections beyond culturally important vascular plant foods, fibers, and medicines, collecting new voucher specimens that greatly expanded the Karuk Herbarium. The Karuk Herbarium was established by KDNR and UC Berkeley collaborators in 2016 under the previous AFRI-supported Tribal Food Security Project. Housed and maintained by the Karuk Tribe, this growing collection of cultural use species is used for research and educational purposes.

Project team members gather around Kathy Ann Miller, Curator of Algae at the University & Jepson Herbaria, to learn about collecting and mounting seaweed voucher specimens. Photo credit: Jennifer Sowerwine.

KARUK CULTURAL USE PLANT GUIDE

With help from UC Berkeley undergraduate student researchers, project team members developed a plant guide focused on cultural use plants of the Karuk Tribe. The guide consists of 226 cultural use trees, shrubs, and herbs, with photos of each plant in vegetative, flowering, and fruiting states and the Karuk, common, and scientific names, plant diseases, and local invasive plant species. The guide has been distributed to local schools, KDNR staff, and the Tribal community.



A guide to common cultural use plant species, invasive plants, and plant diseases developed by the project team and undergraduates at UC Berkeley. Photo credit: Karuk Tribe-UC Berkeley Collaborative.

akvíttip

Alnus rhombifolia

White alder

Jean Pawek, CalPhotos

Keir Morse, CalPhotos

Zoya Akulova, CalPhotos

kusríppan

Arbutus menziesii

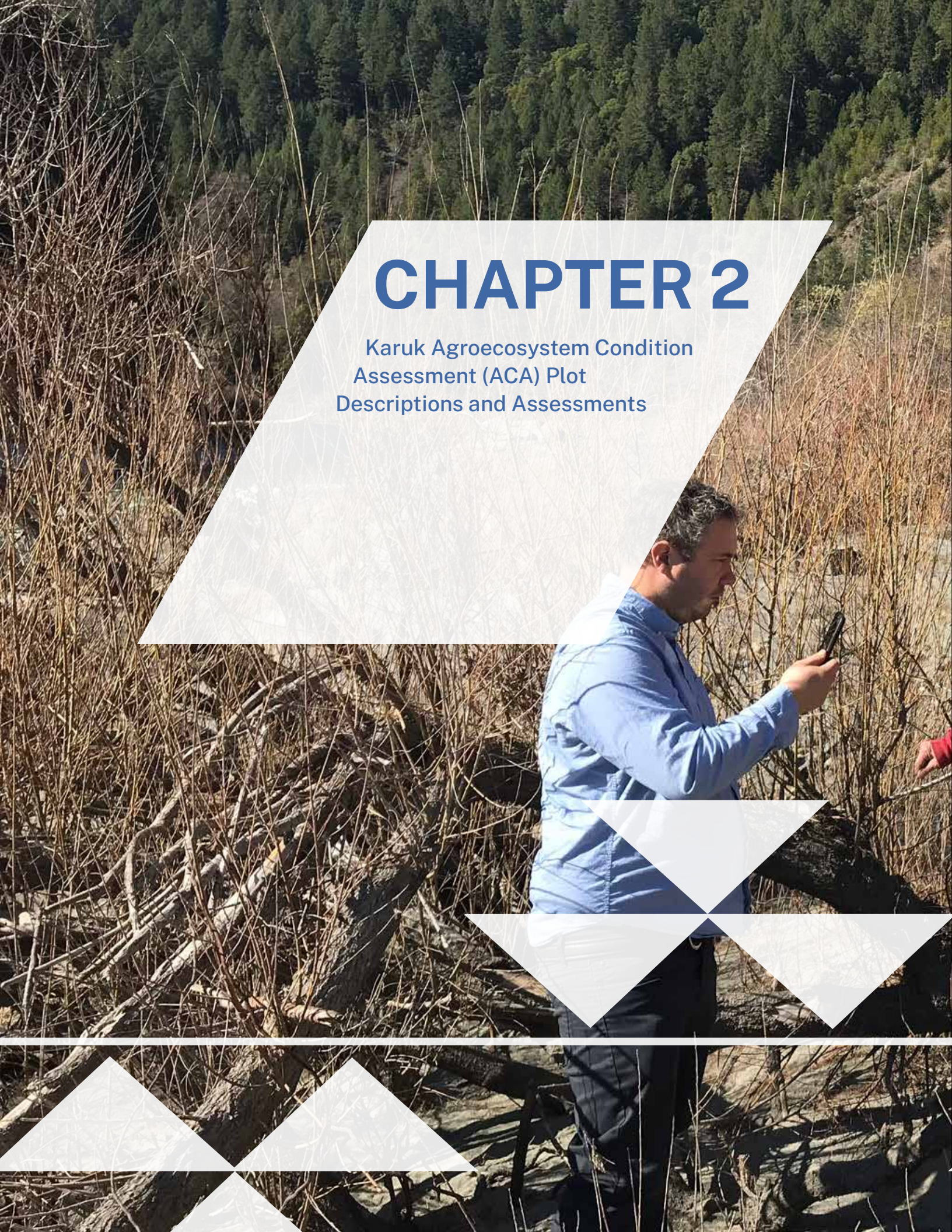
Madrone

Ben Saxon, KDNR

Ben Saxon, KDNR

Barry Breckling, CalPhotos

4



CHAPTER 2

Karuk Agroecosystem Condition Assessment (ACA) Plot Descriptions and Assessments

2.1 INTRODUCTION

In this chapter we summarize the historical, cultural, biophysical and ecological data generated for each of our eight plots in 2019 and 2020, providing a comprehensive snapshot in time of contemporary ecological attributes and the historical conditions that shaped them. We detail the biophysical attributes, vegetation, species and cultural species richness, animal activity, wetland-riparian surveys and land and management history. Each plot was divided into four 15 x 15 meter subplots where soil moisture and rapid species assessments were noted. To better understand the condition of the culturally significant species in each plot, we focused on surveying and monitoring the attributes referenced above for each plot, as well as the focal species themselves. However, we acknowledge that cultural species often grow in diverse plant assemblages and have relationships with both above-and below-ground biological diversity that were beyond the scope of this study to fully capture.

The wetland-riparian information presented is based on CRAM scores (see Table 2.1 below and CWMW 2013 for more info). Each score is based on assessment metrics and submetrics across four attributes-1. Buffer and Landscape Context, 2. Hydrology, 3. Physical Structure and 4. Plant Community Composition and Structure-which are rated according to condition (A–D), weighted and totaled to give a score representing overall ecological condition and function of the wetland-riparian area. These scores do not reflect the cultural significance, uses or values of these places, but rather are intended to suggest potential ways of enhancing the ecological health and function of the wetland-riparian areas and plant communities associated with different types of water bodies in or near the ACA plots. We also report whether additional survey components were undertaken at each plot in order to address Karuk Indigenous knowledge and concerns about particular habitat features and conditions that support cultural use species, such as wet-dry mapping, which records the spatial and temporal distribution of water in a stream, seep, spring, wet meadow or slope wetland, as well as focal patch and harvest surveys for cultural use plant species in wetlands and riparian areas associated with bodies of water in or near ACA plots.

TABLE 2.1: CRAM attributes, metrics, and submetrics

Attributes	Metrics and Submetrics *(See CWMW 2013 for further information)*
Buffer and Landscape Context	• *Aquatic area abundance* is the spatial association of the wetland being assessed with other water bodies, wetlands and riparian plant communities nearby and its ability to interact ecologically and hydrologically with them • *Stream corridor continuity* measures any disruptions or breaks in ecological and hydrological connection in the stream and riparian area corridor such as blockages or land use conditions that impact the ability of wildlife to access the stream 500m upstream and downstream from the area being assessed • *Buffer* metrics assess the condition and extent of the area adjoining the waterbody and riparian area that protects it from stressors, disturbances and contaminants, provides habitat for wildlife and enhances its ecological function
Hydrology	• *Water source* measures factors that influence the extent, duration and frequency of saturated conditions in the wetland and impact dry season water availability and the composition and health of plant and animal communities • *Hydroperiod* is the typical frequency and duration of inundation or saturation of a wetland, waterbody or riparian area throughout the year • *Hydrologic connectivity* assesses the ability of water to flow in and out of the wetland, linking aquatic and terrestrial habitats • *Channel stability* measures the degree of channel aggradation (accumulation of sediment and raising of the channel bed) or degradation (loss of sediment and raising of the channel bed) in riverine wetlands • In riverine wetlands, hydrologic connectivity is based on *channel entrenchment*, which measures the separation of a river channel from its floodplain. This is calculated as the *flood-prone width* (width of the stream corridor at an elevation equal to twice the maximum bankfull depth, or the height of channel-filling flow above the thalweg, the deepest part of the stream) divided by the *bankfull width* (the hydrologic stage when water in the river channel begins to flow onto the floodplain)
Physical Structure	• *Structural patch richness* measures the abundance of features and physical surfaces that provide habitat for aquatic, wetland or riparian species, indicative of the capacity of a wetland to support flora and fauna • *Topographic complexity* refers to the abiotic features and physical elevation gradients in a wetland that promote habitat features and ecological functions such as surface water storage, groundwater recharge and nutrient cycling

Attributes	Metrics and Submetrics *(See CWMW 2013 for further information)*
Biotic Structure	• Plant community composition and structure are evaluated through assessing species richness, the number of plant layers at different heights, the number of co-dominant species and the percent of invasive species in the wetland or riparian area • *Horizontal interspersion* measures the number of distinct plant zones and the amount of edge between then, indicating the spatial heterogeneity of the plant communities within an Assessment Area • *Vertical biotic structure* measures the degree of overlap among distinct plant layers of different heights throughout the Assessment Area and indicates the ability of the wetland's plant community structure to support diverse habitats for macroinvertebrates, fish, amphibians and birds

The data on biophysical settings (BPS), existing vegetation types (EVT) and existing vegetation cover (EVC) from LANDFIRE (Landscape Fire and Resource Management Planning Tools) is also shared. LANDFIRE is a platform of landscape scale geo-spatial products used by the wildland fire management programs of the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior to support cross-boundary planning, management, and operations (see https://landfire.gov/about.php). We report the available data and make recommendations in some instances for reclassifying the existing vegetation types and cover based on field surveys in order to more accurately represent the actual species and cover present, as well as the species composition and structure concerns of our Karuk partners.

We also present information on planned prescribed fire and fuels treatments for plots that overlap with Karuk Tribe DNR and Western Klamath Restoration Partnership planning units, where available, to give a sense of the intended land management trajectory for the ACA plots and surrounding areas.

For each of the eight Agroecosystem Condition Assessment (ACA) plots, we collected the following information, summarized in Box 2.1. We also took photographic images of each plot (see below), wetland areas, and focal species, as well as 360-degree photographs from the center of each subplot over four seasons.

BOX 2.1 Karuk ACA plot attributes and information.

- Plot name, location and accessibility
- Land designation/ownership status
- Biophysical setting (Landfire)
- Existing vegetation type (Landfire)
- Geology
- Physical attributes (elevation/slope/aspect/fuel depth)
- Vegetation/culturally significant plants
- Focal species being monitored
- Animals active at site
- Wetland-riparian information
- Land use and management history
- Fire history
- Long term land use/land cover change
- WKRP treatments (completed and planned)

Table 2.2 provides a summary of ecological data across all 8 plots. Broadly speaking, the plots ranged from 4.2–88.56% canopy cover with more open, meadowlike areas (*Táasich and Tishánik*) to closed forest (*Ikxariyátuuyship*, Upper Sims, and Patterson) (see Table 2.2). Douglas fir (*Pseudotsuga menziesii, ithárip*) and Ponderosa pine (*Pinus ponderosa, ishvírip*) predominantly accounted for the upper canopy in all plots, with a more diverse range of hardwoods accounting for the understory, as well as a diverse array of shrub and herbaceous plants below (Table 2.2). It is important to note that we used rapid assessments to identify plant, fungi and animal diversity. Future research opportunities include conducting more in-depth studies of plant, animal and fungal diversity as well as below-ground assessments of soil moisture and biological diversity. Tree coring would help illuminate historical water availability represented in tree ring size. In addition, we recommend following up with cultural practitioners and community members who are connected with and steward these sites and surrounding areas over time. In-depth interviews can yield further insights on historical and contemporary land use and management, as well as future stewardship goals for the plots and focal species.

TABLE 2.2: Karuk Agroecosystem Condition Assessment plot data summary

	1. *Táasich*	2. *Kámmaahriv*	3. *Tishánik*	4. Lower Sims
% canopy cover (average and range)	16.2 (0-64.64)	63.08 (12.64-88.56	4.2 (0-16.8)	65.94 (60.48-71.92
Species richness	36	20	22	28
Cultural species richness	22	16	12	13
Most abundant trees	1. Douglas fir 2. Apple/pear 3. -	1. Chinquapin 2. Tanoak 3. Douglas fir	1. Madrone 2. Ponderosa pine 3. Oregon ash	1. Douglas fir 2. Tanoak 3. Madrone
Most abundant seedling/ sapling	1. Douglas fir 2. Incense cedar 3. -	1. Tanoak 2. Chinquapin 3. Douglas fir	1. Madrone 2. Douglas fir 3. -	1. Madrone 2. Douglas fir 3. -
Most abundant shrubs	1. Hazel 2. Manzanita 3. -	1. Pine mat manzanita 2. Evergreen huckleberries 3. Salal	1. Manzanita 2. Scotch broom 3. -	1. Black cap 2. Himalayan blackberry 3. Gooseberry
Most abundant herbs	1. Grasses 2. Bracken fern 3. Aster	1. Bracken fern 2. Beargrass 3. Iris	1. Grasses 2. Blue dicks 3. Lupine	1. Deerbrush 2. Bedstraw 3. -
Most abundant dead trees and shrub	1. Apple/pear 2. - 3. -	1. Douglas fir 2. - 3. -	1. Scotch broom 2. Madrone 3. Douglas fir	1.Douglas fir 2. Tanoak 3. -
Dominant tree species	Douglas fir	Douglas fir	Ponderosa pine	Douglas fir

5. Upper Sims	6. *Ikxariyátuuyship*	7. Owl Mine	8. Patterson
81.8 (82.32-84.4)	88.56 (81.28-96.88	82.06 (69.84-92.72	82.06 (81.28-92.72)
33	20	21	12
21	13	13	9
1. Douglas fir 2. Black oak 3. -	1. Douglas fir 2. Madrone 3. Black oak	1. Tanoak 2. Douglas fir 3.Madrone	1. Tanoak 2. Douglas fir 3. Madrone
1. Tanoak 2. Douglas fir 3. -	1. Douglas fir 2. Madrone 3. Black oak	1. Tanoak 2. Douglas fir 3. Madrone	1. Tanoak 2. Douglas fir 3. Madrone
1. Hazel 2. Evergreen huckleberry 3. -	1. Hazel 2. Honeysuckle 3. Tanoak	1. Tanoak 2. Evergreen huckleberry 3. Salal	1. Poison oak 2. Tanoak 3. Honeysuckle
1. Sword fern 2. Moss 3. Whipplea	1. Poison oak 2. Wood rose 3. -	1. Bracken fern 2. Honeysuckle 3. Stream violet	1. Wintergreen 2. Honeysuckle 3. Snowbrush ceanothus
1. Black oak 2. Madrone 3. -	1. Black oak 2. Madrone 3. Douglas fir	1. Madrone 2. Manzanita 3. Tanoak	1. Madrone 2. Douglas fir 3. Tanoak
Douglas fir	Douglas fir	Douglas fir	Douglas fir

	1. *Táasich*	2. *Kámmaahriv*	3. *Tishánik*	4. Lower Sims
Co-dominant tree species	Incense cedar	Tanoak	Douglas fir	Tanoak
Cultural focal plant species and other cultural use plants present	Focal species: hazel, manzanita, and iris in plot, yew, tanoak, sugar pine, huckleberry, bay laurel and chinquapin in wetland-riparian area and patches near plot	Focal species: tanoak, chinquapin, tanoak mushrooms, red huckleberry, and beargrass in the plot; external plots of woodwardia, yew, and sugar pine. Other culturally significant species: Oregon grape, salal, and Western prince's pine also present.	Focal species: blue dicks and manzanita; patches of willow (stem and root) outside of plot. Other culturally significant species: Oregon grape, deer potato, ceanothus, madrone, mugwort and other native grasses and bulbs.	Focal Species: black cap, tanoak, black oak Other culturally significant species: madrone, woodwardia and maidenhair fern in riparian area

Manzanita shrubs at the Owl Mine plot. Photo credit: Daniel Sarna-Wojcicki.

5. Upper Sims	6. *Ikxariyátuuyship*	7. Owl Mine	8. Patterson
Alder	Black oak	Tanoak	Tanoak
Focal Species: black oak, hazel, yerba buena, woodwardia fern Other culturally significant species: tanoak, iris, soap root	Focal Species: bay laurel, black oak, hazel Other culturally significant species: madrone	Focal Species: tanoak, tanoak mushrooms, manzanita, iris, evergreen huckleberries, Other culturally significant species: prince's pine and madrone.	Focal species: tan oak Other culturally significant species: elk clover, big leaf maple, prince's pine, madrone, salal, rattlesnake plantain, Oregon grape, yew, hazel, chinquapin, iris, woodwardia fern, and trailing blackberry

Willows along the Klamath River. Photo credit: Daniel Sarna-Wojcicki.

2.2 ACA SURVEY DATA BY PLOT

2.2.1 PLOT 1. *TÁASICH*

Land status: Karuk Aboriginal Territory. Claimed and administered concurrently by USDA Forest Service — Six Rivers National Forest.

Biophysical setting (Landfire): Mediterranean California Mixed Evergreen.

Existing vegetation type (Landfire): California Montane Woodland and Chaparral.

Geology/Generalized Rock Type/Soil information[8]: *Pz* (Paleozoic); marine sedimentary and metasedimentary rocks.

Description: Undivided Paleozoic metasedimentary rocks. Includes slate, sandstone, shale, chert, conglomerate, limestone, dolomite, marble, phyllite, schist, hornfels, and quartzite. Soil: Red clay.

Physical attributes: *Táasich* is a flat and open meadow/grassland with a 5% south facing slope. The site has red clay soil with an average fuel depth of 2.25 cm (range 0-6 cm).

Vegetation/cultural use species: The plot contains focal plants hazel, iris and manzanita, with external patches of yew, bay laurel and evergreen huckleberry nearby. It is adjacent to a forested slope wetland rich in cultural plant diversity, including Pacific yew, hazel, red alder, chinquapin, tan oak, cascara, skunk cabbage, deer/woodwardia/bracken/sword ferns and red huckleberry. The southeast edge of the plot includes a thicket of azalea and hazel. Just beyond the northern edge lies a forested area with a path up to the road. Shaded evergreen huckleberries grow along the road and chinquapin, sugar pine and tanoak grow nearby. The northeast side of the plot (subplots 3 and 4) has more canopy cover (Douglas fir, tanoak, and domesticated fruit trees) than subplots 1 and 2.

8 From Geologic Map of California, 2010 (1:750k). A republication of the 2010 Geologic Map of California for online/ArC GIS use. California Geological Survey, C.W. Jennings, Carlos Gutierrez, William Bryant, George Saucedo, Chris Wills. California Geological Survey, California Department of Conservation, California, Geology. Created 2015, updated Jan 22, 2020.

Plot canopy cover is second lowest among our plots at 16.2% cover (ranging from 0–64.64%). Out of 36 identified plant species, 22 are cultural use species. The most abundant and dominant tree species is Douglas fir, along the north fringe of the meadow; there are a few apple and pear trees from prior settlement of the meadow. Co-dominant tree species are incense cedar. The most abundant seedlings and saplings are Douglas fir and incense cedar; most abundant shrubs are hazel and manzanita (although very few in number). Most abundant layer is herbaceous plants comprising largely annual grasses, asters and bracken fern. Dead trees include apple and pear trees.

Focal species being monitored: Iris and manzanita (in plot); evergreen huckleberry, sugar pine and bay laurel (patches near plot); hazel and yew patches in associated forested slope wetland.

Animals active at site: Animal sign indicated heavy elk, deer and bear use, as well as less frequent use by gray fox, Steller's jay, yellow jackets, grouse, quail, coyote, and toad.

BOX 2.2 Plot 2 Wetland-riparian area: forested slope wetland/seeps

- Overview: ~2.60 Acre Non-Channeled Forested Slope Wetland consisting of 5 distinct seeps converging at bottom of slope
- Hydraulic regime: perennial
- Wetland-riparian vegetation: legacy Pacific yew trees, sword/bracken/deer/woodwardia ferns, salal, red and evergreen huckleberry, tanoak, Douglas fir, hazel, alder, cascara and wild ginger
- Canopy closure at seeps: 84.40%, 79.20%, 85.44%, 91.68%
- CRAM Scoring:

    1. Buffer and Landscape Context: a. Aquatic Area Abundance: D; b. Buffer: i. % AA w. Buffer: A; ii. Average Buffer Width: B; iii. Buffer Condition: B; Total attribute score: 53.8%

    2. Hydrology: a. Water Source: B; b. Hydroperiod: A; c. Hydrologic Connectivity: B; Total attribute score: 83.33%

    3. Physical Structure: a. Structural Patch Richness: A; Topographic Complexity: A; Total attribute score: 100%

4. Biotic Structure: a. Plant Community Composition: i. Number of Plant Layers: A; ii. Number of co-dominant species (>10% AA): A; iii. % invasive species: A; b. Average plant community composition: A; c. Horizontal Interspersion: B; Plant life forms: A; Total attribute score 91.67%

5. Overall score: 82.2%

- Wetland-Riparian other monitoring: Depth and surface of 5 seeps monitored seasonally 2019-2021, three yew focal patches established

Land use and management history: Pre-European contact and settlement, the site was likely a high-elevation village site occupied year-round and connected to major villages along the Klamath River mainstem corridor. The site was likely associated with acorn processing and fermentation (*píish*) and with other nearby ceremonial/cultural areas. Karuk cultural practitioner, KDNR founder and ceremonial leader Leaf Hillman describes the *píish* pits near the meadow:

> *...prior to European contact and settlement, that landscape was a very significant landscape, very heavily utilized and managed...Where a couple of these springs kind of join, you find these píish pits...what they've done is they've dug these enormous pits, and then they divert those little springs into those pits...they run in and run out of those so it becomes part of that whole system; it doesn't alter the system. It still goes (to the creek), but they're just diverting them slightly, (by getting) these little springs to run into these píish pits. And those people that lived there, exploited that production in that small area harvesting, and they specialized in producing píish. There were times and occasions [during] ceremonies, for one, where people didn't produce their own but had other resources they were willing to trade for píish. And píish being one of those specialty kind of — it wasn't a requirement that people had. It was one of those things that wealthy people could afford, and people from other Tribes even would trade for, people that had disposable income, so to speak. So they were entrepreneurs who were hoarding that resource to produce a massive quantity of píish acorns...Turns out, very possible [that the seep complex in the riparian area behind the meadow was used for making píish] and I would say probably likely. (Leaf Hillman, Indigenous Traditional Ecological Knowledge (ITEK), 8.20.2019)*

Other cultural resource uses include yew (for bow and other tools and weapons), coast live oak (limbs for dipnet poles), sugar pine (pitch for medicine, roots for basketry, wood/lumber for canoes, house planks, graves, nuts for food, pitch wood as fire tender), huckleberries (fruit), alder (bark for basketry dye), hazel (sticks for basketry and nuts), medicinal herbaceous riparian plants, and hunting/trapping. Post-European contact land use included mining, homesteading, grazing, fire suppression/exclusion, road building and logging.

Fire history: Closest fire 3,500 meters NW, 8/13/1969.

Long term land use/land cover change: Figure 2.1 below summarizes the long-term change in land use and land management and corresponding changes in land cover classes over time. The top rows show the sequence of available aerial images, labeled by year taken. The second panel displays major land management and ecological disturbance events, represented in a timeline matching the graphed changes below (tick marks indicate specific years or ranges of years). The third panel shows overall changes in cover class over time, noting proportions of the plot area classified each year as woody, herbaceous, bare ground, or road. (If there is no data point shown for a given class in a given year, the proportion was zero.) The "alluvial plots" on the bottom panel show the individual transitions of specific pixels from one class to another over the years. Proportions in the bars at image years should match the percentages shown in the figure above.

Figure 2.1 shows that the meadow was being maintained by homesteaders (likely through burning and/or grazing) at the time the first aerial photo was taken in 1944, but had encroached significantly by 1984, likely due to lack of burning and thinning. Logging roads were built into this area in this period between 1944 and 1984. The meadow was opened up slightly between 1984 and 1989, but surrounding woody vegetation has been slowly encroaching on it since then.

Seep with Pacific yew at *Táasich*. Photo credit: Daniel Sarna-Wojcicki.

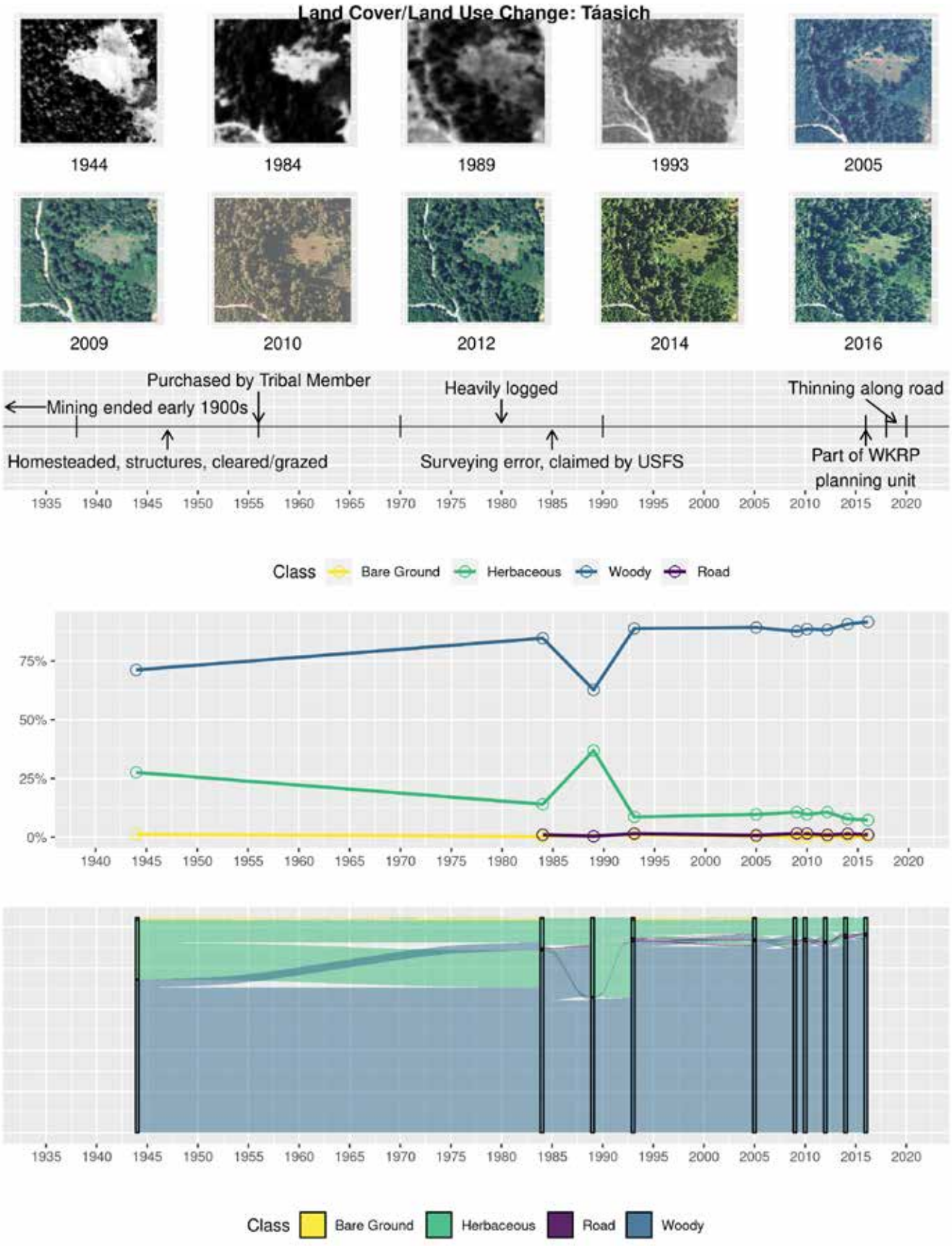


FIGURE 2.1: Land use/land cover change image for Táasich plot.

WKRP treatments completed and planned: Plot and wetland/riparian area part of a 28.69 acre WKRP unit; black oak and elk foraging prioritized, commercial timber possible, great potential for meadow restoration and other cultural resources. Proposed Action: Mechanical ground-based treatment.

Táasich Meadow and ACA Plot. Photo credit: Daniel Sarna-Wojcicki.

KDNR staff member Shawn Bourque sits against legacy yew tree in riparian area/forested slope wetland seep. Photo credit: Daniel Sarna-Wojcicki.

2.2.2 PLOT 2. *KÁMMAAHRIV*

Land Status: Karuk Aboriginal Territory/claimed concurrently by USDA Forest Service Six Rivers National Forest/Orleans Ranger District.

Biophysical setting (Landfire): Mediterranean California Mixed Evergreen Forest

Existing vegetation type (Landfire): Mediterranean California Mixed Evergreen Forest

Geology/ Generalized Rock Type/Soil Type: *Pz* (Paleozoic); marine sedimentary and metasedimentary rocks (see 2.2. 1 Plot 1 above for description).

Physical attributes: The plot has a 10% slope with a north-east facing slope with areas of red-clay soil and an average fuel and duff depth of 3.65 cm ranging from 0.5–5 cm.

Vegetation/culturally significant plants: This site is a flat knoll with sloping sides. It has a high diversity of cultural plants, with a large patch of unburned beargrass, large chinquapin and tanoak trees, manzanita on the edge of the plot, red huckleberry, large sugar pines, Oregon grape, salal, and prince's pine. This plot has been logged, likely in the 1960s–70s, removing canopy that sheltered many of these plants their entire lives, leaving them exposed to unfamiliar harsh conditions. Two small first-order intermittent streams flow beside the knoll, one to the south and one to the Northwest, converging ~700 m to the Northeast and downhill from the plot. The north stream contains woodwardia fern patches, red and evergreen huckleberries and azalea thickets. The south stream riparian area hosts yew trees, red huckleberry, chinquapin, tan oak and huckleberry.

Canopy cover of this plot is 63% (ranging from fairly open, 12.64% to fairly closed, 88.56%). Out of 20 identified plant species, 16 are cultural use species. Tree species, in order of abundance, are chinquapin, tanoak, and Douglas fir. The most abundant seedlings and saplings are tanoak, chinquapin and Douglas fir. Most abundant shrubs include pinemat manzanita (*Arctostaphylos nevadensis, apúnfaath*), evergreen huckleberries, and salal. The most abundant herbaceous plants include bracken fern, beargrass, and iris. The most abundant dead trees are Douglas fir. Dominant tree species is Douglas fir and co-dominant tree species is tanoak.

Focal species being monitored: beargrass, chinquapin, tan oak, red huckleberry (in plot); sugar pine, tanoak, yew, woodwardia (in patches near plot on ridge and in creeks).

Animals active at site: deer, bear, elk, fox and mountain lion scat in the riparian area, bear digging browse and clawing at trees, and squirrel and bear chew marks on sugar pine cones.

BOX 2.3 Plot 2 Wetland-riparian information

- Overview: Two small, first-order confined intermittent streams flow around the knoll, converging 700m to northeast
- Wetland-Riparian Vegetation: woodwardia/bracken/sword fern, salal, Himalayan blackberry, evergreen and red huckleberry, azalea, chinquapin, maple, yew, dogwood, bay laurel, Douglas fir, tanoak
- Canopy closure at transects: 89.60%, 95.84%, 96.88%, 84.40%, 83.36%
- CRAM Scoring:
    1. Buffer and Landscape context: i. Stream corridor continuity: A; ii. Buffer: a. A, b. B,

c. A; Total attribute score = 96.54%

2. Hydrology: a. Water Source: B; b. Channel Stability: B; c. Hydrologic Connectivity: A; Entrenchment ratios (flood-prone width/bankfull width): T1: 2.5; T2= 1.9; T3: 1.37; T4: 1.13, T5: 2.49; average= 1.878, technically an "A" but channel form around T4 and downstream is unstable, steep, channel is incising and cutting into the south bank; total attribute score: 83.33%

3. Physical Structure: a. Structural Patch Richness: A, b. Topographic Complexity: A, A, B, C, B = 9.6; Total attribute score = 90%

4. Biotic Structure: i. Plant Community Composition: a. # plant layers: A; b. # Co-dominant species: A; c. % invasion: A; ii. Horizontal Interspersion: B; iii. Vertical Biotic Structure: A; Total attribute score= 91.67%

5. Overall score: 90.39%

- Wetland-Riparian other monitoring: 5 stream and wetland-riparian vegetation transects, stream channel wet (depth and width) and dry (bankfull and flood-prone width/depth) dimensions conducted Aug 2020; Wet/dry mapping of streamflow on both streams in October, 2021

Land use and management history: Pre-European contact and settlement, uses of the site likely included management, gathering and processing sugar pine nuts, tanoak acorns, chinquapin nuts, beargrass fiber, red and evergreen huckleberries, woodwardia fern fronds and yew wood. The site is claimed concurrently by USFS and was a former plantation, likely heavily logged in the 1960s–70s, replanted (with Douglas fir) in 1980, and thinned/pile-burned from 2005–2009 and in 2019. RACCCA team member Kathy McCovey, a Karuk anthropologist, archaeologist and cultural practitioner, found a significant number of signs of cultural uses in the plot area. She shared her reflections on historic cultural uses in the area:

> *I really do think that some of these were utilized in processing some of the sugar pine nuts and also some of the chinquapin nut[s]...Phoebe Maddox [Karuk cultural practitioner and basketweaver, interlocutor of ethnographer John Harrington]. She knew my grandmother. They grew up together. My great-grandma. And in her interview, she talks (about) the gathering site for the village right up the hill behind them. And my grandma, my great-grandma told my uncle, Casey, "Everything that we need is right*

here. Is right in front of you and it's up the hill." Well, that statement was corroborated by Phoebe Maddox in that interview because she said from the village...they gathered on the way up the hill....She said that they would gather, as they came out of the village on different times a year, she said that behind them was the manzanita up the hill. They got the sugar pine from the ridge. And in the [late summer/fall], they would gather, collect both the sugar pine and the manzanita, and then they'll save them and dry them, and then they'll eat them together in the winter time. So they had two crops closely together here. And then she would talk about the flats here, all the acorns, tanoak acorn trees that were here. We see the remnants of some of them, and that is what we're seeing over the hill right here. They're really nice....Some of those really big ones — grown, look at how well spaced they are. I mean, there are so many food resources out here for the people. And so he said that back here was where they would get their acorns and their mushrooms....
(Kathy McCovey, ITEK, 7.16.2019)

Sugar pines are ripe in mid-August, and manzanita berries in September, depending on elevation, aspect and soil types (see also Shenck and Gifford 1952).

Fire history: Closest fire on record is 2,000 m west, 7/31/1911, Arson, 16 acres, Cal Fire Fire # 200006

Long term land use/land cover change: Very little historical land use data is available for this area, so the timeline largely reflects what is visible in the images themselves. The knoll was clearcut, save for a few legacy tanoak and chinquapin trees, and logging roads were built to remove timber between 1944 and 1984 (likely in the 1960s–70s based on ethnographic accounts). There appears to have been thinning and prescribed burning (likely pile burning) between 2005 and 2009. There is only a small amount of "Bare Ground" present in 1984, and this class is otherwise absent. The amount of herbaceous cover increased again between 1984–1989, likely due to more logging. Since 1989, the amount of woody cover has increased and herbaceous cover has decreased steadily, with the exception of 2005–2009, likely due to thinning, fuels treatments/prescribed burning, and pile burning in those years.

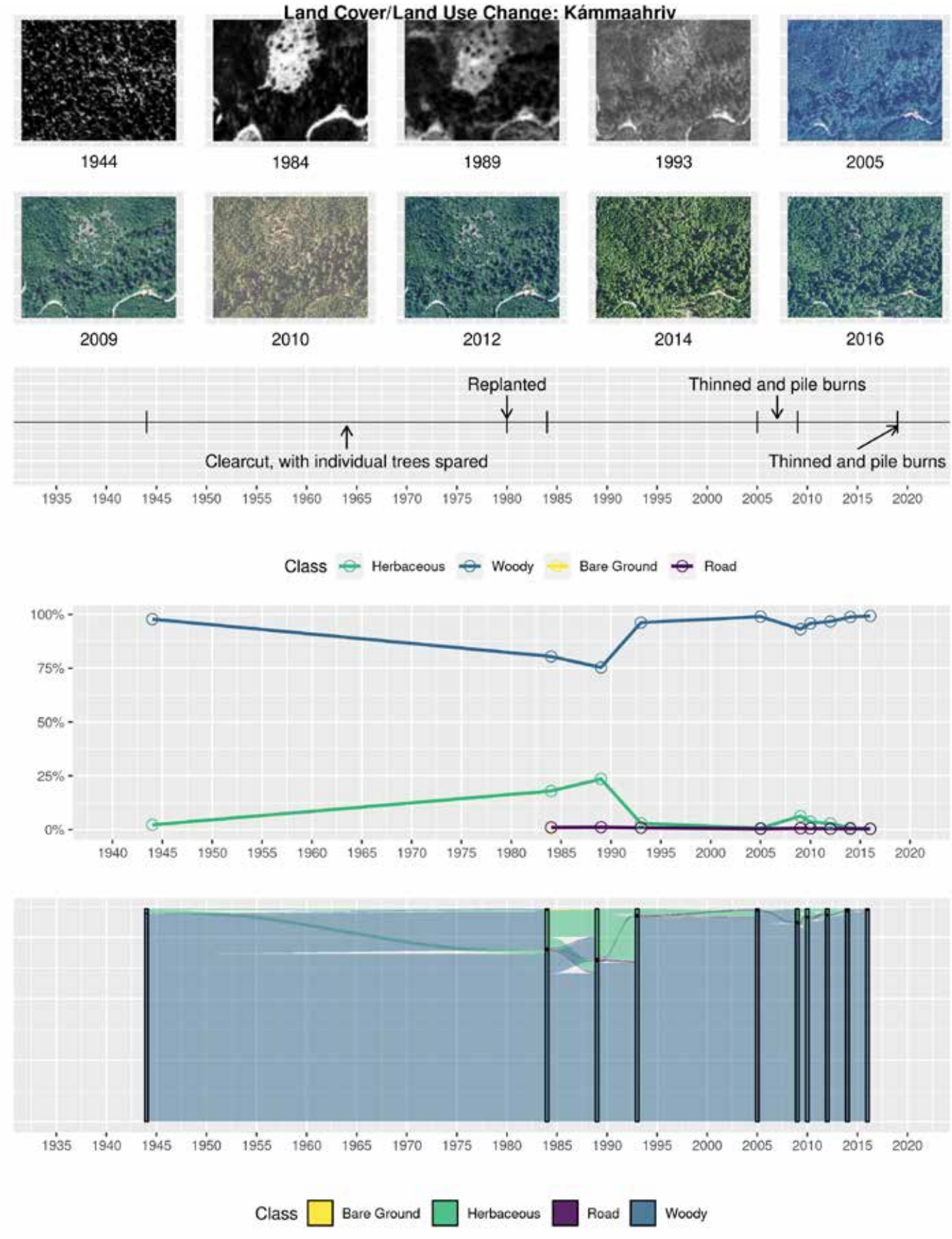


FIGURE 2.4: Land use/land cover change images for Kámmaahriv plot.

WKRP planned and proposed treatments: 3.43 acre unit; Rx category: 3, 4c, 4d, 5d; Proposed action: mastication. Pre-plan: Not in road buffer-previous pre-commercial thin. Try burn only.

Beargrass patch in *Kámmaahriv* ACA plot. Photo credit: Daniel Sarna-Wojcicki.

Stream #2 and riparian area to the south of *Kámmaahriv* ACA plot.
Photo credit: Daniel Sarna-Wojcicki.

2.2.3 PLOT 3. *TISHÁNIK*

Land Status: Karuk Tribe owns.

Biophysical setting (Landfire): Mediterranean California Mixed Evergreen Forest. LandFire should change this classification to a more open vegetation community type, potentially: California Montane Riparian Systems, California Montane Woodland and Chaparral, or Northern and Central California Dry-Mesic Chaparral.

Existing vegetation type (Landfire): Introduced Upland Vegetation-Perennial Grassland and Forbland.

Geology/Generalized Rock Type/Soil Type: Gen Rock Type J (Jurassic); marine sedimentary and metasedimentary rocks; Jurassic shale, sandstone, minor conglomerate, chert, slate, limestone;

minor pyroclastic rocks. Soil: Mine and dredge tailings, floodplain deposits (large cobble with fine grain sand in pockets).

Physical attributes: The soil is rocky in all four subplots with an average of 2.75 cm (range 0-6 cm) of litter/duff on the ground.

Vegetation/culturally significant plants: The Riverine floodplain plot is a flat rocky area covered in grasses and small forbs including blue dick Indian potatoes. Other plants include manzanita, madrone, lupin bicolor, ponderosa pine, Douglas fir, blue dicks, pink clover, young Oregon ash, wild grape, and poison oak. Notably, there is invasive Himalayan blackberry, start thistle and Scotch broom as well. The majority of this plot has no canopy cover and dries quickly from intense sun and heat in the summer. The western edge of the plot has some canopy cover from manzanita, Scotch broom, and madrone. The focal patch of Indian potatoes in the southeast subplot is a little more covered from the sun and thus holds soil moisture better than other areas of the plot. A high order unconfined stream and riparian area exists to southwest of the plot and the Klamath River mainstem corridor and floodplain wraps around the east and south of the plot. Riparian vegetation includes willow, mugwort, Oregon grape and cottonwood.

We identified 22 different species at *Tishánik*, 12 which had known cultural use by Karuk people. This plot has very little canopy cover, with an average of 4.2% cover in the plot and range of 0-16.8% cover in each subplot. Ponderosa pine is the dominant tree species with Douglas fir codominant. The most abundant tree species are madrone, ponderosa pine, and Oregon ash with madrone and Douglas fir the most abundant seedling and saplings. Manzanita is the most abundant shrub followed by invasive Scotch broom. Dead and dying Scotch broom, madrone, and Douglas fir are also found in the plot. The plot is largely open with grasses, blue dicks, and the miniature lupin species as the primary herbs.

Focal species being monitored: Manzanita, blue dicks.

Animals active at site: Elk, deer, bear, coyote, mole and quail sign observed at plot, and robins, flickers, crow, red tailed hawks, scrub jay and Steller's jays observed at plot during seasonal and harvest visits.

BOX 2.4 Plot 3 Wetland-riparian information

- Overview: A high order unconfined stream and flows to southwest of plot and the Klamath River mainstem corridor and floodplain wraps around the East and South of plot

- Wetland-Riparian vegetation includes willow, mugwort, oregon grape and cottonwood
- Canopy closure at transects in creek and riparian area:
    - Transect 1, Channel 1 (south), right bank: 11.60%, thalweg: 10.56%, left bank: 26.16%; Transect 1, Channel 2 (north), right bank: 88.56%, thalweg: 37.60%, left bank: 93.76%;
    - Transect 2, right bank: 62.56%, thalweg: 0%, left bank: 24.08%;
    - Transect 3, right bank: 64.64%, thalweg: 7.44%, left bank: 55.28%
- Wetland-Riparian other monitoring: 3 stream and riparian vegetation transects, stream channel wet (depth and width) and dry (bankfull and flood-prone width/depth) dimensions conducted in lower high order, unconfined stream to West of Plot; Willow root and stem patches and harvest surveys

Land use and management history: Pre-European colonization and settlement, this riverine floodplain plot was a prominent village site, ceremonial area and important ecocultural landscape supporting habitat for culturally important plant, fish and animal species. After gold was discovered in the Salmon River in 1851, extensive placer deposits near Orleans attracted miners around 1852 and smaller placer mines, hand sluices, mining claims and homesteads were established in the direct vicinity of the plot in the 1850s-1880s. The Orleans Gold Bar Mining Syndicate was formed in the 1880s and undertook larger mining operations, including hydraulic mining beginning in 1890s, followed by dredge mining through World War II. These mining activities significantly modified the topography, soil, vegetation, geomorphology and hydrology of the cultural riverscape and floodplain. The channel of the large creek to the south was modified and straightened by a USDA Forest Service boulder stream structure project in the mid-20th century. Karuk people continued to live at this site after colonization, as reflected in historic maps and correspondence from the 1850s through 1958. The revitalization of ceremonies at the site is documented as early as 1873 and continued through WWII circa 1944. Following a brief pause in the mid-20th century, ceremonies began again in 1989 and have continued to the present. The site is part of the Panamnik World Renewal Ceremonial District, which was added to the National Historic Register in 1978 after an attempt to build a bridge through the area. The Karuk Tribe *rematriated*, meaning returned the land to Tribal ownership and management in stages: first a small parcel in the floodplain in the early 2000s, the majority of the full floodplain in 2015, and a parcel in the adjacent creek mouth in 2019. The Tribe and collaborators are in the process of restoring the river, riparian area and floodplain, and revitalizing cultural resource patches such as willow, grape, manzanita, blue dick and deer potatoes (Triteleia

laxa, *pufichtáyiith*) through cultural burning, thinning, coppicing, pruning, transplanting and invasive management. The area has been treated with cultural burns in 2015, 2018, 2019, 2020 and 2021. Treatments have been designed to control invasive species (Scotch broom, locust, star thistle and invasive grasses) and promote native cultural use species, for example to control pests and encourage young, straight willow shoots for basketry, or to encourage the growth of edible geophytes (deer and blue dick potatoes) and Oregon grape root.

Cultural practitioner Lisa Morehead-Hillman shared her future hopes for this site:

> *What is the dream for this area? [It's] about being able to re-establish this place as a ceremonial district in the minds of the decision-makers who are, in this case, the federal government. It's those people in 1978 who had this dream of bringing back world renewal ceremonies. And that dream drove some people to fight for it or to say, "This is what we want." And [the] federal government, recognizing that this is now, in our more modern times, an obligation to the people from this area, especially after so many years of genocide. And it's not over yet, let's not just say that, but that there is a change in the way that people think about land and what should be done with it. And I think that those dreamers of the past and of now can help people understand the things that should be done.*
> *(Lisa Morehead-Hillman, ITEK, 7.31.2020)*

Fire History:

1. 8/7/1910, Arson Fire, 498 acres, Fire #200016

2. 8/6/1924, Debris Fire, 90 acres, Fire #200136

3. 9/10/2001, Unknown/Campfire, 62 acres, Fire #73

4. 6/28/2003, 85 acres, Fire #17

5. 7/29/2013, 577 acres, Incident # 22

6. Prescribed burns: 2015, 2018, 2019, 7/17/2020 (Broadcast burn, 13.47 acres), 10/2021

Land use/land cover change: The land use/cover change summary figure below shows the impact of the large flood of 1964, which denuded the floodplain of vegetation completely. First herbaceous cover re-established quickly after the flood disturbance, then woody land cover re-established steadily after, with manzanita shrubs and other woody vegetation taking over herbaceous cover, with the exception of between 2012 and 2014, likely due to the 2013 fire. Note that the 1989 image, though displayed, is not included in the analyses below due to poor image quality.

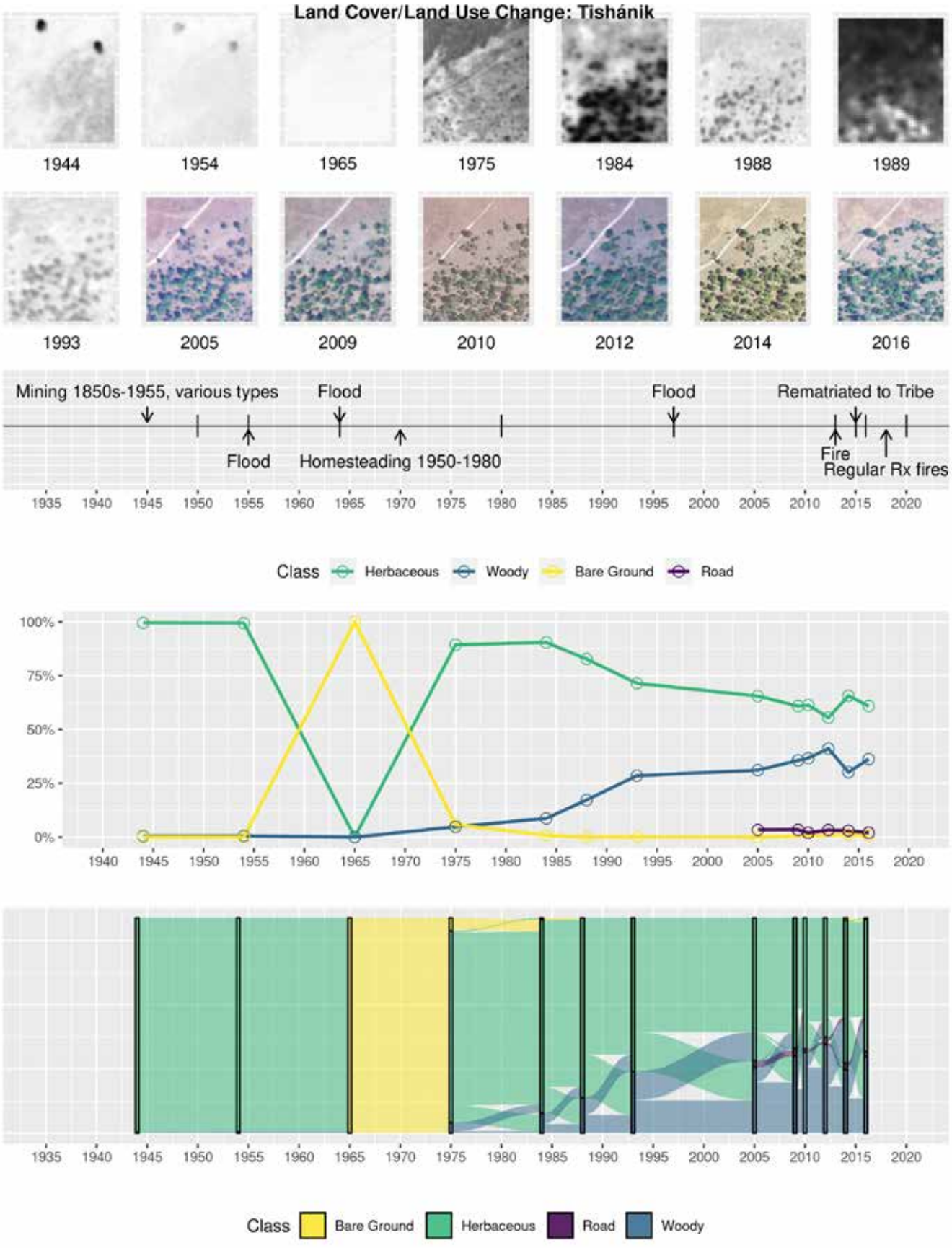
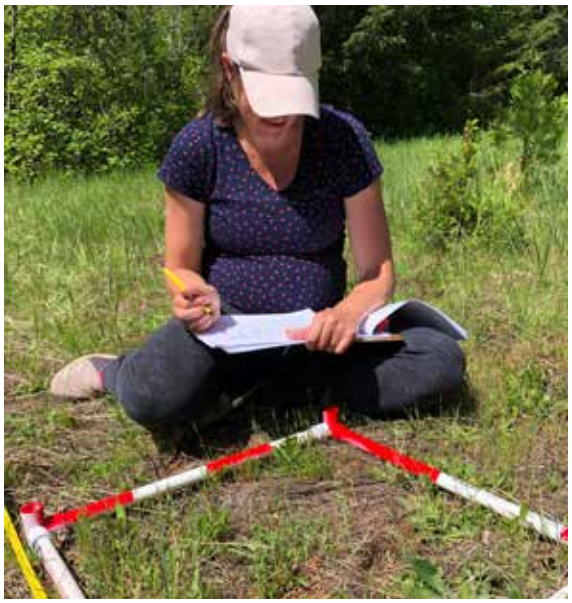


FIGURE 2.5: Land use/land cover change image of Tishánik plot

Cultural Resource Technician Vikki Preston conducts seasonal survey and harvests deer potatoes in the ACA plot, October 2019. Photo credit: Daniel Sarna-Wojcicki.



Megan Mucioki surveys herbaceous vegetation in an ACA Plot. Photo credit: Jennifer Sowerwine.

Daniel Sarna-Wojcicki sets up a transect. Photo credit: Jennifer Sowerwine.

Shawn Bourque and Kathy McCovey harvest willow roots in the riparian area of the creek mouth/mainstem confluence, March 2020. Photo credit: Daniel Sarna-Wojcicki.

Kathy McCovey harvesting willow roots in the riparian area of the creek mouth/mainstem confluence. Photo credit: Daniel Sarna-Wojcicki.

USDA Forest Service research ecologist and Karuk cultural practitioner Frank Lake observes the impacts of a recent cultural burn on a manzanita shrub in the ACA plot, October 2020. Photo credit: Daniel Sarna-Wojcicki.

2.2.4 PLOT 4. LOWER SIMS

Land Status: Karuk Tribe owns.

Biophysical setting (Landfire): Mediterranean California Mixed Evergreen Forest. Indications are that the area had an intermix of vegetation characteristics historically. This should be addressed accordingly in the LandFire data and corresponding layers.

Existing vegetation type (Landfire): Mediterranean California Mixed Evergreen Forest

Geology/Generalized Rock Type/Soil Type: Gen Rock Type J (Jurassic); marine sedimentary and metasedimentary rocks (see above for description). Soil type: “Horseshoe family” (NITMP 1997).

Physical attributes: It has a 25-30% southwest facing slope with areas of red-clay soil and shale schist. The average fuel and duff depth is 3.88 cm, ranging from 0-9 cm.

Vegetation/culturally significant plants: This plot features a large patch of blackcap that is being encroached by Himalayan blackberry. Douglas fir and tanoak comprise the tree overstory canopy. There have been both wildfires and controlled burns (2012, 2015, 2017, 2019) at this site, one (2017) that burned very hot and killed many tanoak and Douglas fir trees, resulting in standing dead trees. There is also an abundance of madrone seedlings in portions of this plot. A small second order, confined intermittent stream runs to the east of the plot, and riparian vegetation includes Himalayan blackberry thickets, gooseberry, Oregon grape, woodwardia/bracken/maidenhair fern, evergreen huckleberry, California hawthorne, bay laurel, madrone, black oak, tanoak and Douglas fir.

The Lower Sims plot has an average of 65.94% canopy cover with a fairly even cover throughout. Out of 28 identified species, 13 were known cultural use species. Douglas fir, tanoak, and madrone are the three most abundant tree species. Douglas fir is the dominant tree species and tanoak the codominant tree species. Madrone is the most abundant seedling/sapling species followed by Douglas fir. Black cap, Himalayan blackberry, and gooseberry are the most abundant shrub species and young deer brush and bedstraw are the most abundant herbs. The canopy is uniform by species, with Douglas fir accounting for 45.38% of the canopy and tanoak 14.92%.

Focal species being monitored: Blackcap, external plot of yerba buena nearby.

Animals active at site: Elk, bear, deer, coyote, fox and hairy woodpecker.

BOX 2.5 **Plot 4 Wetland-riparian information (confined intermittent stream)**

- Overview: Small second order, confined intermittent stream empties from a culvert below the road and runs to the east of the plot downstream to a confluence with a larger creek
- Wetland-Riparian vegetation: Himalayan blackberry thickets, gooseberry, Oregon grape, woodwardia/bracken/maidenhair/sword fern, evergreen huckleberry, California hawthorne, bay laurel, madrone, black oak, tan oak, Douglas fir
- Canopy closure at transects: 94.80%, 41.76%

- Wetland-Riparian other monitoring: 3 stream and riparian vegetation transects, stream channel wet (depth and width) and dry (bankfull and flood-prone width/depth) dimensions conducted Aug 2020

Land use and management history: This plot is located close to a Karuk village site noted on an 1885 mining map and was likely used precontact for acorn management, harvesting and processing in mid-slope terraces; black cap and fern management, harvesting and processing in riparian areas and terraces. It is associated with the *Panamnik* World Renewal Ceremonial District. Extensive mining around the plot began in 1852, and small creeks were re-routed for hand sluices beginning in the 1850s. The lower ditch below the plot was constructed ca. 1880. The Orleans Bar Gold Mining Company (OGBMC) built 15 miles of ditches, flumes and tunnels in 1887 to service 4 hydraulic mines, with the upper ditch above the plot constructed in 1887. The nearby Karuk village was destroyed by hydraulic mining in winter 1904. OGBMC mining operations and ditches were abandoned in 1912. As mentioned in a Non-Industrial Timber Management plan for the unit that includes the plot, "Karuk village sites (were) washed away by hydraulic monitors...The displacement of Karuks and destruction of their subsistence radically altered the landscape. The cessation of cultural burning patterns resulted in a change of vegetative type from oaks to conifers...Bedrock exposed by mining remains denuded of soil and vegetation 100 years later." A cabin and homestead existed below the plot from the 1880s through the 1930s. Logging began in the 1880s and continued through the 20th century, with selection, salvage and heavy removal harvest entries throughout the property from the 1880s to 1955; tractor logging 1955-1968 for larger diameter trees; and from 1968-1978, 60 acres harvested for smaller dimensions. Between 1930 and 1965, a number of trails, fire roads and logging roads were built between the Smith River and California State Route 96 near Orleans by the USFS. Plans were developed by USFS in 1963 to build a major transportation route between Gasquet and Orleans, the so-called "G-O Road". By 1965, road construction in between the lower and upper Sims ACA plot locations had begun and by 1975 had been completed. However, further construction of the full G-O Road corridor was halted in the 1970s-80s due to its potentially devastating impacts on culturally sensitive areas by Tribal community activism, archaeological surveys, Environmental Impact Statements, a National Register of Historic Places designation, court cases, the passage of the California Wilderness Act of 1984 and finally the Smith River National Recreation Area Act of 1990. The Karuk Tribe rematriated the property in 1994 from a private landowner, and began conducting cultural burns and fuels treatments through the Karuk-led Western Klamath Restoration Partnership Training and Exchange (TREX) programs. The property was treated in 2012, 2015, 2017 and 2019.

Fire history:

1. 1916 Fire, “Sims Gulch Fire”, wildfire, 206 acres

2. 1929 Fire, “Camp Creek Fire”, wildfire, 338 m West, 84 acres

3. 1949 Fire, “Upper Camp Creek” wildfire, 27 acres, 1.3 km west

4. 1993, Listed in Non-Industrial Timber Management Plan-emergency 16-acre arson fire followed by salvage operation.

5. 2002 Fire, “Go Fire”, wildfire, 626 m south

6. 2012 Rx Burn

7. 2013 Fire, arson fire, 576 acres, 280 m south, at *Tishánik*

8. 2015 Rx Fire, Broadcast Burn, 64 acres

9. 2017 TREX “fire use” treatment type, 392 acres

10. 2019 TREX Burn, 10/7-10/19/2019, Broadcast Burn, 61.47 acres

Long term land use/land cover change: In the figure below, aerial images show the forested/woody land cover growing consistently since 1944, with the exception of 1975-1984, likely due to selective logging and the building of the G-O road, and 2014-2016, likely due to thinning and prescribed burning in the unit.

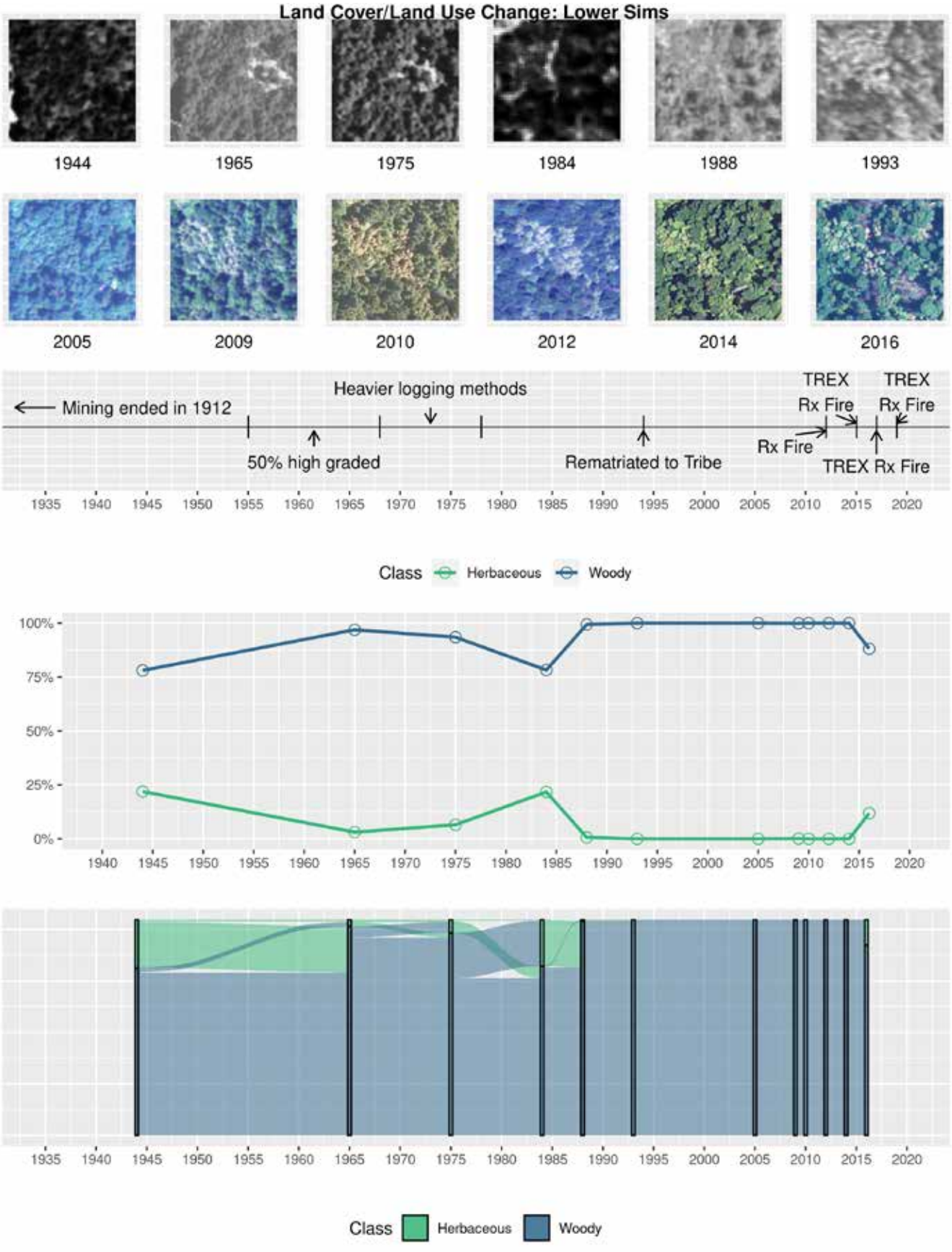


FIGURE 2.6: Land use/land cover change image for Lower Sims.

Center of Lower Sims ACA plot facing south. Photo credit: Daniel Sarna-Wojcicki.

Invasive Himalayan blackberry chokes up the creek along the Lower Sims ACA plot. Photo credit: Daniel Sarna-Wojcicki.

Creek and riparian area to the east of the plot. Photo credit: Daniel Sarna-Wojcicki.

Along creek, below Transect 2 on the east bank looking north. Photo credit: Daniel Sarna-Wojcicki.

2.2.5 PLOT 5. UPPER SIMS

Land Status: Karuk Tribe owns.

Biophysical setting (Landfire): Mediterranean California Mixed Evergreen Forest. Indications are that the area had an intermix of vegetation characteristics historically. This should be addressed accordingly in the LandFire data and corresponding layers.

Existing vegetation type (Landfire): Mediterranean California Mixed Evergreen Forest

Geology/generalized Rock Type/Soil Type: Gen Rock Type J (Jurassic); marine sedimentary and metasedimentary rocks (See above for description). Soil type: "Horseshoe family" (NTIMP 1997).

Physical attributes: The average fuel and duff depth was 7 cm, ranging from 4-12 cm. The plot has a slope of 20% with a north-west facing slope and brown-clay soil throughout.

Vegetation/culturally significant plants: This plot features large legacy black oaks which are experiencing crowding from conifers, as well as yerba buena, hazel, tanoak, woodwardia, and evergreen huckleberry. There is a small, first order intermittent creek that emerges from a seep at the bottom of a hillslope directly to the north of the plot and runs along the eastern edge of the plot. Portions of the stream retain flowing water into the dry season and most of the plot remains moist throughout the season.

The Upper Sims plot has fairly uniform 81.80% (range 82.32-84.4%) canopy cover with Douglas fir the dominant tree species and alder the co-dominant species. There are 33 species, 21 of which are cultural use species. Douglas fir and black oak are the most abundant tree species in the plot with tanoak and Douglas fir accounting for the most abundant seedlings/saplings. Black oak and madrone are the most numerous dead species. Hazel and evergreen huckleberry are the most abundant shrub species and sword fern, moss, and whipplea the most abundant herb species.

Focal species being monitored: Yerba buena, hazel, woodwardia, evergreen huckleberry and black oak.

Animals active at site: Elk, deer, bear, coyote, fox, acorn woodpecker, chipmunk, Steller's jay.

BOX 2.6 Plot 5 Wetland-riparian information (seep and confined, first order intermittent creek)

- Overview: Small, first order intermittent creek emerges from seeps at bottom of a hillslope north of the plot, runs along the eastern edge of the plot
- CRAM scoring:

  1. Buffer and Landscape Context: a. Stream Corridor Continuity: A; b. % AA w Buffer: A; c. Average Buffer width: B; d: Buffer Condition: B; Total attribute score: = 90.3%

  2. Hydrology: a. Water Source: B; b. Channel Stability: A; c. Hydrologic Connectivity: Average Entrenchment Ratio: (2.08 + 1.45 + 4.58)/3= 2.7, "A" (>1.8); Total attribute score = 91.67%

  3. Physical Structure: a. Structural patch richness: A; b. Topographic Complexity: B; Total attribute score= 87.5%

  4. Attribute 4: Plant Community: a. Plant community composition: i. Plant layers: A; ii. Number of co-dominant species: A; iii. % Invasion: A; Plant Community Metric Average= A; b. Horizontal Interspersion: B; c. Vertical Overlap: B; Total Attribute Score: 83.33%

  5. Overall Score: 88.2%

- Canopy closure at transects: 80.24%, 85.44%, 91.68%
- Wetland-RIparian Vegetation: yerba buena, hazel, tanoak, black oak, red alder, woodwardia/bracken/sword fern, and evergreen huckleberry
- Wetland-Riparian other monitoring: Wet/dry streamflow mapping, Oct 2020, 2021; Woodwardia and Tea patches established; Transect 1 and Transect 2 of ACA plot veg. transect overlaps w. Riparian Transect 1/Transect 2 (respectively)

Land use and management history: Located in close proximity to a traditional village site, this site was likely tended for cultural resources such as hazel, black and tanoak, woodwardia, soap root, iris, yerba buena and alder. Kathy McCovey explained Karuk pre-contact burning strategy:

> *[F]rom the village site, the women burned about a two-mile radius for fine-grain material. That's oak woodlands, grasslands for basketry material, medicinal plants. All the medicines that we took are herbs and most of the medicines that we pick are herbs and they're made in tea form. And so that first two-mile donut was women burning. Women burning for fine-grain mosaic. After that was another two-mile donut area and it was felt that the men burned those areas for the coarser grain mosaic, for the deer feed and stuff like that. So they were burning for coarser grain in the two miles, so you got four miles from your village is being heavily managed and then would take you out four miles, so four miles further, you're probably getting a combination of men burning as they come in from the high country hunting, and you're getting some lightning strikes...probably about five or six miles out of town. (Kathy McCovey, ITEK, 5.15.2019)*

In the mining era, this plot was inhabited by miners and ditch tenders dating back to about 1868. Sections of the plot were logged and replanted in the 1960s-1980s. The Karuk Tribe reacquired and rematriated this land from a private landowner in 1994.

Fire history:

1. 1916 Fire, "Sims Gulch Fire", wildfire, 206 acres.

2. 1949 Fire, "Upper Camp Creek" wildfire, 27 acres, 1.3 km west.

3. 1993 — Listed in NTIMP — emergency 16-acre arson fire followed by salvage operation.

4. 1998 Fire, No Name, wildfire, 287 acres about 540 m from plot center.

5. 2013 Fire, arson fire, 576 acres, 280 m south.

6. 2015, 2017 2019, TREX prescribed burns below plot in lower Sims; did not impact plot.

Long term land use/land cover change: In the figure below, the cleared area around the former ditch tender's cabin can be seen in the center right of the 1944 aerial image. The logging activities of the 1960s and 1970s converted much of the land cover from woody to herbaceous vegetation, especially in the northwest corner of the plot. The vegetation remained herbaceous and fairly open through the 1993 image set and has rapidly converted to woody cover (Douglas fir, planted redwood and some remaining legacy black oaks) whose canopies now cover nearly the entire plot.

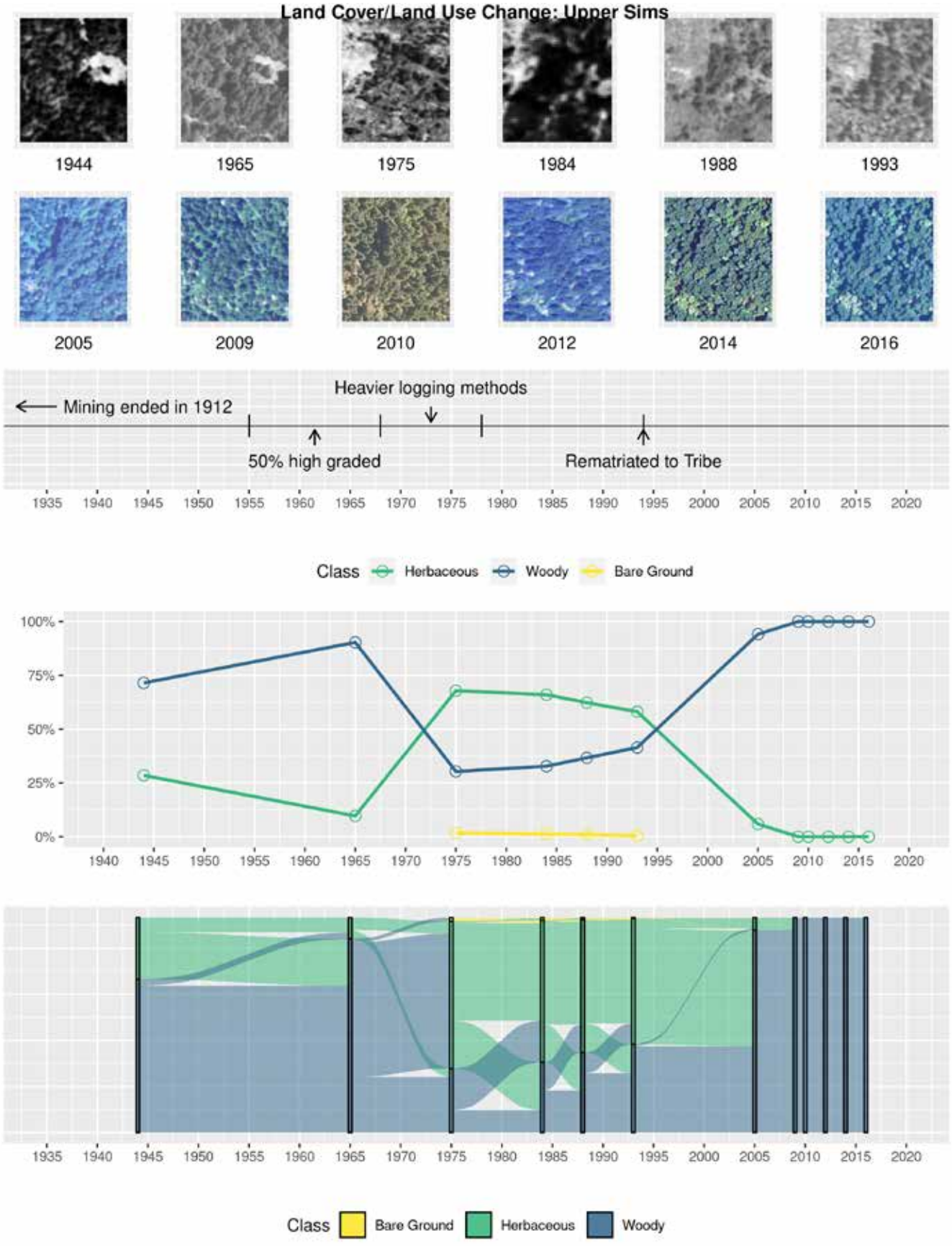


FIGURE 2.7: Land use/land cover change image for Upper Sims.

Kathy McCovey harvests yerba buena, May, 2021. Photo credit: Daniel Sarna-Wojcicki.

Woodwardia patch near Transect 1 in Upper Sims ACA plot, facing northeast, 4.18.2020.
Photo credit: Daniel Sarna-Wojcicki.

Woodwardia fern patch at Upper Sims ACA Plot. Photo credit: Daniel Sarna-Wojcicki.

Hazel shrub in ACA plot. Photo credit: Daniel Sarna-Wojcicki.

2.2.6 PLOT 6. *IKXARIYÁTUUYSHIP*

Land Status: Karuk Aboriginal Territory/claimed concurrently by USDA Forest Service Klamath National Forest-Administered by Six Rivers National Forest.

Biophysical setting (Landfire): Mediterranean California Mixed Evergreen.

Existing vegetation type (Landfire): Mediterranean California Mixed Evergreen.

Geology/Generalized Rock Type/Soil Type: Generalized Rock Type: um/ultramafic. Description: Ultramafic rocks, mostly serpentine. Minor peridotite, gabbro, and diabase; chiefly Mesozoic. Soil: serpentine.

Physical attributes: The plot is flat with a 9% slope and is located at mid-slope. It has red clay soil throughout with an average fuel dept of 11.88 cm.

Vegetation/culturally significant plants: This plot is a historic black oak grassland gathering area that has since been encroached by Douglas fir. This area has serpentine soils and includes remnant black oaks and hazel, iris, wood rose, pepperwood, sword fern, black cap, and Douglas fir. We identified 20 different plant species, 13 of which had known cultural uses. The plot is very densely forested, with an average canopy cover of 88.56%, ranging from 91.68% to 81.28% in the four subplots. Douglas fir is the dominant species in this plot with black oak the co-dominant species. Douglas fir, madrone, and black oak are the most abundant adult and seedling/sapling tree species, as well as the species with the most abundant dead material. Hazelnut, honeysuckle, and shrubby tanoak are the most abundant shrub species. Poison oak and wood rose are the most abundant herb species.

Focal species being monitored: Hazel, black oak, tan oak, bay laurel/pepperwood.

Animals active at site: Deer, bear and elk.

Riparian other monitoring: Nearby pond riparian fringe rapid vegetation assessment; depth of pond monitored August 2020, October 2021.

Land use and management history:

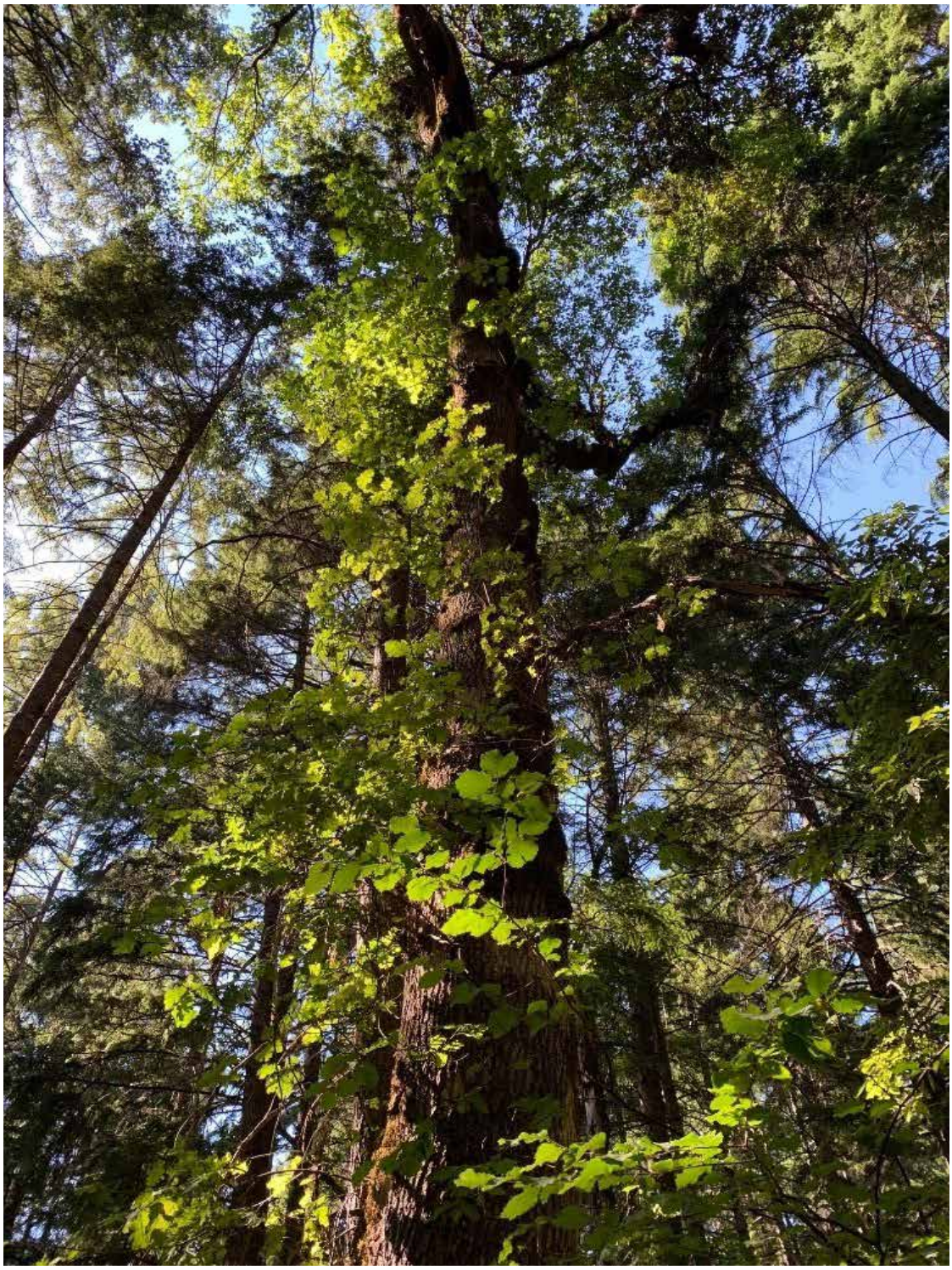
> *We're on what they call Offield Mountain. We call it Ikxariyátuuyship, which is the spirit people's mountain. This is the only one we call that...the mountain here [is] at our center of the world and it's ceremonially during the [Katimin Pikyawish] that we traditionally would go up on top of this mountain and roll logs off in three different chutes...We haven't done that in many, many years because a lot of our ancestors*

were arrested or hung down the hill for that activity...but it really needs to happen... and we're planning a project with a lot of our family members to restore the landscape to be able to accept fire in a good way...and I hope that we can get it together and done so [the] kids can be the ones to bring that back.
(Chook Chook Hillman, ITEK, 8.14.2020)

Precontact, this area was part of a ceremonial landscape burned annually and stewarded for cultural resources including black oak and tanoak acorns, hazel sticks and nuts, iris string and fiber, pepperwood nuts and black cap berries (See also Kroeber and Gifford 1949, p. 21). The area was heavily logged by the USFS from the 1950s-1980s, until a standoff with the Karuk Tribe in the mid-1980s brought logging to a halt. USFS fire exclusion and suppression of cultural burning converted an actively managed black oak-hazel-grassland to mixed evergreen forest dominated by young Douglas fir trees. There is no riparian area associated with the plot other than a small pond a couple of miles to the north which is an important ceremonial area and also critical turtle breeding habitat.

WKRP planned or completed treatments: ACA plot 6 is part of a 43.26 acre unit in the *Ikxariyátuuyship* project, with the proposed treatment actions including Mechanical-ground-based, Manual and Rx Burn treatment types.

Pond, wetland and riparian fringe near ACA Plot. Photo credit: Daniel Sarna-Wojcicki.



Encroached Black Oak in *Ikxariyátuuyship* ACA plot, July 2020.
Photo credit: Daniel Sarna-Wojcicki.

2.2.7 PLOT 7. OWL MINE

Land status: Karuk Aboriginal Territory/USDA Forest Service Six Rivers National Forest.

Biophysical setting (Landfire): Mediterranean California Mixed Evergreen Forest.

Existing vegetation type (Landfire): Mediterranean California Mixed Evergreen Forest in forested section of plot (about 2/3 of plot). Meadow and manzanita patch section (about 1/3 of plot) should be reclassified as California Montane Woodland and Chaparral.

Geology/Generalized Rock Type/Soil Type: Gen Rock Type J (Jurassic); marine sedimentary and metasedimentary rocks (see above for description).

Physical attributes: The soil is red clay with 8.45 cm of fuel. The risk of Sudden Oak Death infection is low for this plot.

Vegetation/cultural use plants: The plot includes tanoak, tanoak mushrooms, manzanita, iris, evergreen huckleberries, prince's pine, and madrone. The plot has dense sections of invasive Scotch broom, sweet pea, and Himalayan blackberry. The dominant tree species is Douglas fir with the co-dominant tanoak. Tanoak, Douglas fir, and madrone trees account for the most abundant adult and seedling/sapling trees. Madrone, manzanita, and tanoak are the most abundant dead trees and shrubs. Shrubby tanoaks, evergreen huckleberry, and salal are the most abundant shrubs; bracken fern, honeysuckle, and violet are the most abundant herbs. The canopy cover is 82.06%, ranging from 70-93%. Out of 21 identified plant species, 13 had known cultural uses.

Focal species being monitored: Tanoak, tanoak mushrooms, huckleberry, manzanita.

Wetland-riparian: None present.

Animals active at site: Bear, elk and fox.

Land use and management history: This plot was historically managed by three nearby villages. The area was then mined and inhabited by homesteaders from the 1880s-1930s, with cars, bedframes, machinery, foundations and other household items still remaining in the plot and a capped deep mine shaft close by. The site is slated for future management by the Karuk Tribe and WKRP partners.

Owl Mine meadow on east side of ACA plot. Photo credit: Daniel Sarna-Wojcicki.

RACCCA team after setting up an ACA plot at Owl Mine, June 2020. Photo credit: Jennifer Sowerwine.

Legacy tan oak trees in Owl Mine ACA plot. Photo credit: Daniel Sarna-Wojcicki.

2.2.8 PLOT 8. PATTERSON

Land Status: Karuk Aboriginal Territory/USDA Forest Service Klamath National Forest-Administered by Six Rivers National Forest.

Biophysical setting (Landfire): Mediterranean California Mixed Evergreen Forest.

Existing vegetation type (Landfire): Mostly Mediterranean California Mixed Evergreen Forest, but the top northeast corner classified as Western Warm Temperate Urban Shrubland/Developed Upland Evergreen Forest/Mixed Evergreen-Deciduous Shrubland due to proximity to road and geo-referencing discrepancy between satellite/aerial images LandFire classified (2018).

Geology/Generalized Rock Type/Soil Type: um, ultramafics, plutonic rocks, ultramafic rocks, mostly serpentine (see above for description). Soil: red clay.

Physical attributes: The plot is mid-slope with a 15% slope. It has red clay soil with an average fuel depth of 8.6 centimeters. The plot is at medium risk for SOD transference, with tanoak but no bay laurel present and close to the road.

Vegetation/culturally significant plants: This plot is an old tanoak acorn grove managed and used for gathering and processing acorns, with a diversity of other culturally important plants including elk clover, big leaf maple, princes pine, yew, madrone, salal, rattlesnake plantain, hazel, Oregon grape, chinquapin, Iris, woodwardia and trailing blackberry. The dominant tree species is Douglas fir and co-dominant tanoak. Tanoak, Douglas fir, and madrone are the most abundant seedling/sapling species and dead materials in the plot. The tree canopy cover is fairly dense, 82.06% on average for the four subplots, ranging from 70-93%. Poison oak is the most abundant shrub followed by tanoak (shrub form) honeysuckle, and snowbrush ceanothus; there is very little herbaceous cover or diversity in this plot. Of 12 identified species in the plot, 9 had known cultural uses.

Focal Species being monitored: Tanoak.

Animals active at site: This area may also have been managed and used for deer and elk hunting.

BOX 2.7 **Plot 8 Wetland-riparian information (intermittent creek)**

- Overview: Small second order intermittent creek flowing 10-15 m to South of ACA plot. Creek empties from a culvert under a logging road and flows west for ~1km to confluence with another creek.

- Wetland-Riparian vegetation: sword/woodwardia/bracken fern, elk clover, hazel, tanoak, dogwood, Douglas fir, big leaf maple
- Canopy closure at transects: 89.58%, 90.63%, 93.75%
- CRAM Scoring:

    1. Buffer and Landscape Context: a. stream corridor continuity: A; b. % w buffer: A; c. av. buffer width: B; d. buffer condition: A; Total attribute score=96.53%

    2. Hydrology: a. water source: B; b. channel stability: B; Bank and stream channel incision, bank undercutting on 2/3 transects; erosion and bank failure on one.; c. Entrenchment ratios (2.27, 3.44, 1.36; av=2.32): A; Total attribute score=83.33%

    3. Physical structure: structural patch richness: A; topo complexity: B2; Total attribute score: 87.5%

    4. Biotic Community: plant layers: A; co-dominant species: A; % invasion: A; Average=A; Horizontal interspersion: C; Vertical Biotic Structure CRAM rating: B; Total attribute score=75%

    5. Overall score: 85.59%

- Wetland-Riparian other monitoring: 3 stream and riparian vegetation transects, stream channel wet (depth and width) and dry (bankfull and flood-prone width/depth) dimensions conducted, Aug 2020, Wet/dry streamflow mapping conducted Oct 2021

Land use and management history: The plot at Patterson is a legacy tanoak acorn grove likely used for gathering with a diversity of other culturally important plants. The area was also potentially used for deer and elk hunting and processing, according to Karuk archaeologist-anthropologist and cultural practitioner Kathy McCovey. A small intermittent, confined second order creek flows 10-15 m to the south of ACA plot. The creek empties from a culvert under a logging road and flows west for about 1 km to a confluence with another creek downstream. Riparian vegetation includes sword/woodwardia/bracken fern, elk clover, hazel, tanoak, dogwood, Douglas fir and big leaf maple. The plot was close to the McCash Fire footprint August-November 2021. Management actions were taken to protect legacy tanoak trees and ultimately the plot did not burn. On October 15, 2021, part of the ACA plot near the legacy tan oaks was partially prescribed burned, but the burns did not cover the whole plot.

WKRP planned or completed treatments: Proposed treatments (4/23/2017) included manual, then broadcast burn to protect property, and a note to consider fire control features and fuel breaks on private property. Treatment actions were undertaken in 2021, including Mechanical-Machine Pile Burn (10.21 acres) on 1/19/2021, Mechanical-thinning and machine pile 6/25/2019-8/1/2019 (10.21 acres), followed by a broadcast burn (10.21 acres) as part of TREX 2021 on 10/15/2021.

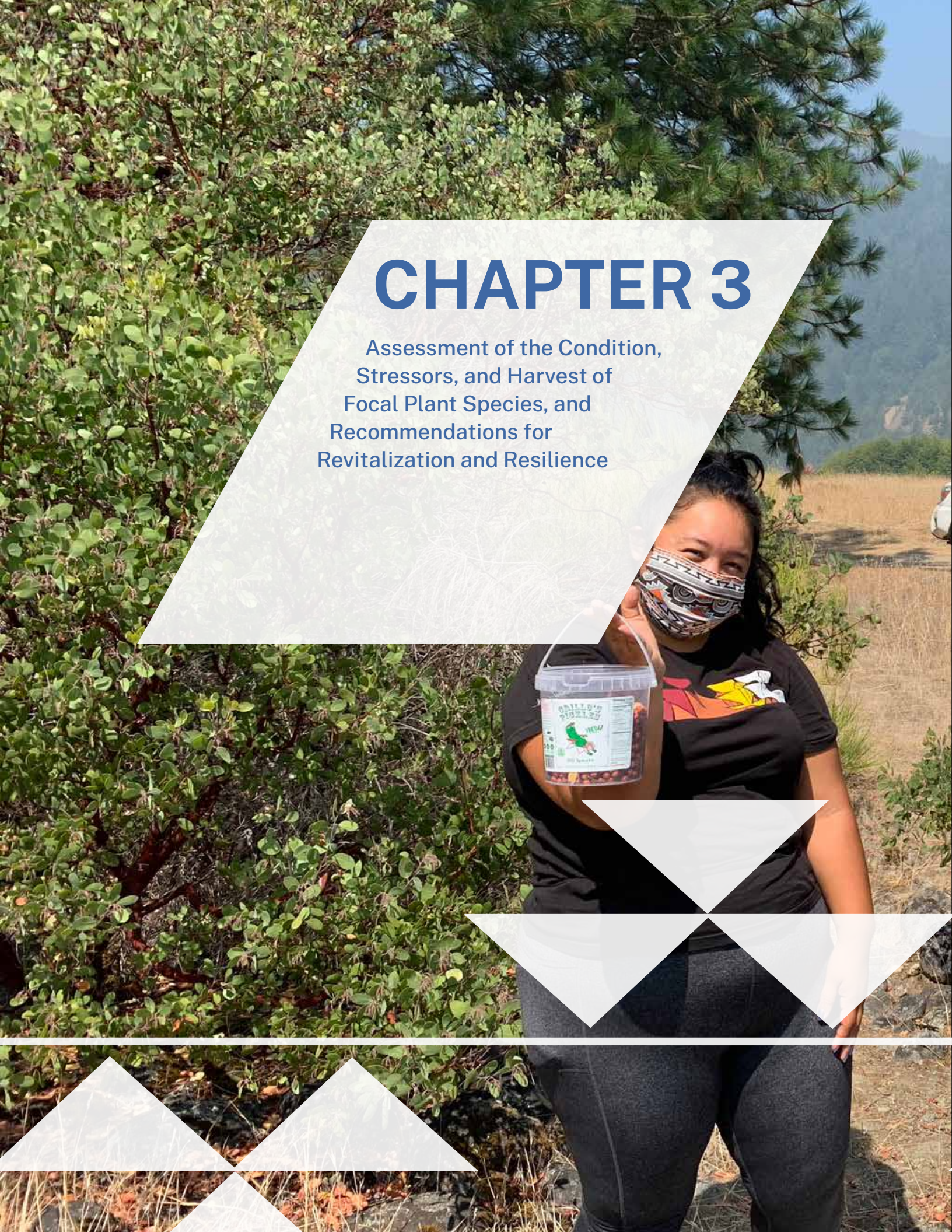
Riparian Transect #3 facing east/upstream, Oct 2020. Photo credit: Daniel Sarna-Wojcicki.

TREX burn in Patterson ACA plot, Oct 15, 2021. Photo credit: Frank Lake.

Creek, riparian area and large woody debris near the Patterson ACA Plot. Photo credit: Daniel Sarna-Wojcicki.

CHAPTER 3

Assessment of the Condition, Stressors, and Harvest of Focal Plant Species, and Recommendations for Revitalization and Resilience



3.1 INTRODUCTION

Chapter three presents our observations and assessment of the quality, condition, abundance and stressors of 19[9] cultural plant "focal species" in 31 plots and patches, that have been prioritized by the Karuk Tribe for long-term monitoring (see Table 1.2 in Chapter 1). For each species we summarize observations of phenology, evidence of climate stress, disease and threat from invasive plants, as well as harvest data from the 2019 and 2020 seasons (summarized in Table 3.1). We conclude with recommendations for future management and monitoring from cultural practitioners to ensure the health, abundance, and harvest quality of these plants in this chapter and in chapter four. We also discuss the findings from our analysis of historical voucher specimens regarding the historical collection and distribution of culturally significant plants in the Karuk Aboriginal Territory.

Woodwardia fern patch near *Kámmaahriv* plot. Photo credit: Daniel Sarna-Wojcicki.

9 In Chapter 1, we present a table of 20 focal plant species that we focused on in this project. In chapter 3, we detail findings on 19 of these plants, with more information needed on California/trailing blackberry.

Pacific yew tree, *Táasich* ACA Plot. Photo credit: Daniel Sarna-Wojcicki.

3.2 GENERAL OBSERVATIONS OF FOCAL PLANT CONDITION AND CLIMATE STRESS

The overall quality and condition of the majority of the focal species found in our plots and patches were relatively poor, and harvests were unpredictable. During the 2019 and 2020 harvest seasons, 18 out of 31 (58%) focal plant areas had failed harvests or no reproduction at all. Many others had very limited harvest or highly variable harvest across the two years (see Table 3.1). The data collected suggest an urgent need for intervention management to enhance cultural use quality, as well as close monitoring of species experiencing climate stress.

We observed climate stress in several species. We found focal plants which require cool, wet environments to survive and thrive, including black fern (or five-finger fern), yerba buena, and yew, to be especially sensitive to acute changes in soil moisture and exposure. Many focal species do tolerate some level of water and heat stress, although they may not thrive and produce at their best in these conditions. This ability may be an advantage in outcompeting other species in less preferable conditions and claiming space and resources to support mature growth. We observed this with chinquapin.

Species like manzanita that prefer full sun, are drought resistant, and tolerate extreme summer heat, had sunburnt berries in the height of summer during our observational years, likely due to an anomaly heat dome and high pressure event. A year of failed reproduction coupled with a year of abundance was observed in evergreen huckleberry, chinquapin, manzanita, and sugar pine; in some instances, we suspect this is a sign of stress due to climate variability (i.e. unseasonable temperatures promoting early flowering, followed by a drop in temperature causing flower abortion, or earlier and longer periods of heat causing premature fruit to dry and drop). Several of the berry species are dioecious and depend on birds for distribution of their seeds. This poses potential challenges for reproduction if the population is small or fragmented and if there is timing mismatch between birds and berries. Several species-focused studies led by Ph.D. and master's students in collaboration with the Karuk Tribe have been invaluable in understanding the ecological and management requirements of culturally important plants (Halpern et al. 2022; Hart-Fredeluces et al. 2021; Marks-Block et al. 2021, 2022; Rentz 2003; Rossier 2019).

Most focal species are fire adapted and benefit from low-intensity fire. Many can survive high-intensity fire through resprouting at the base or crown (e.g. black oak, hazel, chinquapin, tanoak). However, they do not tolerate repeated high-intensity fires, which can threaten an entire landscape by altering the form of trees and large shrubs to small, shrubby, unproductive versions of themselves. Overly frequent fire can reduce the conditions and time needed for germination, development, and survival of seedlings — the next generation of reproductive organisms. It may also lead to proliferation of fire adapted early successional noxious weeds such as Scotch broom, as we observed in one of our plots. While many tree and shrub species do have regenerative mechanisms, mortality of mature, productive trees following catastrophic fire events (such as the Slater Fire that burned through Happy Camp in 2020) can be devastating to cultural use, as it can take decades for some trees (e.g. chinquapin, oak species, sugar pine, yew, and bay laurel) to reach a mature enough state for adequate reproduction, often the nuts, seeds or fruit utilized for food. Below we detail climate observations and harvest data for each focal plant from 2019–2020, and make management recommendations based on our findings.

Evidence of stress and disease in cultural use species: aborted trailing blackberry, curling brown hazel leaves, weevil infested tanoak, undeveloped madrone berries. Photo credits: Jennifer Sowerwine and Megan Mucioki.

3.3 CLIMATE AND HARVEST OBSERVATIONS AND MANAGEMENT RECOMMENDATIONS FOR FOCAL PLANTS

1. FIVE-FINGER/BLACK/MAIDENHAIR FERN (*Adiantum aleuticum, ikrittápkir*)

As soil moisture and perennial streams decline, this species is presumably at risk for water stress and drying up:

> *They are really susceptible to climate change because they tend to grow in areas that have some running water. So, as we are going through a drought — they just put out a little forecast that said we were in a drought condition here in Northern California. So, the more water dries up, the less that these five-fingered ferns will be sprouting out. (Kathy McCovey, ITEK, 3.3.2020)*

Water stress and hot, dry spring and summer seasons are complicating the quality and timing of harvest of black fern. Weavers have noticed that the black fern is dried out and brittle during harvest, not soft, as it should be for processing and weaving. Weavers use the black side of the stem as an overlay material, and when brittle, it will fray or break off from the weft root. Additionally, stems are not turning as dark as usual but remain brown; fronds are not a rich green but remain a light green color.

> *The black fern...used to be gathered in July, but it seems too hot, dry, and brittle now. So, I don't know if we need to start gathering it earlier. Talking with some other weavers, we're thinking that we just need to pay more attention and test it every little while to see when it is the best. Because, the last few years the black fern's been really brittle. (Climate Focus Group, ITEK, 1.15.2019)*

Twenty ferns were harvested in early August 2020 from Camp Creek Road patch (Table 3.1).

Black fern gathering, as with other gathering activities, is done in community with friends, family, and children. On the left, Frankie Tripp and her children gather black fern stems (pictured in little girl's hand) for basketry weaving. Pictured on the right, Lisa Morehead-Hillman and her granddaughter, Vunsiip, gather prolific black ferns. Photo credits: Lisa Morehead-Hillman and Leaf Hillman.

Maidenhair fern growing alongside a road and steep cut bank. Photo credit: Daniel Sarna-Wojcicki.

Kathy McCovey and Lisa Morehead-Hillman (on left and right) share their knowledge and basketry work with others in the community. The basket cap (pictured on the right) includes a design made using the black fern stems. Photo credit: Sophie Neuner Weinstein.

BOX 3.1 Management recommendations for black fern.

- Black fern habitat and patches are not widespread. The areas where they grow are important places to manage and maintain.
- Black fern patches must be avoided during back fires and riparian areas must be avoided when falling hazard trees during wildland fire fighting.
- Cool understory burn, around perimeter of fern patches. Night burn with high humidity in a very small area, very cost-effective to manage.

- Black ferns die back and regenerate in spring. This process creates an accumulation of dead material which must be managed. While gathering, clip dead material (do not pull by the roots) and remove them from the patch. Occasional lower intensity fires in riparian areas reduced competition with other understory vegetation and can rejuvenate black ferns if the rhizomes are not killed

2. GREEN LEAF MANZANITA (*Arctostaphylos patula, pahav'íppa*)

During the study period, the team observed more obvious and frequent death of whole manzanita bushes throughout Karuk Aboriginal Territory. Manzanita berry harvest is influenced by spring cycles of warming and cooling, making production and ripening erratic. Torrential spring rains have knocked flowers and younger forming/developing berries off the bush as they are ripening. Extreme temperatures in late spring and summer have caused berries to quickly turn brown as if they are being "cooked on the vine" (as described by Kathy McCovey during spring and summer 2020). Kathy McCovey noticed that the berries are predominantly seeds, with little flesh: "I just broke open a green berry. It has a little bit of fruit, but it looks like most of the energy of this plant is being utilized in the seeds, and that again to me is a sign of stress." (Kathy McCovey, spring/summer 2020). Kathy shared that manzanita berries have inherent worms that are expelled when heated. Many manzanita bushes had pink galls on their leaves from the manzanita leaf gall-aphid. This does not normally influence the health of the plant unless it is heavily infested.

At *Táasich* brown spots were observed on the leaves in full sun in May 2019. At *Tishánik*, in July 2019, many flowers and berries were found aborted during harvest time — we hypothesize as a result of excess heat. Some berries were also sunburnt from extreme heat. In August 2019, the same bushes had yellow/brown leaves and dried berries on the bush. At Owl Mine, 2020, there were no signs of fruiting on the bush or ground. Some of the leaves were dried.

The manzanita at *Táasich* was not harvestable for two seasons. Manzanita at *Tishánik* yielded four pounds of berries from a single bush in mid-July 2019. The following year the same group of bushes yielded fewer berries in good harvest condition, with only 20% of the manzanita in harvestable condition in early August 2020. In our study plots overall, we observed few berries at varied stages of ripeness. In 2020, we gathered only a small bucket-worth of berries: 46 oz.

BOX 3.2 Management recommendations for manzanita.

- Burning around and under manzanita bushes is needed to clear out brush and dead woody material. This will enhance the ability to gather from these bushes. Kathy struggled to get sheets under the bushes to collect the berries (Kathy McCovey, ITEK, 8.18.2020).
- Prior to burning, dead material (top layer of leaf litter) under and around the manzanita must be raked back so roots are not burned and damaged in the fire. Without this preparatory work, there is risk of damaging or killing manzanita bushes beyond repair.

Four pounds of manzanita berries harvested by Kathy McCovey in July 2019 at *Tishánik*. Photo credit: Kathy McCovey.

Aborted manzanita berries at *Tishánik*. Photo credit: Jennifer Sowerwine.

3. GIANT CHINQUAPIN (*Chrysolepis chrysophylla, sunyíththip*)

At the *Kámmaahriv* plot, older chinquapin trees are dying and experiencing sun and wind or snow blowdown damage and water stress due to exposure from timber harvest and removal of overstory. The larger trees in the plot had dead lower limbs, yellowing leaves and looked generally stressed (May 2019). In May and July 2019, there was no evidence of flowering or fruiting on younger trees (20-30 years old). Over two years of gathering chinquapin nuts, Lisa Morehead-Hillman observed no meat inside the shell, suggesting that the good nuts could have been eaten by animals or may have not developed at all (Table 3.1).

> *Just revisiting the chinquapin stand that we gathered so many chinquapin nuts from last year. And I went back to the tree that we gathered from, and that one's an older tree. It's probably about 38 inches in diameter, maybe about 35. Anyway, produced hundreds of nuts, sacks [laughter] — hundreds of chinquapin nuts in their enclosure sacks, and I picked up a few of them and I take them over to the truck and crack them open to find out what condition those chinquapin nuts are in. Now last year, if you look over here, to the left, that area had burned a couple years prior. These chinquapin trees - the younger ones are up here - were dying. In the process of dying. I'm sure they have a stress crop to begin with, and we just happened to have come upon them last year, when they were dropping that stress crop. If you look up there, there's a lot of chinquapin that's dying in there. (Kathy McCovey, ITEK, 10.10.2020)*

Chinquapin at *Kámmaahriv* showed evidence of potential nut production in 2019, with empty shells on the ground, but no potential for harvest. In 2020, the trees at this site did not produce chinquapin nuts. In contrast, the Camp 3 patch had a mass production of nuts in the fall of 2019. In 2020, production was less and by early October the nuts had fallen to the ground and were consumed by animals (Table 3.1).

BOX 3.3 Management recommendations for chinquapin

- Prescribed fire. In one chinquapin patch, Kathy noted a major fuel problem: "You needed to basically come in and cut a lot of it down and pile-burn it and run fire through the stand. And it will encourage those mature chinquapin and tanoak to start producing nuts."
- Culture larger chinquapin. A lot of the area around Orleans does not have old growth chinquapin because they were removed to preference plantations. What remains are

large swaths of even-aged chinquapin with dense fuels. Many of these areas have been burned repeatedly by wildland fire, resulting in many dead standing chinquapin. In these stands, we need to reduce the fuels and foster growth of larger chinquapin for nut production.

- Isolated, healthy chinquapin should be considered trees of special interest to be protected. When doing cultural and prescribed burns, pull back surface fuels at the base of the chinquapin to protect the tree.
- Culture chinquapin starts.
- Thin multi-stemmed trees to a few stems to promote larger diameter growth of trees.

Chinquapin tree, fruits and nuts. Nuts harvested and cleaned by Kathy McCovey.
Photo credit: Jennifer Sowerwine

4. YERBA BUENA (*Clinopodium douglasii, champínnishich*)

Decreased soil moisture spurred by a drop in precipitation and higher rates of evapotranspiration pose a risk to yerba buena (or Indian tea) habitat and survival. Generally, we have observed brown or yellow, dry leaves that look burnt from intense sun or reduced sunlight due to prolonged smoke inversion during long duration wildfires. Additionally, yerba buena leaves are turning purple and aging in August (cultural practitioner Kathy McCovey has never seen this before). Yerba buena patches are commonly consumed by deer and elk which can decrease the harvestable volume. The yerba buena patch at Upper Sims, where there is a small creek flowing year-round, is healthy but shows some signs of stress, with yellowing on a few leaves and barely moist soil. The patch has gotten smaller and may have been browsed by deer (Table 3.1).

The yerba buena patch at Lower Sims plot was in very poor condition and not harvestable. A second patch of yerba buena in the Upper Sims plot was small, but healthy. It was harvested in 2019. The act of harvesting and pruning the plant has caused the patch to proliferate substantially (Table 3.1)

BOX 3.4 Management recommendations for yerba buena

- Yerba buena should be tip-pruned to promote growth, and harvested in annual intervals thereafter to allow for recovery and growth. Kathy uses this method:

  > *It's not a lot of it (yerba buena at Upper Sims), but I did harvest it and I clipped off the tips. I went to almost every plant and then cut off the tips. And I left maybe some six inches to probably ten inches of vine. And I'm expecting that the ones that I pruned will have side sprouts coming off, which will eventually produce their own plants off of the main stem. And then the plants grow by the — what's the word I'm thinking — the vine. And then the vine ends up sprouting in the ground. And then that's how it propagates itself. Also has seeds. After pruning and harvesting from a Yerba Buena patch, I wait a full year to visit the patch again. I have a few patches in rotation. (Kathy McCovey, ITEK, 12.10.2019)*

- Patches can be watered intermittently particular during times of water deficit
- Rotate a few different patches for harvest to give them time to grow and respond to the disturbance of the harvest.
- Note, this is an easy plant to propagate by cutting with roots.

A small but healthy patch of yerba buena (or Indian tea) at Upper Sims, which expanded substantially after cutting back and harvesting. Photo credits: Megan Mucioki and Jennifer Sowerwine.

Vikki Preston surveys the yerba buena patch at the Upper Sims ACA plot. Photo credit: Jennifer Sowerwine.

5. CALIFORNIA BEAKED HAZELNUT (*Corylus cornuta ssp. californica, súrip/áththip*)

Cultural uses of hazel (or hazelnut) include both sticks for basket-weaving, games, weapons and other implements, and nuts for consumption. The timing for harvesting and peeling hazel sticks is increasingly unpredictable as spring weather fluctuates from unseasonably warm to cold. This "yo-yo" temperature pattern also influences the growth and phenology of hazel.

> *The hazel too. I feel like its growth is getting stunted, because it seems to start budding out too early, because we get this weird shot of hot weather early, and then they think it's time to bud out, but then they stop, because it'll snow after that, and then they'll start growing again. And it seems like they're not as long and beautiful as they were 20 years ago. It seems like it stunts their growth, or something. Well sticks, everybody was checking, "They're not ready. They're not ready." Then it's like, "Oh, they're ready." And then a week later they're budding out already. For like three days. (Climate Change Focus Group, ITEK, 1.15.2019)*

The hazel exposed to full sun in *Táasich* is dying with yellow and brown leaves and some leaves dropping (left). In the same area there are also healthy hazel (right). Photo credit: Megan Mucioki.

Hazel needs to be burned for regrowth of prime weaving materials. In one of our plots the hazel is too shaded and has not been managed with fire for a long time, although there are potentially many hazel sticks of different age classes.

The burning would have the hazel bush die back. We'll probably need to cut it a little bit, too, but ideally, you want to burn your hazel bush back to the stump, so that starts stump sprouting again, and that's where you get those really nice, long, slender acorn cooking baskets sticks. It's a manipulation of vegetation. Native people, especially the Karuks weren't stumbling and mumbling around the forest. They had specific management areas that were managed for specific things. That's how they were able to be one of the oldest tribes on the Klamath River. (Kathy McCovey, ITEK, 2.11.2020)

Hazel sticks in two plots were not harvestable and will not be harvestable until they are pruned and burned. In the *Táasich* plot, a few nuts were produced in 2020, but not a harvestable volume. The hazel patch at *Ikxariyátuuyship* was harvested for sticks in April 2020, with 25% of the patch in good harvest condition. This same patch of hazel produced no nuts in 2020 as the area is too shaded for nut production (Table 3.1). Kathy McCovey reports that she used to pick hazelnuts in logging blocks with 0% canopy cover.

BOX 3.5 Management recommendations for hazel

- In many places hazel is too shaded for nut production and needs to be burned for basket stick production. In some places hazel must be cut back before burning.
- Seven years after burning, hazel sticks are ready to use, with interim maintenance during that period of time. For spring-burned hazel, the shoots are ready to harvest for basketry the next spring. For fall-burned hazel, the shoots are ready the second spring (17–18 months) for basketry shoots. Seven years post-wildfire produced the most abundant higher elevation shrubs for hazelnuts production
- For hazelnut production, the forest canopy needs to be opened (30-40% canopy closure). Nuts will not be produced without sunlight.

  For stick production, an overstory of Douglas fir or black oak with 60-80% canopy closure can be maintained. This can also support a balanced need for owl and fisher habitat requirements. (Frank Lake, ITEK, 6.2020)
- Shrubs managed for sticks require hotter fire to make sure the bush is consumed (ie, complete cambium kill of stems, but roots protected) and no standing materials are left before regrowth. Nuts need cooler fire, maintenance burn and pulling back from the bush.
- See Marks-Block et al. 2019, 2021 for further management recommendations for hazel.

California beaked hazelnut fruits. Tanoak acorn tree at *Kámmaahriv*, 08.2019.
Photo credit: Megan Mucioki

Hazel plant at *Kámmaahriv* plot, 07.19.2019. Photo credit: Megan Mucioki

Hazel unprocessed: Harvested sticks waiting to be processed into weaving materials.
Photo credit: Lisa Morehead-Hillman.

Hazel sticks processed by weaver Lisa Morehead-Hillman. "I sorted, and bundled these for storage. They need to be 'seasoned,' which means stored for about a year before using. Before that, they are more easily susceptible to breaking while weaving."
Photo credit: Lisa Morehead-Hillman.

Lisa Morehead-Hillman weaves a baby basket with now seasoned hazel sticks. Photo credit: Leaf Hillman.

Lisa, one year later, with four baby baskets she wove from these hazel sticks. Photo credit: Sophie Neuner Weinstein.

6. BLUE DICK POTATOES (*Dichelostemma capitatum ssp. capitatum, táyiith*)

Many geophytes are endangered due to fire suppression and habitat fragmentation of meadows and grasslands. The blue dicks in our plots are healthy with no signs of disease or stress. They may be threatened in the future by encroaching non-native plants and grasses (Table 3.1).

Blue dick potatoes at *Tishánik* were harvested in May 2019. The potatoes were prevalent, good quality and size, but the rocky substrate made it very hard to harvest efficiently. This patch was visited the following year, June 2020, but was not harvested. The Owl Mine patch of potatoes was not harvestable in June 2020 (Table 3.1).

BOX 3.6 Management recommendations for blue dick potatoes

- Active gathering and tillage to aerate soil and eliminate rocks from the beds being actively harvested.
- Cultural burning of potato beds to maintain meadow, reduce competition with other plants, and support productivity of the potato plants. After the burning at *Tishánik* the stems and corms tripled in size.
- Blue dick potatoes are a little bit sensitive and not as responsive to hotter fire. They need a cool fire, maybe at night.
- Replant small corms while gathering.
- Transplanting corms to less rocky soil is possible to solve substrate challenges.

A freshly dug blue dick potato in May 2020 from *Tishánik* plot. The underground delicacy is topped by a vibrant cluster of purple flowers in the late spring. Photo credit: Jennifer Sowerwine.

A patch of blue dicks growing in the *Tishánik* ACA plot. Photo credit: Megan Mucioki.

7. ROPE OR STRING IRIS (*Iris purdyi or Iris tenax, achviv'ápkaas*)

Iris populations have been impacted by fire exclusion and fragmentation and dwindling of meadows and grasslands, combined with hot periods that start earlier, get hotter and last longer than before. Their habitats were reduced as management regimes shifted and open areas were no longer maintained with low-intensity burns to prevent encroachment of conifer and invasive species. Today iris is seen growing in forest openings along roadsides, as the thick and uniform canopy of the forest is too shady. In some areas, non-native grasses and thick conifer needle groundcover encroach on and inhibit growth.

Iris usually stays green all year, however, in July and August (2019-20) the iris at *Táasich* was completely desiccated and dried up. Plants were encroached by grasses and crowded by duff. No material was harvestable.

BOX 3.7 Management recommendations for iris

- Reseed iris in areas where populations have been encroached by grasses.
- Manage or eradicate competing grasses.
- Clear duff around iris and encroaching grasses. For example, in some spaces, Kathy McCovey cleared the area around individual iris plants to sweep a radius free of needle cover around each plant (Kathy McCovey, ITEK, 3.11.2020).
- Look for additional areas that have large clumps of iris that can be restored. Smaller rhizomes of larger plants can be transplanted when harvested in the later winter/early spring to expand populations

Kathy McCovey harvests fiber from Iris. Photo credit: Megan Mucioki.

Iris in full bloom in a clearing on Karuk land. Photo credit: Jennifer Sowerwine.

8. TANOAK (*Notholithocarpus densiflorus, xunyêep*)

The tanoaks at *Kámmaahriv* plot are stressed from shock and exposure after logging removed overstory trees. At this same plot, the dense forest structure does not support the space and resources needed for healthy tanoak trees. Forest density and age uniformity is not conducive to acorn production. Heat and water stress within this dense forest structure has resulted in stressed crop production, aborting of fruits, yellowing leaves, and tree mortality at *Kámmaahriv*. Lack of understory burning results in buggy acorns (infested with filbert weevil and moths) increasing harvest labor and decreasing quality. Generally, there have been frequent recent years of poor acorn production, and people are running out of acorns to eat and share.

Two of the tanoak groves we monitored did not produce acorns at all or produced very few during the 2019 and 2020 seasons. The third grove produced quite a few acorns in October 2020, but they were very bug-infested, with three people gathering only 15 good acorns in 30 minutes (Table 3.1).

BOX 3.8 **Management recommendations for tanoak**

> *The tanoak, for pretty obvious reasons we have a lot of tanoak that needs loving up and the humans need to eat acorns and for us to eat a lot of acorns we need to manage the land. (Chook Chook Hillman, ITEK, 8.14.2020)*

- Thinning of tanoak in even-aged tanoak stands to reduce competition and water stress.
- Protect legacy tanoaks by thinning and brushing around trees, clearing out understory fuels and thinning small diameter Douglas firs and other competing vegetation.
- Conduct cultural burns under tanoak trees to minimize infestation of filbert weevil and moth. For more see Halpern et al. (2022).

Tanoak acorn tree at *Kámmaahriv*, 08.2019 and examples of healthy and weevil-infested acorns.
Photo credit: Jennifer Sowerwine.

9. SUGAR PINE (*Pinus lambertiana, ússip*)

Sugar pine trees adjacent to *Kámmaahriv* are suffering from exposure after having the overstory removed during logging. The tops of sugar pine trees in this area are starting to die, indicating that the trees are stressed and may eventually succumb to the elements. Legacy sugar pine trees require a lot of water, and in the hotter climate and more crowded forest, they may not be getting enough.

> *All together it (removing the overstory) would've changed how the environment's feeling around here, and it would've been wind protection. Because we were getting five mile an hour, 5.5 gusts out of that creek and stuff. So they're getting hit by wind now. They're getting hit by solar. A lot of times those big trees have big limbs. So that tree, that would've been protected by the bigger trees over top of it, but now they're gone. So that, that kind of stand is experiencing environmental conditions that it really never experienced before because of the removal of the neighboring stands. But here, in the flat area, you've got your new second growth that's coming up from the original stand. That one has a totally different history going on with it.*
> *(Kathy McCovey, ITEK, Kámmaahriv, 7.16.2019)*

White Pine Blister Rust has been an issue for younger sugar pine trees, although it was not evident in any of our study areas. The trees are making quite a few cones with a bumper harvest in 2020 which we suspect was a stress crop. Squirrels eat sugar pine cones (like corn-on-the-cob) once the cones are on the ground and if they are not gathered quickly enough by people, the sugar pine cones are not usable.

The sugar pine grove produced cones in 2019 and 2020. In 2019, we counted about 35 cones on the ground, but we were too late to harvest as the squirrels had already eaten the cones and nuts. The 2020 harvest was huge, overflowing a burden basket (Table 3.1).

BOX 3.9 Management recommendations for sugar pine

- Fire management. "Sugar pine stands indicate the site of past fire management and places where management should take place today" (Karuk Tribe 2016).
- Spacing.

> *The way that we manage the forest does matter for a lot of different reasons, including just simple things like access. When the trees [sugar pine]*

are crowded, then they go straight up. And they don't throw out limbs until they're way out there because they're trying to compete instead of spreading their wings out. And as a result of that, it's hard to find those trees that now, you can actually have limbs low enough to actually climb them because that's how they climbed them — was with hooks. But it turns out not if the first limbs are 150 feet up there.
(Leaf Hillman, ITEK, 5.27.2021)

- Understory burn around these trees carefully, clearing the area under the tree before the burn and pulling the fuel back from the tree to avoid burning the roots.

- Alert wildland firefighters to avoid cutting sugar pine, a key species to protect during wildland fire activities. The most dangerous thing to sugar pine is wild land fire fighters who cut and burn them.

Sugar pine cone. Photo credit: Jennifer Sowerwine.

Kathy McCovey holds up remnants of a fallen sugar pine cone that has been consumed by grey squirrels. Photo credit: Jennifer Sowerwine.

10. BLACK OAK (*Quercus kelloggii, xánthiip*)

Black oaks are severely crowded and smothered by dense Douglas fir stock. Many are dying or on the brink of death with hardly any crown due to lack of space and sunlight. There is very little to no acorn production, with evidence of aborted acorns, at Upper Sims. Many of the lower limbs are dead and breaking off. No acorns were harvested.

BOX 3.10 Management recommendations for black oak

- Remove or thin Douglas fir to provide space and a chance for the black oaks to survive.

  > *And I think it's just disgusting that those poor old black oak trees have to try to survive and they're not going to survive. We need to get in here and we need to get this Doug fir out. I don't know what the plans are for this place but this Douglas fir needs to be removed. Otherwise, it's going to knock over whatever little bit of advanced reproduction that we got of our favorite trees. It's going to knock them over.*
  > *(Kathy McCovey, ITEK, 5.15.2019)*

- Thinning must be done carefully in intervals to try to prevent the black oaks from toppling over. KDNR Director Bill Tripp reports that reducing the canopy at 30% intervals is the suggested method.

- Experiment with topping black oaks about 25–30 feet up. Black oaks growing under Douglas fir encroachment are very top heavy and can be weak and unstable when the surrounding Douglas firs are removed (harvested or cut). It is possible that topping the released trees will spur the growth of a healthier, stronger crown in a more open environment (Frank Lake, ITEK, 6.2020).

Black oak in Upper Sims area overcrowded and shaded by neighboring conifers.
Photo credit: Daniel-Sarna-Wojcicki.

11. BLACKCAP RASPBERRY (*Rubus Leucodermis, attaychúrip*)

Black cap berries at Lower Sims were harvestable but noticeably small and soft. The berries ripened asynchronously on a single plant:

> *There was the ripe ones then there was the red ones then there was the hard-green ones then there was the ones that were flowering. So they weren't — a lot of times berries will come in in a couple of flushes but these were — I was totally amazed at the difference in maturity that was found on one bush and in different bushes. (Kathy McCovey, ITEK, 12.10.2019)*

This could be attributed to the unusually hot weather (100-plus degrees) and cold weather during the first few weeks of June. In 2019, a black bear in the area was consuming the berries. Black cap berries started to age and dry up on July 27th, about 2 weeks earlier than expected, in 2019. Yellowing leaves and aborted berries indicated water and heat stress in August 2019. This patch is encroached by Himalayan blackberries and fallen dead trees, and limbs from standing dead trees from the 2018 prescribed burn.

Black caps were harvested in 2019 and 2020 (Table 3.1).

BOX 3.11 Management recommendations for black cap

- Remove and continually manage encroaching invasive, Himalayan blackberry.
- Manage the black caps with frequent burning every 3–5 years to support black cap growth but prevent unbated growth of huge vines that are not productive. Black caps will re-sprout after low intensity fire. Black caps respond positively to burning.
- Black caps act as a seed bank, once you apply fire and clear the area the black cap will start to come back. They are hanging on the edge of the road because that is where they get the full sun.
- Remove downed trees and fuel to maximize access.

Black cap berry development in Lower Sims area with invasive Himalayan blackberry encroaching on the site. Some black cap berries were found to be aborted in this area (pictured right). Photo credit: Jennifer Sowerwine.

12. SANDBAR WILLOW (*Salix exigua, pâarak*)

Without low intensity cultural burns and scouring of the river banks by high water (due to water flow being regulated by dams), willow is often infected by beetles and bugs, damaging the sticks used for basketry. Shrubs are overgrown from lack of natural management by the river, which at high flow prunes the shrubs and cleans out debris and pests. The river flow was too low, even during the season of high flow, to provide these services to people and plants. For example:

> *Today is June the 28th. It's 11:08. And I'm here at the willow patch along the river along Camp Creek. I'm looking at some extremely tall willows that years ago we would have been picking from. And I did pick from them [laughter] years ago as a matter of fact. There are some blackberries that are based here. This is a willow bush that is not pickable. It's got really, really stumpy little leaves on it. It also looks like it's — I know there are some bugs that I have been seeing on the way in here today. I was wondering if it might be part of what's going on right there. There were some silver bugs last time I was here. There's something making a little cocoon right there. I'm not seeing the bugs. But I'm seeing a lot of stick areas with deformities. And a lot of them look like they're folded over almost like they're dying. This whole area is just out of production. We do have some new starts kind of coming from a fallen — he's a little tree. I call them a tree. We used to call them little bushes. But now they're trees. (Kathy McCovey, ITEK, 6.28.2020)*

Willow stick peeling in the spring is less predictable and sap flow and budding are occurring out of order.

> *Your stick, right now, if you get it when the sap's running, the sap will allow you to take the bark off of the stick in one fell swoop. So it's still a little dry right there. I'm peeling it back like a banana and I can see that there's not much sap. I don't even feel the wetness. And usually, there'll be a really nice wetness to it that helps you get the bark off, and you have a nice shiny clean stick. But we're not getting that because the sap's not running yet, but we've got it budding out right here. That means lumpy sticks. So I'm going to try and strip this one. I can't even get past that hump right there. Let's try to loaf it further down to see if I can — I should be able to just strip. You see right there? You see those fibers that are stuck on there? Those won't be there when the sap's running. So that's why I'm having such a hard time with this because it is not ready to strip, the sap's not running. Sap is still shut down in the stick. However, the leaves are still growing. But, again, we have lumpy sticks. But here we have a bug hole probably. It looks like a bug hole. This would not be a good stick. I wouldn't take this home because inside of it there's little eggs and then probably a little worm. And if you take the stick home with your other sticks, you've got good clean ones. You*

have a lot that you didn't have bugs in. As the sticks sit your house, it's nice and warm, those bugs are going to start multiplying, those worms, and pretty soon all your sticks are going to have holes in them. So one reason is that we need river high water to flush these basket materials out, to flush the willows out so that we have nice straight strong sticks that don't have bugs in them. But here again, we're running into something odd going on with the weather. I don't see it too many times where I can't strip the stick.
(Kathy McCovey, ITEK, 3.3.2020)

In both our monitored willow patches in April 2020, we found willow sticks budding before the bark could be easily peeled. Easy peeling is necessary for ideal harvesting; budding before bark can be peeled results in poor quality sticks. Fifty sticks for larger baskets, of medium quality, were harvested from the Camp Creek patch in 2020 (Table 3.1).

BOX 3.12 Management recommendations for willow

- Burn and thin to cleanse willow bushes of bugs (sawfly and midge larva, see Lake 2007) and mold from standing water at the base.
- Prune to keep the size of the bushes down and make the sticks accessible to harvest.
- Manage a patch for different sizes and shapes of sticks so when you harvest you have access to a diversity of stick types. When you are harvesting keep pruning in mind the whole time.
- Head pruning a bush promotes the growth of side shoots. Cap selectively.
(Lisa Morehead-Hillman, ITEK, summer 2019).
- Keep in mind elder access to willow stick areas and harvest and manage accordingly. "We're always thinking, 'Okay, so is this someplace that an elder is going to come?' Because then you don't do heavy harvesting there. You do heavy managing there" (Lisa Morehead-Hillman, ITEK, summer 2019).
- Invasive Himalayan blackberries are encroaching on the willows in some places which can make it very hard to harvest without getting all scraped up. Invasive management needed to reduce competition and increase accessibility.

Kathy McCovey gathers willow sticks from a young grey willow at a patch near the Klamath River. Lisa Morehead-Hillman displays a willow stick basket called a drying basket. It is meant to hang, allowing air to circulate completely around the tea or medicinal leaves stored here for drying. Overlay materials used for the design ("stacked wood") are maidenhair fern for the black, woodwardia fern fibers dyed with alder bark for the red, and beargrass for the white. Photo credits: Megan Mucioki and Lisa Morehead-Hillman.

13. YEW (*Taxus brevifolia, xuppáriish*)

At *Táasich* the yew trees are healthy overall. One tree is being top-killed by fallen tanoak which exposed more light for other yew trees in 2019. We observed some brown needles on *Táasich* yew trees in July 2020. We learned about harvesting yew wood but did not harvest any as it is harvesting etiquette to gather only what is needed. Yew is an exceptionally hard wood and especially slow growing tree, requiring about 70 years for harvest maturity.

BOX 3.13 Management recommendations for yew

- Promote shade/canopy around trees, >80% cover, or no more than 15 light points, around the yew groves.
- Maintain enough shade around the yews and seeps to keep water in them, but avoid conifer or shrub encroachment which sucks out water. Some strategic thinning of small to mid-size trees would be okay.
- Create fuel breaks around yew groves.

> *You don't want to nuke the [sensitive] habitat that they exist within because once you do that they're not going to be there...They're pretty light-sensitive...And moisture-sensitive as well. So retain some canopy around them... And it doesn't mean you have to exclude all fire but it means that fire it has to be low intensity — the moment you get high intensity in there — you're done and they're not coming back.*
> *(Leaf Hillman, ITEK, 5.27.2021)*

Shay Bourque rests beneath a prolific yew tree thought to be at least 200 years old near *Táasich*.
Photo credit: Daniel Sarna-Wojcicki.

14. TANOAK MUSHROOM (*Tricholoma magnivelare, xáyviish*)

Tanoak mushroom production depends on rainfall, air-soil temperature regime, and moist soils that are well drained — sunlight, a thin layer of ground litter, and cool temperatures with a warming and cooling pattern in the fall are required for fruiting. (See Anderson and Lake 2013 and Richards 1997 for more information). Today, environmental and climatic conditions for fruiting may be less common especially in forests that have experienced severe fires. During 2019 and 2020, there was a lack of tanoak mushroom fruiting for entire seasons following seasons of poor rainfall.

In 2019, 10% of the mushroom patch at *Kámmaahriv* was harvestable, yielding 11 total mushrooms. In 2020, there was no mushroom production at this site (Table 3.1). There was a huge mushroom harvest, with many flushes, in 2021, estimated about 100 lb of mushrooms at *Kámmaahriv*.

BOX 3.14 Management recommendations for tanoak mushrooms

- The Karuk Tribe suggests equipment exclusion zones to protect mycelia and sustain gathering areas. They view the presence of tanoak mushrooms as a sign of a balanced ecosystem (Karuk Tribe 2016).
- Require that a certain amount of canopy cover be maintained.
- If any type of thinning is done in mushroom patches, the equipment must be kept on skid trails.

Harvesting tanoak mushrooms at *Kámmaahriv*. Mushrooms harvested are displayed by Frank Lake and Vikki Preston. The far right has been gnawed by an animal. Photo credit: Jennifer Sowerwine.

15. CALIFORNIA BAY LAUREL (*Umbellularia californica, páhiip*)

California bay laurel (or pepperwood) trees are dying and not producing nuts in season due to encroachment from conifer saplings as well as increasingly warm or hot springs. Bay laurel trees have lower branch die-off and curling leaves, both signs of water stress from drought. The bay laurel downriver, in Yurok Tribe territory, is doing better because there is more fog and moisture closer to the ocean shore.

> *Do you see how yellow that pepperwood tree is? All of those young leaves that came out got burnt because when they came out in first of spring when it should've been nice and rainy and cool, it was 100-something degrees for a couple of weeks at a time and it burnt those. Where you see the yellow and the limbs are going to die. That's cumulative. Next year, the same thing happened. (Kathy McCovey, ITEK, 7.28.2020)*

In 2020, about a dozen nuts were harvested. In this pepperwood grove (Bark Shanty Patch), shaded trees did not produce nuts at all while trees in the sun had nuts that were not completely ripe by October 19th (Table 3.1).

BOX 3.15 Management recommendations for bay laurel/pepperwood

- Remove conifer sapling poles encroaching on the pepperwood to allow for more sunlight.
- Young pepperwood can be thinned at times to minimize risk of sudden oak death transfer to tanoak trees.
- Spend time on recruitment of large pepperwood trees and caring for individual trees as nut producers.
- Pull back surface fuels, prior to low-intensity burn under the base of healthy and productive pepperwood.

Pepperwood/California Bay Laurel tree with fruits. Photo credit: Shawn Bourque.

16. EVERGREEN HUCKLEBERRY (*Vaccinium ovatum, purith'íppan*)

Huckleberry reproduction is influenced by heavy spring downpours which can knock off flowers and inhibit pollinators, and by hot dry summers which often dry out and shrivel berries, reducing their harvest quality. Harvesters have noticed a phenological shift, with the first flush of berries now ready in July. Berries were previously first harvested in September. In 2020, the few berries at Owl Mine had little moisture content.

Evergreen huckleberry patches at our sites produced very few or no berries in 2019 and 2020 (Table 3.1).

Daniel Sarna-Wojcicki collects seasonal visit data on a huckleberry patch near *Táasich*. This patch had very limited berrying over the two seasons we monitored and remained primarily vegetative.
Photo credit: Megan Mucioki.

Frank Lake demonstrates evergreen huckleberry response to pruning. Photo credit: Jennifer Sowerwine.

BOX 3.16 Management recommendations for evergreen huckleberry

- Open the canopy to provide needed light. According to Rossier (2019), 60% canopy cover is the ideal cover for huckleberry production. "Just from that one tree falling or all the branches that it took out, too, the huckleberry have blooms this year, which they didn't last year. The last two, three years, really". (Vikki Preston, ITEK, 5.2021)
- Active harvesting with pruning.
- The presence of evergreen huckleberry is an important cultural indicator for where to burn according to the Karuk Climate Vulnerability Assessment (2016).
- For more on evergreen huckleberry management see Rossier (2019).

17. RED HUCKLEBERRY (*Vaccinium parvifolium, mîithipar*)

At *Kámmaahriv* there is one small red huckleberry bush which did not produce any berries in 2019 or 2020. There were several non-producing red huckleberry bushes in the riparian area adjacent to *Kámmaahriv* as well. *Ikxariyátuuyship*, on July 30, 2020, there were many berries ready to harvest. Southern-and sun-exposed shrubs had significantly more berries (Table 3.1).

BOX 3.17 Management recommendations for red huckleberry

- Red huckleberry needs to be cared for and enhanced where found because it is sparse. (It is often found in greater density in higher elevations towards the coast.)
- Bushes need water and humidity, and open but sheltered areas.
- Wildland fire back burning (which can be even more intense than the wildland fire itself) and heavy equipment are damaging to red huckleberry.
- Low-intensity fire at night or in the evening should be okay.

A red huckleberry shrub in bloom/flower. Photo credit: KDNR.

18. CHAIN FERN (*Woodwardia fimbriata, típtiip*)

Woodwardia grows in soils with full to partial shade with moderate to high moisture near streams, springs, and seeps. At times it can be dried out and brittle during the typical harvest times. The patch at Upper Sims was healthy overall; there was some encroachment by other species and a few brown/yellow fronds.

The Woodwardia patch in Upper Sims plot was harvested in 2019 and 2020. At the time of harvest, the ferns appeared to be healthy. However, once processed, cultural practitioners reported that the material was buggy with holes, not good quality weaving material (Table 3.1). The cultural practitioner who gathered and processed the material said after processing it was horrible with brown and bug spots that weakened the fiber and rendered the material next to unusable. See photo below.

BOX 3.18 Management recommendations for woodwardia

- Actively harvest and manage woodwardia patches through thinning by clipping out dead materials to support young shoot emergence. Woodwardia likes space between fronds.
- Woodwardia likes open areas "with its feet in the water." Shady areas make for poor quality weaving materials.
- Woodwardia needs water and humidity.
- Intensely hot fire created by backburns, and heavy equipment used during wildland fire fighting can damage woodwardia.

Woodwardia fern fronds glistening in the sunlight. The vascular bundle, composed of two long fibers in the frond's stem is harvested and used for overlay patterns in Karuk basketry. Photo credit: Megan Mucioki.

Woodwardia fibers harvested in fall 2019 at Upper Sims site (roll on the right) show browning and bug spots. The material on the left, is good quality, harvested from a spot with more water and regular harvesting. Photo credit Lisa Morehead-Hillman.

Woodwardia fibers being dyed with alder tree bark by weaver Lisa Morehead-Hillman for use as overlay material in basketry patterns. Photo credit: Lisa Morehead-Hillman.

19. BEARGRASS (*Xerophyllum tenax, panyúrar*)

Beargrass is dying and chlorotic at *Kámmaahriv*. Beargrass in this plot has not been burned and thus is not ideal quality material — brittle blades with protruding mid-vein, bugs and yellowing leaves. The G-O Road beargrass patch is of better health and quality, harvestable because it was burned in 2008 and 2019. Due to that recent burn, some of the plants were not yet mature enough for harvest but will be in coming years. This patch is enough for the weavers in Orleans. Beargrass is typically found at higher elevations; these lower populations are indicative of historical transplantation for ease of access for cultural use.

Lisa Morehead-Hillman gathers beargrass from a patch along the G-O Road that had been burned in the last 2–3 years. Photo credit: Shawn Bourque.

The beargrass at *Táasich* was not harvestable and is in very poor health. However, the G-O Road beargrass patch that had been recently burned produced harvestable material each year, with 150 beargrass blades harvested in 2019 and 2020 (Table 3.1).

BOX 3.19 Management recommendations for beargrass

- Spring burns of beargrass may need to be done earlier than usual to account for dry springs and higher temperatures in spring and early summer. This will prevent the fire from burning too hot and actually damaging or killing the beargrass.

  > *You want the beargrass burned down to a nubbin so that when it sprouts, all that new growth for three, four years, you'll be picking off that plant. You'll be picking new blades that come out of the middle.*
  > *(Kathy McCovey, ITEK, 12.10.2019)*

  > *Another basket weaver said: "Third year is already too late. I harvested some up the G-O Road with Shay a year and a half ago, and that beargrass never really turned white and was brittle and the edges razor sharp [slicing fingers]."*

- Buggy beargrass needs to be burned to clean out the pests.

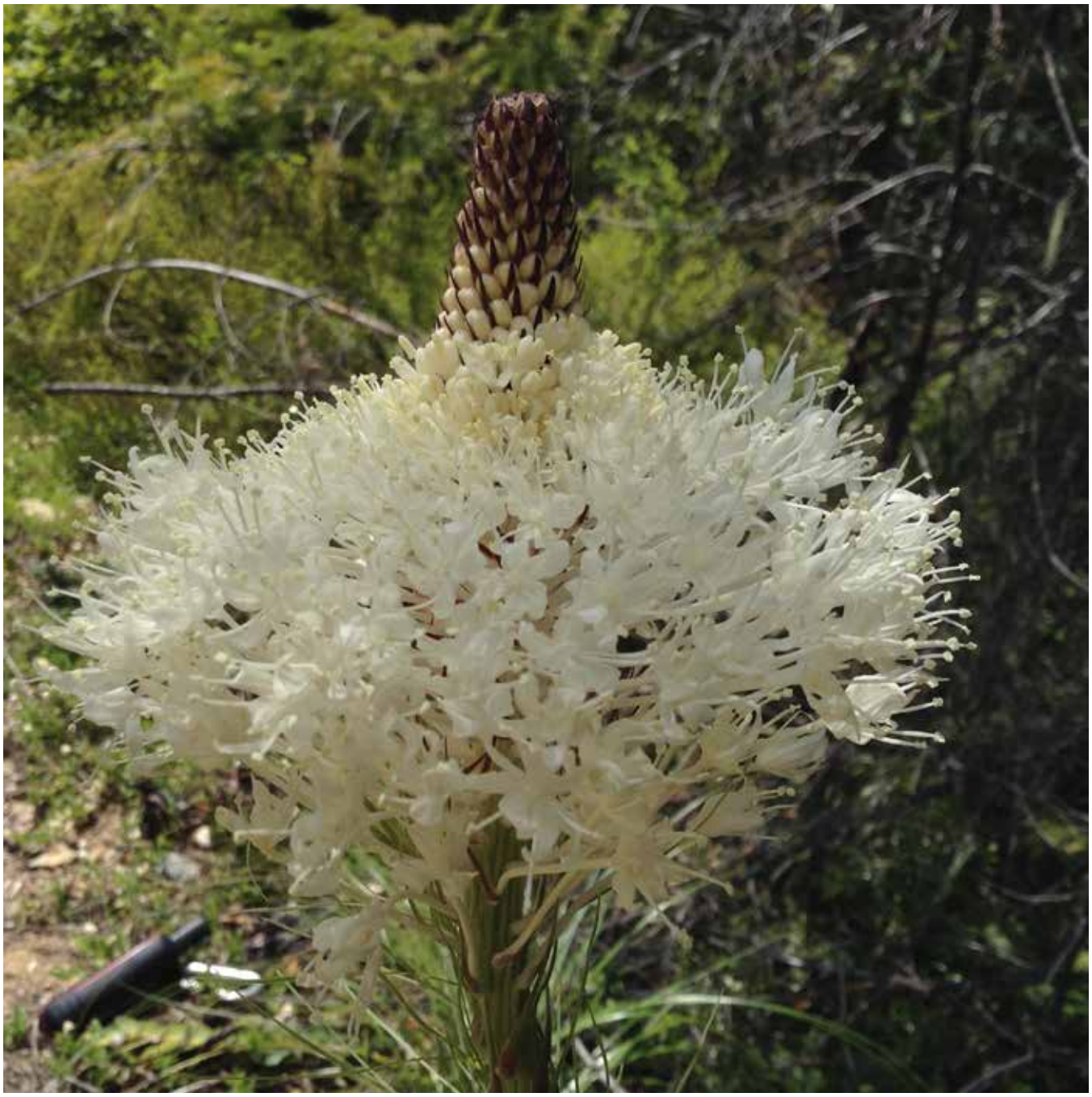
  > *It (burning) would help to eliminate the bugs. It would regenerate and rejuvenate what we have going right here, so that would be my recommendation to improve it. I would not remove any of the overstory yet. I think that is a good canopy cover. It leaves light in and the beargrass looks good.*
  > *(Kathy McCovey, ITEK, 9.2019)*

- Follow up burns need to be done after a fire has stimulated growth and proliferation of Douglas fir seedlings that can ruin a beargrass patch. Kathy McCovey recommends a hotter burn in the fall. If there is concern about losing the overstory and killing the beargrass with a hot fire, then you could pull out the Douglas fir seedlings and thin to cultivate the canopy (labor-intensive).

- More overstory and moisture is needed in some places.

  > *The best beargrass comes from places that get humidity and water from the fog that comes in from the coast. So that's why beargrass patches that are kind of more towards the west-inclined territories seem to have excellent material, because they got the shade and they got the water.*
  > *(Kathy McCovey, ITEK, 12.10.2019)*

- For more on beargrass management see Rentz (2003), Hummel & Lake (2015), and Hart-Fredeluces et al. (2021).



Beargrass flowers. Photo credit: Ben Saxon.

Dessicated Beargrass in poor health at *Kámmaahriv* plot. Photo credit: Jennifer Sowerwine.

TABLE 3.1 Focal plant harvest data from plots and patches from spring/summer/fall 2019 and 2020. For plots and patches established in 2020, one year of data is listed

	Location	Harvest 2019	Harvest 2020
Beargrass	*Kámmaahriv*	Not harvestable	Beargrass has not been burned in 100 years and is not harvestable. Experiencing drought and heat stress. Drying out the leaves. (Harvest date Oct 12, 2020. Typically beargrass is harvested in July/August).
Beargrass	G-O Road patch	There are about a hundred plants. There are no harvestable plants in the burned area and 30 plants in the unburned area that are harvestable. From each harvestable plant, we were getting about 5–15 blades depending on size of the plant. The actual number of blades harvested was a fist full, approximately 150 blades (give or take a dozen or so). This is a very small percentage of what would normally be harvested because this patch was just burned and that means this year it is in flux. (Harvest date Sept 29, 2019. Typically, beargrass is harvested in July/August).	Harvested 150 blades. The beargrass here is enough for the entire town of Orleans to gather as much as they want. (Harvest date Oct 12, 2020. Typically, beargrass is harvested in July/August).
Black cap	Lower Sims	June/July 2019: Kathy harvested an unknown quantity	June 11, 2020: Not very big berries but they are ripe. 40% of the patch in good harvest condition, the remainder not ripe yet. About 25% of the good stuff is large enough to harvest. Two people gathered for 30 minutes and they got 1 quart of berries. Mesic soil.
Black Oak	Upper Sims	Fall 2019: One black oak tree fruited but very scant nuts.	Oct 27, 2020: Older oaks, late in life. 0% of this patch is good for harvest. The trees are not getting any light and the firs are choking them out, mesic soil.
Blue dicks	Owl Mine		June 23, 2020: Zero potatoes produced. They need fire management.

	Location	Harvest 2019	Harvest 2020
Blue dicks	*Tishánik*	May 8, 2019: Kathy harvested 8 potatoes (.5-1-inch diameter) in 1 m^2 area. The prevalent rocks in the soil made digging difficult and harvest efficiency low. To manage for potatoes, the rocks need to be eliminated from the potato bed. The ideal soil type is sandy with no rocks. Kathy would harvest 50% of individuals, taking the older plants.	June 4, 2020: Cultural practitioner would not harvest from this patch now because it is flowering (allow we did harvest during flowering last season). 75% of the patch is in good harvestable condition.
Chinquapin	*Kámmaahriv*	Sept 26, 2019: No harvestable nuts. Found shells of nuts but no actual nuts (eaten or rotted). The number of shells suggested a poor yield.	Oct 12, 2020: No nuts produced
Chinquapin	Camp 3 patch	Fall 2019: Mass production of nuts. Kathy suspects a stress response.	Oct 10, 2020: They nuts are ready early, have fallen to the ground, and been consumed by animals. The remaining shells did not make a nut. No nuts to gather.
Evergreen huckleberry	Upper Sims	No berries	No berries
Evergreen huckleberry	*Táasich* patch		Sept 3, 2020: Not enough berries to gather, although they are ready.
Five finger fern	Camp Creek patch		August 6, 2020: 20 ferns harvested.
Hazel (sticks)	*Táasich*	Not harvestable	Not harvestable
Hazel (sticks)	Upper Sims	Not harvestable	Not harvestable
Hazel (sticks)	*Ikxariyátuuyship*		April 16, 2020: The sticks were peeling well and 25% of the patch is good for harvest while the remaining hazel is overgrown and needs to be burned. One person gathered for 30 minutes and gathered 30 small sticks for fine baskets.
Hazel (nuts)	*Ikxariyátuuyship*		Oct 20, 2020: Time of year to harvest but there are no nuts of harvestable quality here. The area is too shady for nut production.

	Location	Harvest 2019	Harvest 2020
Iris	*Táasich*	Not harvestable quality	Not harvestable quality
Manzanita	*Táasich*	Not harvestable quality	Not harvestable quality
Manzanita	*Tishánik*	July 19, 2019: Kathy harvested four pounds of berries from a single green leaf manzanita bush. She estimates the bush is about 19 years old and the berries were very thick on this bush. At the time of harvest the soil was xeric.	August 4, 2020: It should be time to harvest, but the plant is not looking good this year with only 20% of the patch in good harvest condition. Generally, few berries and some are not ripe or overripe. Two people gathered for 11 minutes and got a bucket worth of berries (46 oz.). They just gathered enough for a small sample and maybe to make one drink. Usually this patch is a good place to harvest from.
Pepperwood	Bark Shanty Patch		Oct 19, 2020: Harvested about a dozen nuts, shaded trees not producing at all. Trees in the sun have nuts that are not completely ripe yet.
Red Huckleberry	*Kámmaahriv*	Sept 26, 2019: No berries produced	No berries produced.
Red Huckleberry	*Ikxariyátuuyship*		July 30, 2020: Good huckleberry year. They were ready to harvest and had lots of berries. Southern exposure and sun exposed bushes have significantly more berries.
Sugar Pine	*Kámmaahriv*	August 2019: Cones dropped and were very abundant in August. About 35 cones between 7–10 inches long. The squirrels ate the nuts before we harvested them. Mesic-xeric soils	Fall 2020: Huge harvest of cones. Lisa gathered more than a burden basket of cones. The most she has ever harvested from a sugar pine patch.
Tanoak	*Kámmaahriv*	Sept 26, 2019: So few on the ground that they did not harvest any.	Oct 12, 2020: Did not make any acorns
Tanoak	Owl Mine		Oct 27, 2020: Producing well but the acorns are pretty buggy. Three people gathered for 30 minutes and gathered 15 acorns. They did not gather what they needed because there are not many good acorns.

	Location	Harvest 2019	Harvest 2020
Tanoak	Patterson		Oct 29, 2020: This patch is not harvestable right now because it is too early for harvest. Very few actual acorns. Three people gathered for 20 minutes and got 15 acorns. Might want to check this spot again in 1 week but suspects this spot is not good this year.
Tanoak mushroom	*Kámmaahriv*	Oct 27, 2019: From the whole patch approximately 10% were harvestable. An ideal harvest would be from a patch that was 75% harvestable. Many mushrooms were not harvestable because they were still young or animals had eaten parts of them. We only gathered 11 mushrooms leaving dozens of buttons and parts left by animals.	Dec 8, 2020: No mushrooms this year
Willow sticks	Camp Creek patch		April 6, 2020: 50 sticks harvested. Starting to bud but not peeling perfectly. Sticks in the patch are good for larger baskets.
Willow sticks	*Tishánik*		April 6, 2020: 10 sticks harvested. Budding and striping a little but budding early. Starting to bud but not peeling great yet. If the sticks are not harvested now, buds will make bad sticks.
Woodwardia	Upper Sims	June/July 2019: Kathy harvested unknown amount	Oct 27, 2020: 90% of patch is in good harvest condition. The patch will freeze soon so the harvest window will end soon. Although, once the ferns were harvested, cultural practitioners reported they were buggy and poor quality.
Yerba Buena	Lower Sims		February 14, 2020: Too brown and dry. Looks like it would in October before the rain.
Yerba Buena	Upper Sims	Harvested by Kathy.	Harvested by Kathy.

3.4 SURVEY OF HERBARIA COLLECTIONS FROM KARUK ABORIGINAL TERRITORY

Between the year 1876 and the year 2016, over 400 parties (individual botanists or groups of collectors) collected 10,979 botanical voucher specimens[10] in Karuk Aboriginal Territory (and potentially more that are not geolocated to date). Of those specimens, 3,459 or 31.51% are considered cultural use species for the Karuk Tribe (based on the Tribe's provided list) and 532 or 4.85% are focal species identified for our project. That averages to about 2 specimens for every square kilometer in Karuk territory. In a study of herbarium specimen records of 11 western states, California had the highest number of specimens collected, with San Francisco County having 99.2 specimens per square kilometer (the highest density of specimens among all counties studied) (Taylor 2014). While specimen density is correlated with human population density, California is overall a well-collected state with even sparsely populated counties within the geography of Karuk Aboriginal Territory (e.g. Humboldt or Siskiyou County) having at least one specimen per square kilometer. Del Norte County has a much higher rate of collection than Trinity County and Humboldt and Siskiyou fall in the middle (Taylor 2014). There was little collection of samples on open water.

Among the specimens from Karuk Aboriginal Territory, 496 unique genera have been captured. Four genera encompass more than 200 specimens, making up over 2% of the collection within KAT. This includes *Quercus* (289 specimens), *Carex* (273 specimens), *Eriogonium* (230 specimens), and *Ribes* (245 specimens). In the KAT, mean road density and developed land cover are low, indicating low levels of ecological disturbance. Almost 100% of the specimens were collected on federal land, illustrating that governance and control of the vast majority of Karuk landscapes and botanical ecosystems is under the jurisdiction of the federal government.

10 A voucher herbarium specimen broadly defined is a pressed plant sample with collection data deposited for future reference. It can be used to support taxonomic, ecological and environmental research as well as education and may be examined to verify the identity of the specific plant used in a study.

BOX 3.20 Overview of voucher specimens collected in Karuk Aboriginal Territory

- Total number of voucher specimens between 1876 and 2016: 10,979
- Total number of unique genera: 496
- Total number of cultural use species vouchers: 3,459
- Total number of focal plant species vouchers: 532

Voucher collections in Karuk Aboriginal Territory have spanned 140 years so far (more have surely been collected in recent years but are not yet mounted and catalogued in herbaria). Within that timespan, no collecting occurred in just 23 non-consecutive years. Years with zero collection predominantly predate 1918. Most collection years included less than 100 specimens. The majority of vouchers (about 75%) were collected between 1950 and 2000. Years with the highest number of collections were 1979 and 1980, with 22.31% of the specimens in the territory collected between those two years, sourced from across the territory by multiple collectors. Another 15.07% of specimens were collected in 1968 and 1969, mostly due to the vast number collected by Frederick W. Oettinger in the English Peak region and around lakes in the southeast corner of the Territory. Throughout the 1960s and 70s, Karuk Territory experienced increased access to the region through the establishment of an extensive Forest Service road system for fire suppression and to access timber, as well as completion of a paved highway through the territory, and the partial implementation of a federal plan to connect Orleans with Gasquet (the "G-O Road") through acres of sacred Tribal high country.

Over 400 different people or groups collected botanical specimens in this region. The majority of collectors were responsible for less than one percent of the collection, in other words collecting fewer than 112 specimens in this region. Exceptions include Frederick W. Oettinger's 1,384 specimens, J.O. Sawyer's 610 specimens, and Maralyn A. Renner's 592 specimens. The first collections were made by Thomas J. Howell, one of the top self-trained botanists in the Pacific northwest at the time, in 1884 just prior to passage of the Dawes Act, by which the federal government assumed control of more than 90 million acres of land from Native Americans (NPS.gov)[11]. The only documented connection by botanists to Indigenous peoples in the area was in the work of Marc A. Baker in his collections for his master's thesis (1981) focused on the ethnobotany of tribes in the region including the Karuk Tribe.

11 See "What was the Dawes Act?" https://www.nps.gov/articles/000/dawes-act.htm, accessed 6/6/2022.

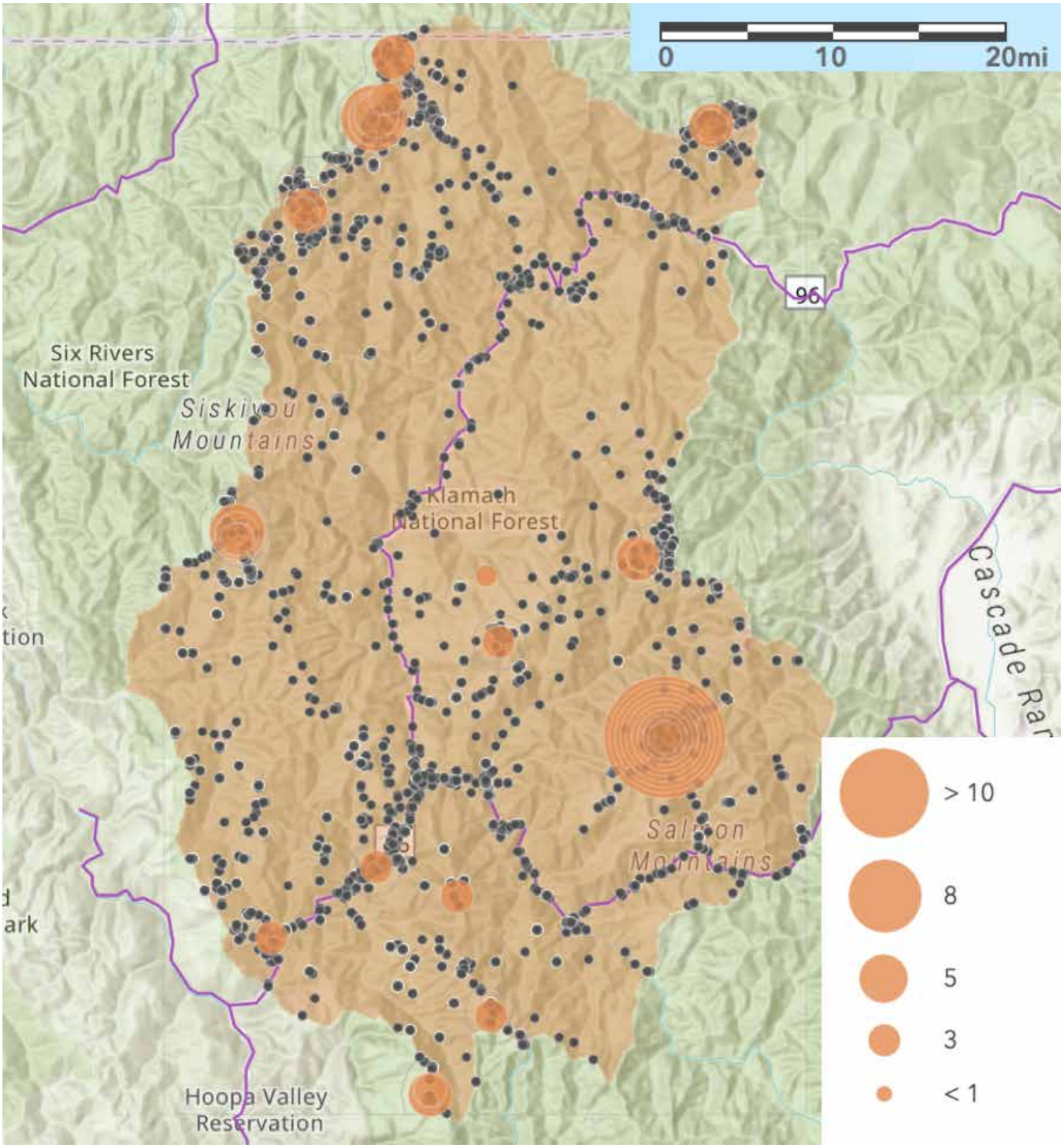
3.4.1 VOUCHER SPECIMENS IN OR NEAR ACA RESEARCH PLOTS

The *Tishánik* plot and area had the most voucher specimens collected within a 1 km radius from the plot center, with 90 specimens recorded from 1926–2016. These include iris, manzanita, lily, evergreen huckleberry, willow, bay laurel, and black cap. Of the other four plots established in 2019, each had less than 10 specimens collected within a 1 km radius, with a lower diversity of focal species — only evergreen huckleberry and iris were recorded.

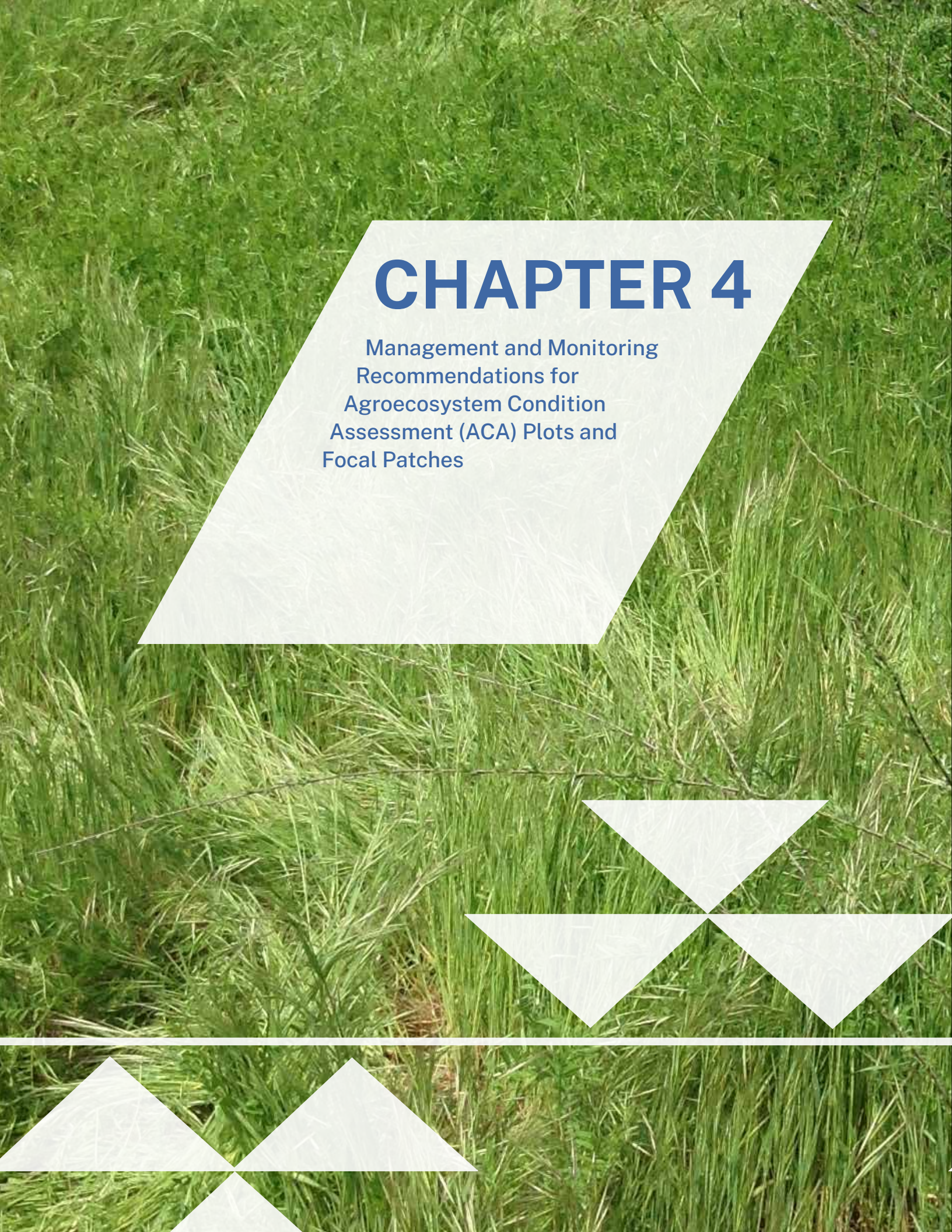
Thomas Carlson, UC Berkeley Professor of Integrative Biology introducing members of the Karuk Tribe DNR to the botanical collections at UC Jepson Herbarium, 01.23.2013.
Photo credit: Jennifer Sowerwine.

Karuk DNR staff and RACCCA team attending an Advanced Herbarium skills workshop at the UC Jepson Herbarium examine historical voucher specimens, 03.2019.
Photo credit: Jennifer Sowerwine.

Herbarium voucher specimens collected, pressed and labeled by Ben Saxon, Karuk DNR, and deposited in the Karuk Tribe Herbarium, August 2020. Photo Credit: Megan Mucioki.



Map of Karuk Aboriginal territory displaying all the voucher specimen collections (grey dots) from 1876–2016, and high-density areas of cultural use plant collection (orange circles). Map developed by Megan Mucioki.



CHAPTER 4

Management and Monitoring Recommendations for Agroecosystem Condition Assessment (ACA) Plots and Focal Patches

4.1 INTRODUCTION

From 2019–2020, we gathered recommendations for enhancing and maintaining agroecosystem resilience based on information Karuk cultural practitioners and researchers shared through ACA surveys, seasonal site and harvest visits, interviews and workshops. In this chapter, we give an overview of management and monitoring actions for enhancing both the resilience of specific cultural use species at specific sites (or plots), and general resilience of cultural agroecosystems, and Karuk peoples' relationships with them across Karuk Aboriginal Territory, now and into the future.

We recognize that the recommendations below are time and context specific: that is, they are based on observations and assessments of specific sites at particular moments in time under certain climatic conditions. Changes in climate patterns (temperature, wind, rainfall and fire), management paradigms and actions, and non-anthropogenic habitat change (such as tree falls and increased variability and intensity of climate events) may alter these recommendations over time.

This chapter is in two parts. We begin with an overview of specific recommendations for each plot including:

(a) management actions that will enhance the resilience of cultural focal species and habitats in ACA plots to climate change, climate variability and management threats,

(b) management and monitoring recommendations for increasing resilience in riparian areas associated with ACA plots, and

(c) ongoing monitoring of agroecosystem resilience in focal plots and patches.

We then discuss general recommendations for enhancing Agroecosystem Resilience in Karuk Aboriginal Territory.

The Salmon River winds through the heart of Karuk country, April 2019. Photo credit: Daniel Sarna-Wojcicki.

Karuk cultural practitioner, archaeologist, ethnobotanist, elder and RACCCA team leader Kathy McCovey. Photo credit: Jennifer Sowerwine.

4.2 MANAGEMENT RECOMMENDATIONS FOR ACA PLOTS

4.2.1 *TÁASICH*

Landscape:

- Maintain meadow through prescribed low intensity cultural burns up to riparian edges as explained by Leaf Hillman:

> *The meadow is being encroached upon. You need a low ground fire that's creeping; you're not talking about a raging fire. And when it creeps to the edges — presumably, you have enough fuel to carry it to the edges — as long as you're burning when it's going to carry whatever ground fuels that are there, when it reaches that edge area, it's not going to go anywhere. It's going to then die out there. And nowadays, because of how dangerous it is to be running a fire at certain times of the year, there are mechanical things that you can do to slow it down as insurance. But a little bit of fire in those areas is fine...it's beautiful, it's a meadow. And our meadows are so encroached — I mean, in my lifetime, I've seen meadows go away completely. A lot of big meadows are well on their way, and if we don't get fire in them [they're done]...I'd like to see the right kind of fire, at the right time, actually not trying to be too aggressive about [burning] taking one step at a time...keeping that low ground fire, and yeah, you're letting it go into the fringes, but you're monitoring it and making sure that it's not going to get into that [riparian area and yew groves]. So that's what I would like to see...I think that the timing of burns...has always been important but I think [it will be] more important going forward. That importance is really going to be emphasized because of different weather patterns and so adjustments will need to be made for consideration of those conditions.*
> *(Leaf Hillman, ITEK, 5.27.2021)*

- Create and maintain patch-scale plant community (or habitat heterogeneity) across and around ACA plot and riparian area through thinning, prescribed and cultural fire, thereby reducing evapotranspiration and resulting in the creation of pockets of soil moisture near adjacent seeps or springs.

- Protect legacy trees and stands: reduce surface and ladder fuels around legacy sugar pine, chinquapin, tanoak and canyon live oak; clear debris in and near basal cavity at base of tree trunks prior to burn to prevent legacy tree mortality; harvest sugar pine roots only up to drip line to prevent dewatering; harvest and pile burn pest-infected and diseased tanoak acorns to prevent transmission of pests and pathogens; and harvest canyon live oak (*Quercus chrysolepis, xanpúttin*) burl sprout shoots with natural crook as a means of thinning and to make frames (or bows) for dip nets.

Cultural Focal Species at Plot:

- Yew groves/seeps/pits: Maintain shade and create fuel breaks around yew groves and seeps, maintain *píish* pits (ensure consistent flow and circulation) and work with cultural practitioners to experiment with different *píish* making strategies (eg. cedar plank boxes, rock crib boxes or earthen pit).

- Evergreen huckleberry: patches along the road need more light to promote flowering (beneficial for pollinators) and berry growth, as well as greater accessibility for gatherers. Co-occurring associates such as salal, tanoak, madrone, chinquapin, and canyon live oak need to be thinned to promote ideal huckleberry growth. Thin, with pruning and chainsaw work around the huckleberry and salal, then pile burn, pull back fuels from legacy tanoak, madrone, chinquapin, and canyon live oak (leave large bent limbs for dip net poles).

- Hazel: Thin and coppice, leaving nut-producing limbs and shrubs (in patches receiving sunlight), then burn on a seven-year cycle with interim maintenance (every two years) for sticks, and to produce side stem production for enhanced nut development. Balance maintenance for both stick and nut production based on a gradient of shadier to sunnier conditions. The shadier it is, the longer the shoots, as they reach for the sun. Sunnier conditions produce stouter stems and more nuts.

- Manzanita: Monitor the one isolated plant.

- Pepperwood nuts: Take out conifer sapling poles encroaching on pepperwood to allow for more sunlight.

- Iris: Re-seed and/or transplant (May to August).

- Potential wildlife focal species or habitat features (based on current observed use) to monitor and/or research as a surrogate for habitat health include: elk, deer, bear, woodpecker.

Táasich Meadow. Photo credit: Daniel Sarna-Wojcicki.

Seep at *Táasich*. Photo credit: Daniel Sarna-Wojcicki.

4.2.2 *KÁMMAAHRIV*

Landscape:

- Fuels: Thin even-age Douglas fir stands.

Cultural Focal Species at Plot:

- Beargrass: bunches appear drought stressed; increase overstory tree growth for shade that will promote understory soil moisture. Beargrass tends to thrive at higher elevations. These may be relics of past transplantation that were nurtured on a continual basis.

- Sugar Pine: Clear out pine needles/duff from around the base of the trees; thin and understory burn.

- Yew: Need more shade and bank stabilization; encourage cultural use and management where and when appropriate.

  > *[Yew] are like cultural artifacts in the landscape, because they are...so slow growing...horticulturally, you can't really use them until they're really old and mature...The process of making a bow takes many years. Actually carving it out of the tree itself, drying it, it's like a [multi-year] process. (Kathy McCovey, ITEK, 5.20.2021)*

- As Karuk cultural practitioner Lisa Morehead-Hillman explains:

  > *My great-uncle Lew Wilder said that a lot of the work training yew trees is done for the next generations of bow-makers. You actually train the tree over many, many years. Then the wood is harvested, and several pieces are cut that could end up as bows. You never really know until you carve it down, because there might be a weak spot that you don't see until you whittle it down. It's really a craft for those with vision, dedication and a LOT of patience. (Lisa Morehead-Hillman, ITEK, 2.27.2022)*

- Woodwardia: Needs more thinning, use, and maintenance, e.g. cleaning out some of the dead fronds from around the roots.

- Red Huckleberry: Enhance and maintain by fostering growth in patches of light in moisture-retaining substrate (some overstory shade); regular pruning or protecting single species from over-browsing; transplanting some to higher elevations with more water access.

I think anywhere we see [Red Huckleberries] on the landscape, they're definitely something that we want to retain because they are kind of rare. [Especially at mid-lower elevations such as this plot] (Analisa Tripp, ITEK, 5.27.2021)

- Potential wildlife focal species or habitat features (based on current observed use) to monitor and/or research as a surrogate for habitat health include bear, deer, elk and mountain lion.

Kathy McCovey harvests beargrass at the knoll, May 2019. Photo credit: Daniel Sarna-Wojcicki.

Vikki Preston harvests matsutake/tanoak mushrooms at the knoll, October 2019.
Photo credits: Daniel Sarna-Wojcicki.

4.2.3 *TISHÁNIK*

Leaf Hillman remarks on the significance of restoring the floodplain, cultural use species and cultural/ceremonial uses of this riverine floodplain/riparian area:

> *You can say this site has been highly disturbed and most of the original land form there has been removed...but the significance of that place has not diminished. The significance today...it's an important place for us because it does encapsulate all of this history that people have endured and been through. That site has that history embedded in it...but yet, we survived and came out the other side of that horrible history and sort of everything that that means [is] embedded in that landscape there today, how people feel about it today, and the importance that people associate with that place today. It really is one of those places of revitalization and renewal, literally. (Leaf Hillman, ITEK, 5.28.2019)*

Landscape:

- Invasive management: Comprehensive invasive management plan for locust, Scotch broom, Himalayan blackberry, star thistle and non-native grasses (eg. cheat grass (*Bromus tectorum*) and hedgehog dogtail (*Cynosurus echinatus*). See Lake, 2007 on survey methods for willow for cultural use and native vs. non-native grasses.

Cultural Focal Species at Plot:

- Blue dicks: Burn to reduce overstory cover and create better soil conditions. Ideal soil conditions are well drained floodplains with sandy loam and lots of light; transplant (dig and transplant corms to suitable soil type areas to enhance productivity) (Anderson & Lake, 2013).

- Manzanita: Annual burning — frequent burning around manzanita to reduce and maintain light surface fuel as manzanita is very fire sensitive (thin bark). Break out dead fuel component from manzanita.

- Willow stems: Continue to coppice, thin and burn willow patches; restore and reconnect floodplain and enhance scouring and sedimentation dynamics.

- Potential wildlife focal species or habitat features (based on current observed use) to monitor and/or research as a surrogate for habitat health include: deer, elk, bear, birds (migratory and resident) salmonids and lamprey eel.

Lisa Morehead-Hillman harvests grape roots at *Tishánik*, August 2019. Photo credit: Daniel Sarna-Wojcicki.

Shawn Bourque crosses Camp Creek on a riparian survey. Photo credit: Megan Mucioki.

Vikki Preston conducts a manzanita berry harvest survey at the *Tishánik* ACA Plot, August 2020. Photo credit: Daniel Sarna-Wojcicki.

Lisa Morehead-Hillman describes a recently burned willow patch, October 2020. Photo credit: Daniel Sarna-Wojcicki.

Kathy McCovey harvests Blue Dicks geophyte bulbs while Jennifer Sowerwine interviews her about harvest quality and cultural stewardship techniques, 5.8.2019. Photo credit: Daniel Sarna-Wojcicki.

4.2.4 LOWER SIMS

Landscape:

- Reduce surface and suspended fuels and fuel jackpots (concentrated areas of fuels leading to high fire intensity/severity and rapid spread of fire) and return cultural fire to the landscape. Bill Tripp discusses an approach to treating fuels and returning cultural fire to the landscape:

> *[P]art of the example set here is that we can utilize features like rivers, roads, historic trails to compartmentalize burn units that we can treat around the edges and implement prescribed fire as our initial treatment in the interior...Before [we treated it] it was thick in here...There were 10 acre chunks of ground you couldn't get through without a machete. At this point you can walk through here and smell the tea that's growing in here, you can see the little bulbs that are important traditional food sources. There are lots of Tribal folks that want to preserve our ability to continue the practices that proliferate these species, and to revitalize our ability to utilize them in a manner to where we don't feel threatened by arrest or persecution. Most people consider humans as separate from the ecosystem, whereas Indigenous knowledge says that humans are a critical component of it...(We're) looking at ramping up the scale and complexity of our actions. The important part — is building capacity to handle the fire issue on our own in the future. This is the start of building that capacity so we can achieve that larger scale vision together. (Bill Tripp, ITEK, 6.5.2016)*

Cultural Focal Species at Plot:

- Blackcap: Remove Himalayan blackberry to enhance blackcap recruitment and reintroduce frequent low-intensity fire around blackcap patch. Kathy McCovey on the importance of clearing out dead fuels and removing invasive Himalayan blackberry from the blackcap patch:

> *The 2019 burn was not able to get rid of competing blackberries but did get rid of many of the Douglas firs. However, now a lot of the dead stuff from the burn is on the ground making it really hard for elk and people to move through the area. Walls of Himalayan blackberry further complicate access...As I look around, I see that a lot of the blackcaps are being crowded out. They're being crowded out by this blackberry. (Kathy McCovey, ITEK)*

Frank Lake on strategies for removing the blackberry from the blackcap patch:

> *The Himalayan blackberry, I mean, you burn it out in the fall or an earlier dry winter. Then, in the springtime, when it re-sprouts and soils loosen, you can come in here and*

dig it out by the roots. And I think that's part of their plan for these areas to do rather than herbicide. MKWC [Mid Klamath Watershed Council] and the Karuk fire crew is [planning] to come in and actually do physical, manual removal to some of the main clumps. And then, after that, you keep running a fire back through [the area] every couple of years and should be keeping the area or the amount of thatch and canes of the Himalayan blackberry down and give the other native stuff [desired species] more of a chance [for recruitment and regeneration]...The seed bank will be in there for a while, right? So it'll keep coming back. But as long as you keep it at bay [density or % of cover lowered] with fire, I think you should be able to manage it easier...eventually, they won't resprout back anymore because you'll have knocked it back enough for a couple of years. (Frank Lake, ITEK, 2020)

- Ceanothus: Thinning and more understory fire.
- Madrone: Recruit and nurture madrone saplings to replace stressed legacy madrones and retain mature madrone component.
- Potential wildlife focal species to monitor for based on current use: Elk, deer and bear.

Frank Lake explains approaches to treating and thinning the dead wood and excess fuels at the Lower Sims plot, October 2020. Photo credit: Daniel Sarna-Wojcicki.

Dead woody debris and fuel build up in Lower Sims, October 2020. Photo credit: Daniel Sarna-Wojcicki.

4.2.5 UPPER SIMS

Landscape:

- Reduce dead materials on the ground by pile burning away from legacy trees and focal patches.
- Thin young Douglas fir, tanoak and redwood.
- Explore strategies for receiving carbon/habitat enhancement credits for cultural fire and landscape stewardship.
- Develop management plan for Tribal land parcel.
- Set up water tank for family-based cultural burning.

Cultural Focal Species at Plot:

- Black Oak: Remove or thin Douglas fir to open up canopy space, but not more than 30% in a single entry to prevent wind fall.

  > *There's a couple of leaning older black oaks over there that are just trying to find the gap in the canopy that we think might benefit from some thinning around them. I guess is there some concern that they'll topple over after — ? Yeah. Some of the other projects where they did plantation thinning, they did end up getting a lot of wind and snow down afterwards. But they were thinning 80% of the trees...And so a lot of the research that we found showed that — as long as you're not reducing the canopy by more than 30% in a single entry, then it gives what's left a little bit more time to [stabilize]....Some of those are just unknowns you have to deal with.*
  > *(Bill Tripp, ITEK, 5.26.2021)*

- Huckleberry: Thin younger Douglas fir, tanoak and redwood trees, open up canopy and prune shrubs to create more light, compact growth and berry production (as well as for "pickable range," 2 feet to 8 feet tall).
- Yerba Buena: Thin younger Douglas fir, tan oak and redwood trees to create more light, conduct annual pruning and harvesting.
- Woodwardia: Manage towards a thicket of woodwardia without other encroaching small trees or shrubs. Thin out non-woodwardia plants, maintain (when it gets too overgrown, thin it out and burn it, harvest and weed).

- Hazel: Burn, harvest, repeat two-or seven-year cycle for sticks and nuts respectively.

> *This whole area has a lot of promise for basket weavers, but without burning it or treating it somehow, it's not quite there…Burned hazel and beargrass have less outer covering bark coating…It's not as brittle. It can be twisted. And if you see in our baskets, there's a whole lot of twisting going on. And so to make a basket and spend that much time and gather all your stuff, you have to make sure you're getting good stuff. You're spending a lot of time gathering it, finding it, gathering it and then working with it. So if you make a basket, you want a basket that's going to last, 60, 100 years. But if you're using bad materials, that basket is not going to last that long.*
> *(Kathy McCovey, ITEK, 5.15.2019)*

As cultural practitioner Lisa Morehead-Hillman elaborates:

> *And it's going to take a lot more time, because you have to replace the sticks and/or roots where bugs or growth anomalies have weakened them. They'll break at those junctions. Or at the very least, the weaver will have to baby that weak-spot and the weaving continuity will suffer visibly.*
> *(Lisa Morehead-Hillman, ITEK, 2.27.2022)*

- Potential wildlife focal species or habitat features (based on current observed use) to monitor and/or research as a surrogate for habitat health include:
    - Elk: Maintain and enhance elk calving habitat features including forage abundance, easy access to water and cover from predators (see Somes Bar Integrated Fire Management Project Environmental Assessment, ie. ideal Elk calving areas are outer riparian places that are bit thicker with adjacent open areas); encourage evergreen huckleberry by thinning out competing species and increasing light for more abundance and productivity on north and west side of creek.
    - Develop avian and amphibian focal species recommendations and target habitat features.

Lisa Morehead-Hillman processing woodwardia fern at Upper Sims, October 2020.
Photo credit: Daniel Sarna-Wojcicki.

4.2.6 *IKXARIYÁTUUYSHIP*

Kathy McCovey speaks about restoring historic vegetation conditions and cultural uses and management of plot area:

> *So looking at it from a forestry perspective, this seems to be that it used to be a lot more open. There's a lot of conifer. And there are a lot of stems per acre in this area, this gathering area for hazel. I think that fire played a large part in the past, about 120 years ago or so. This used to be, to me, to my eye, an oak woodland/grassland. And it had a hazel component to it for its understory. I like the way each individual hazel bush is well-situated and is really strong where it grows. And so, to me, that indicates [a] deep root system. But what I don't like to see is that each of these hardwood trees, especially these oaks, are deteriorating. They're bent over, trying to find a space for their leaves to get sunlight so it can photosynthesize. So these are old. Because of shade, they're starting to break down...The old growth is maybe a couple of trees per acre in here. But, predominantly, it was hardwoods. And there's a lot of manzanita in here. We have to remove Douglas fir because there's a choice to be made right now. Is it going to be a Douglas fir forest? Or is it going to be a hardwood oak woodland with madrone and hazel component? (Kathy McCovey, ITEK, 10.10.2020)*

Landscape:

- Manage or eradicate cheatgrass.
- Thin young Douglas fir stands in and around plot.

Cultural Focal Species at Plot:

- Black Oak: Thin, potentially coppice leaning limbs. Analisa Tripp on restoring legacy black oak component of plot:

> *Unfortunately, in this area, a lot of the black oaks are already dead and dying...And also we're [thinning] slowly in stages because we don't want to shock them either... So there's a lot of things to think about...if you thinned around some of these here, it would just open up too fast...There are a few individuals that are really healthy where you could clear all the way around it and it would be totally fine but then others, you can't take certain trees...But if you got some of them like out here that are reaching for the light and got some good canopy, it's opened around too much. It's going to have crowding all the way down where it gets the light. So if you've got a tree that's used to reaching and leaning and sitting out there with so much weight on it, that*

ends up with all this branching that becomes top-heavy and comes down. But you can go in and top that one and then let a bunch of light in, and then what you cut off is offset by the branch growth, and you'll give it enough time to develop some strength in its root system, not creating too much weight for it to handle…Then you're exposing all of that branch structure in the snow load and all these other factors. So you just got to find your balance in all those things…They resprout well, and they actually grow fairly fast. And so an investment in something the size of this bigger stand-might be a little bit more strategic.
(Analisa Tripp, ITEK, 5.26.2021)

- Tan Oak: Restore legacy tan oak groves by thinning younger trees and shrubs and burning around mature trees.

- Hazel: Burn.

- Iris: Explore options for burning, reseeding, transplanting, division of rhizomes from Iris and re-planting.

- Potential wildlife focal species (based on current observed use) or habitat features to monitor and/or research as a surrogate for habitat health include: Enhance deer and elk habitat, forage availability, movement and migration corridors through thinning and prescribed and cultural burning.

4.2.7 OWL MINE

Landscape:

- Maintain meadow through low-intensity cultural burn.

- Eradicate Scotch broom and Himalayan blackberries. Frank Lake on restoring the meadow and legacy hardwood components and dealing with invasive species:

Start by getting out the thatch, invasive blackberries, and Scotch broom. After the Scotch broom expresses all of its seeds you want to burn again with a burn every two years to get it before it flowers…If we're here on a cold, dry day, like in January, February, you could burn off the grass and then you'd be able to burn the adjacent forest into this…So you kind of break up your fuels, and then if you ever did come in here and do the thinning and prescribed burning, then you really can start to enhance

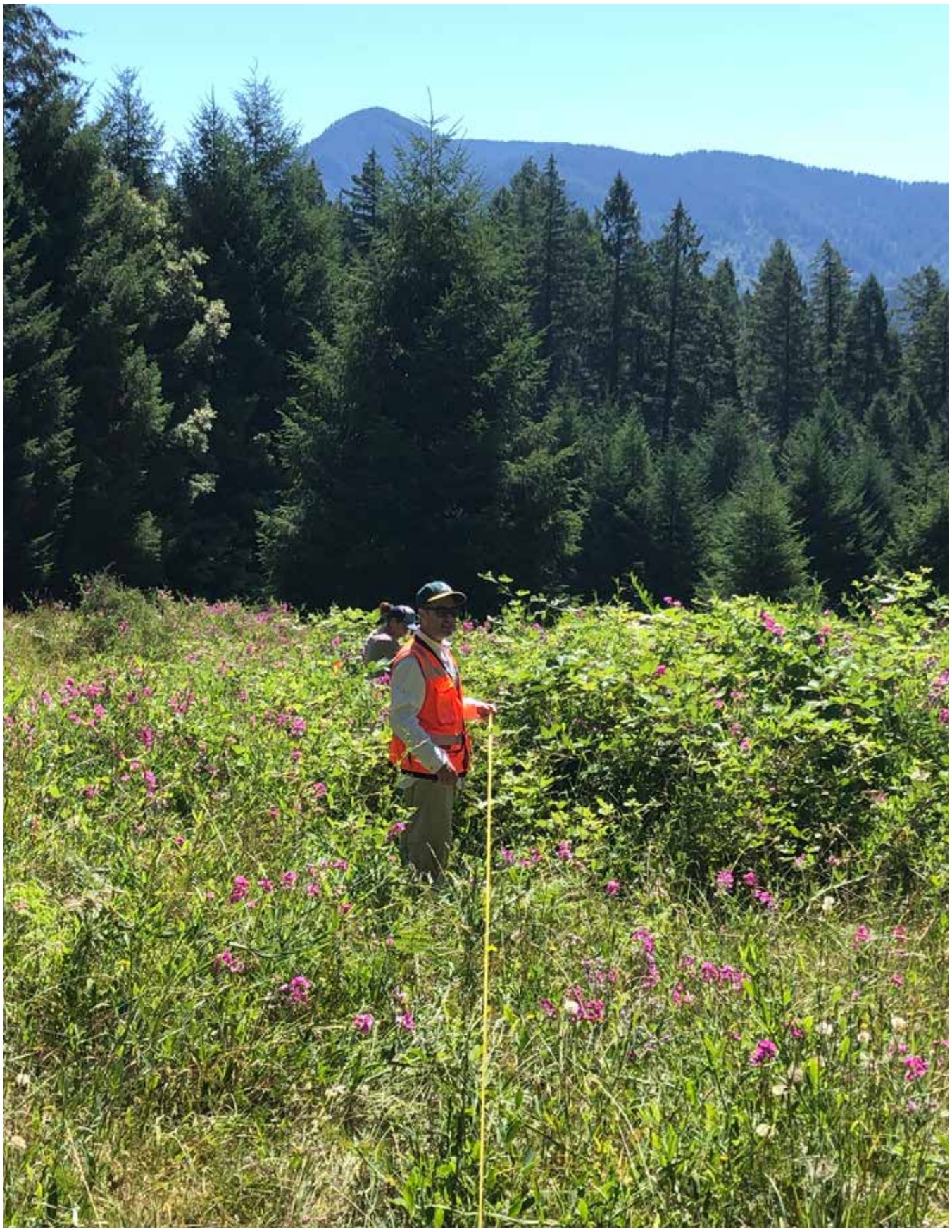
around each of those acorn trees, some sort of logging getting to some of this stuff [encroaching Douglas firs] or--and then the other thing is that some of these Douglas firs that are bigger, you could always pile branches and debris at the base of them and do burn piles at the base of those things and create snags.
(Frank Lake, ITEK, 10.28.2021)

- Thin younger Douglas fir and fuels around legacy oaks and conduct pile burns.
- Facilitate cultural practitioner stewardship and harvest of cultural species (huckleberry, tanoak acorns and mushrooms, manzanita).

Cultural Use Species at Plot:

- Huckleberry: Thin on east and north east of huckleberry patch, remove younger Douglas fir.
- Potential wildlife focal species or habitat features (based on current observed use) to monitor and/or research as a surrogate for habitat health include: deer, elk.

Megan Mucioki and Vikki Preston setting up an ACA Plot near the Owl Mine meadow.
Photo credit: Daniel Sarna-Wojcicki.



RACCCA team researchers Megan Mucioki and Daniel Sarna-Wojcicki set up a vegetation transect through the Owl Mine meadow ACA plot, June 2020. Photo credit: Jennifer Sowerwine.

4.2.8 PATTERSON

Chook Chook Hillman on fuels treatments around plot:

> *You have some really nice sugar pine ridges that were main thoroughfares, and a lot of nice country up there for habitation and animal purposes. And, of course, [historically] that got logged really bad, as well. Pretty wiped out pretty hard, but a lot of neat places. I supervised the [recent] logging, and I'm generally very happy with the end product. I mean, it's not over yet, but it's looking good to me. All the burning that happened this year, if we get the logging mess cleaned — a lot of the individuals that we see here are doing good, and I think that we had a pretty light touch in the plantations, which I think if we plan on going back in 20 years and thinning some more, should do good. I mean, we were hoping that we didn't take down the canopy too much at once to allow for invasive non-natives to take over. That still remains to be seen, but a lot of people say, "Oh, should have taken more," but I think it's probably good for our first entry. And, I wish that there was more that we could have taken, but I mean, the amount of land we have to treat, it's probably best that we didn't.*
> *(Chook Chook Hillman, ITEK, 8.2020)*

Landscape:

- Cultural practitioner burns around hazel and tan oak acorn piles within the next 1–2 years (post-McCash fire)
- Post-fire treatments, e.g. thinning, pile burning and prescribed and cultural burning (5–7 years post-fire, 2026–28)

Cultural Use Species at Plot:

- Legacy tanoaks: Pile burn acorns to get rid of weevils and moths.
- Potential wildlife focal species or habitat features (based on current observed use) to monitor and/or research as a surrogate for habitat health include: deer and elk.

USFS research scientist and cultural practitioner Frank Lake surveys the quality of tan oak acorns in the Patterson ACA plot, October 2020. Photo credit: Daniel Sarna-Wojcicki.

RACCCA team members and Karuk cultural practitioners Vikki Preston and Kathy McCovey and RACCCA researcher Daniel Sarna-Wojcicki discuss possible historical cultural uses of the Patterson ACA plot, June 2020. Photo credit: Jennifer Sowerwine.

TABLE 4.1 Management and Monitoring Recommendations for Riparian Areas in ACA Plots

ACA Plot	Riparian Management and Monitoring Recommendations
Táasich	• Prevent dewatering and maintain year-round flow in seep/*píish* pit
	• Increase connectivity to other nearby (<500m) water features
	• Mitigate road and skid road related erosion into the wetland
	• Monitor depth and surface area of 5 seeps once per year in dry season
	• Take canopy cover points at 5 seeps, especially 4 yew groves at least every 3–5 years
	• Conduct vegetation survey transect in riparian area
	• Conduct wet-dry mapping downstream from seep
	• Install 1–3 soil moisture probes in riparian area
	• Monitor water lines and dewatering of springs
Kámmaahriv	• Stabilize south creek bank, create channel complexity between Transects 4 and 5
	• Monitor depth and width of stream at 5 transect points annually in dry season
	• Conduct wet-dry mapping on north stream
	• Install 1–3 soil moisture sensors around ACA plot and focal patches
	• Repeat CRAM after 10 years or significant management/climate activity
Tishánik	• Coordinate with Lisa Morehead-Hillman, Leaf Hillman, KDNR Fisheries, Karuk cultural practitioners and families connected to site to plan restoration of floodplain, riparian area, cultural vegetation, remove invasive species and build infrastructure to support cultural and ceremonial uses of site
	• Increase connectivity of former channel/floodplain to Klamath mainstem, create better soil conditions, off-channel habitat and moisture availability
	• Invasive monitoring via aerial and ground surveys
	• Continue vegetation transects up Camp Creek to bridge
	• Install streamflow gauge at bridge
	• Continue salmonid and eel population research and stream habitat surveys
	• Research floodplain reconnection alternatives

ACA Plot	Riparian Management and Monitoring Recommendations
Lower Sims	• Himalayan blackberry removal, protect cultural sites • Monitor depth and width of stream at 3 transect points • Conduct wet-dry mapping in Donahue Gulch creek • Install 3–5 soil moisture sensors around Tribal property • Repeat CRAM survey after 10 years or significant management/climate event • Cultural resources survey recommended
Upper Sims	• More large wood in stream for Pacific giant salamander habitat and to prevent erosion/ incision/bank undercutting • Monitor depth and width of stream at 3 transect points during seasonal visits, at least once per year in the dry season • Conduct wet-dry mapping along stream reach annually during dry season
Ikxariyátuuyship	• Thin Douglas firs while maintaining shade for riparian area, pond and turtle habitat • Enhance turtle habitat and migration corridors • Complete Turtle Pond riparian fringe survey. Ground truth drone aerial image vegetation classification with radial vegetation surveys (4–8) going ~20 m out from pond fringe, gps points at start and end of pond. Repeat after 10 years or following significant management or climate event • Measure pond depth at lowest point during the dry season (Aug-Sep) annually • Work with Emilio Tripp and Chook-Chook Hillman to design *non-invasive* turtle habitat and population survey and Karuk community monitoring protocol
Patterson	• More large wood in stream to create habitat and stabilize creek channel and banks • Wet/dry mapping in creek alongside ACA plot this summer and annually in dry season, including channel depth and width measurements at 3 transects

Kathy McCovey and Megan Mucioki conduct a harvest survey for willow stem quality at a focal patch near Camp Creek, May 2019. Photo credit: Jennifer Sowerwine.

Lisa Morehead-Hillman harvests willow roots, August 2019. Photo credit: Daniel Sarna Wojcicki.

BOX 4.1 Monitoring Recommendations for ACA Plots

At each ACA plot:

- Every 10 years or after significant management/climate event repeat ACA baseline survey and CRAM in associated Wetland-Riparian Assessment Areas.
- Three times a year conduct seasonal surveys.
- Annually, conduct harvest visits for each cultural focal species and other cultural use species in the plot.

Special considerations include:

- Monitoring isolated cultural focal species or cultural use species or patches for habitat condition change, climate stressors, focal species health, cultural use quality and yield of harvest.
- Invasive plant species monitoring (e.g. Himalayan blackberry, star thistle, Scotch broom, locust, invasive grasses, etc.) via aerial and ground surveys.
- Align focal species and coordinate ACA plot and patch monitoring with "Karuk Climate Adaptation Plan" (KDNR 2019) and WKRP Somes Bar and *Ikxariyátuuyship* project area monitoring, Karuk Wildlife Division focal species and the "Karuk Eco-Cultural Resource Management Plan." (KDNR 2010)
- Post-fire monitoring for changes in canopy cover, vegetation composition, invasive species, wildlife, soil moisture, and focal species abundance, health, quality and yield of harvest in wildfire, cultural or prescribed fire footprints if they overlap with ACA plots and patches. Monitoring will include repeating transect, subplot, 360° photo and harvest surveys.
- In plots with wildlife focal species of interest, work with the KDNR wildlife division to:
    - Identify wildlife focal species for habitat enhancement and maintenance
    - Install game cameras
    - Install acoustic recorders

- Implement fecal DNA and hair-snag sampling for population research
- Establish traps for wildlife collaring
- Generate recommendations for research, monitoring and managing wildlife habitat
- Support continued Karuk-directed research, monitoring and management by Karuk Tribe DNR wildlife program

Vikki Preston conducts a harvest survey for maidenhair fern, August 2020. Photo credit: Daniel Sarna Wojcicki.

4.3 GENERAL RECOMMENDATIONS FOR ENHANCING AGROECOSYSTEM RESILIENCE IN KARUK ABORIGINAL TERRITORY

Based on guidance from KDNR staff, Karuk cultural practitioners and Tribal community members, we recommend the following general management, policy and institutional actions to support the resilience of Karuk cultural agroecosystems and cultural food and fiber species to climate change-related threats and stressors across Karuk Aboriginal Territory, now and into the future:

1. Support Karuk Tribal sovereignty in natural resource and food systems governance, data sovereignty, and Tribal oversight of research, monitoring, and the communication and transmission of Karuk Indigenous science.

2. Reacquire and rematriate Karuk Tribal land, build back the Karuk Tribal land base and restore habitats and ecosystems at landscape scale. Secure funding to support Karuk Department of Natural Resources staff and Karuk Tribal members and descendants for culturally appropriate jobs in research, monitoring, fuels, wildlife, education, management and administration.

3. Build programs and secure funding for internships, workforce development programs and jobs for Karuk Tribal members and descendants to build leadership among Tribal workforce in wildlife, climate, hydrology, fisheries, fire, watershed management and cultural resources.

4. Fund and facilitate Tribal community and cultural practitioner engagement and direction of management at ACA plots and patches.

5. Facilitate Tribal staff, partner (e.g. WKRP, USFS), community and cultural practitioner selection

of new ACA plots and focal patches for monitoring and management for agroecological resilience.

6. For plots and patches in Karuk Aboriginal Territory currently occupied by USFS, facilitate and support co-management and family-based stewardship of cultural plants and habitats, including pruning, coppicing, thinning, fuels reduction, small scale burning in coordination with Karuk fire crew and in accordance with the USDA Forest Service's Pacific Northwest Forest Plan and Six Rivers/Klamath Land Resource and Management Plan revisions, provided the Plan addresses the most recent national policy direction from the White House's Office of Science and Technology Policy and Council on Environmental Quality regarding IK and Joint Secretarial Orders for co-management/stewardship (Executive Office of the President 2021; USDA 2022; The White House 2021; The White House 2022).

7. For plots and patches on Karuk-owned private land, facilitate and support Karuk family and community stewardship of cultural plants and habitats, including pruning, coppicing, thinning, fuels reduction, and small-scale prescribed fire and cultural burning.

8. Explore strategies for receiving carbon/habitat enhancement credits for cultural fire and landscape stewardship.

9. Work with landowners in Karuk Aboriginal Territory on stewarding cultural plants and habitats for resilience, establishing easements and allowing for cultural practitioner access and stewardship, rematriating land to the Tribe, ensuring ability to harvest and direct management of homesteads for regenerative landscaping, foodscaping, firescaping and cultural plant gardens.

10. Seed and Start Bank: grow native plants at Karuk Tribal farm, store seeds, use plants, seeds and spores for reseeding post-disturbance (fire, flood, roadside, construction, landscaping).

11. Build management infrastructure for KDNR, Tribal community, and cultural practitioners, including water tanks, trucks, engines, CATs, chainsaws, pruners, clippers, and thinning and logging equipment for community use in management and stewardship.

12. Research, monitoring, and education that can support agroecosystem resilience in Karuk Aboriginal Territory:

    a. K–12 education: teach the next generation of land stewards through lesson plans, curriculum and field trips centered on Karuk Indigenous knowledge and stewardship, monitoring of culturally significant plants.

    b. Community workshops: seasonal calendaring exercise, pruning and coppicing work-

shops, basket-weaver gatherings and workshops, field trips such as site visits and river floats with local schools. Support intergenerational learning opportunities for the Karuk community through field trips and school programs, elder-youth interviews, gathering-processing workshops.

c. Citizen science climate application: recruit cultural practitioners and youth to use the Citizen Science climate app to record observations of focal and cultural use plants over the seasons. Continue to collect, collate, analyze data generated from community observations.

d. Climate dashboard: Continue to build out the climate dashboard as a decision support tool to improve land management based on integrated climate, fire history, cultural and biophysical data among other sources of information. Train KDNR managers to use and add data sets, revise and update based on Tribal staff and management needs.

e. Tree ring study: Use increment borer to study tree age growth rings in suitable trees in or near plots to enhance understanding of long-term climate (rainfall) and fire histories.

f. Soil moisture study: Install soil moisture readers with data loggers (after consultation with KDNR, THPO and appropriate Karuk oversight bodies) to study soil moisture levels in plots.

g. Monitor fish and wildlife (including mammals, amphibians, birds, reptiles and insects) population and habitats using methods such as game cameras, acoustic recorders, satellite or telemetry collaring and genetics research (e.g. fecal DNA transects, hair snags, or environmental DNA).

h. Downscale climate scenario modeling, fire behavior and streamflow or soil moisture modeling to help managers plan treatments to enhance resilience of cultural plants based on projected threats and stressors.

i. Scale up land cover change detection research using historical and contemporary aerials. Prioritize historical aerial imagery sets with the best resolution and National Agricultural Imagery Project (NAIP) imagery collected post-2005, including new imagery as it is collected (approximately biannually).[12] The methods used for georegistration of historical aerial photographs and for image segmentation and classification were la-

12 The 1965 and 1975 flights have the finest spatial resolutions of the image sets we analyzed. The 1942-44 images are the earliest sets, but have relatively high contrast making it difficult to discern between live vegetation and shadow. The 1999 images have coarser resolution, but reasonable contrast.

bor-intensive and only appropriate for very small areas such as the acre-sized RACCCA plots. Machine learning techniques (e.g. supervised object-based classification) should be explored for imagery that has already been georegistered and orthorectified and for analyses covering larger areas (e.g. watershed or landscape-scale).

j. Where safe, feasible and culturally appropriate, use immersive visualization (360-degree cameras) and remote sensing (UAVs, aerial and satellite imagery) to study vegetation change.

Kathy McCovey discusses cultural stewardship with Vikki Preston, Analisa Tripp, Frankie Tripp and Heather Rickard at the RACCCA Resilience Workshop, May 2021.
Photo credit: Jennifer Sowerwine.

RACCCA team discussing place-based cultural agroecosystem monitoring and stewardship at community workshop, May 2021. Photo credit: Jennifer Sowerwine.

RACCCA Resilience workshop participants discuss food sovereignty strategies at Karuk Tribal Farm during the May 2021 workshop. Photo credit: Jennifer Sowerwine.

5 GLOSSARY OF TERMS

Agroecosystem: the basic unit of study in agroecology, somewhat arbitrarily defined as a spatially and functionally coherent unit of agricultural activity (the practice of cultivating crops). It includes the living and nonliving components of that unit as well as their interactions.

ACA: Agroecosystem Condition Assessment.

AFRI: Agriculture and Food Research Initiative, a competitive federal grant program for scientific research, education and extension activities in priority areas.

ARC-GIS: software for visualizing, managing and analyzing geographic and spatial information.

Bankfull: is the hydrologic stage when water begins to flow over the floodplain forming and maintaining channels.

CRAM: California Rapid Assessment Method for Wetlands and Riparian Areas.

Cultural fire: the intentional uses of fire by Indigenous people for cultural purposes.

Cultural use species: plants, animals and birds harvested for their food, medicinal use, regalia material and spiritual value.

DBH: diameter at breast height.

Densiometer: spherical crown densitometers are used to measure the amount of light that gets through the forest canopy and determine overstory density.

Stream order: a number used in geomorphology and hydrology to indicate the level of branching in a river system, with a first order stream being the smallest, highest stream in the watershed.

Focal plant/focal species: culturally significant plant species identified by the Karuk DNR as a priority for assessment and management.

Focal patch: an approximately 10 x 10 m area focused on 1-2 focal plant species established for long-term monitoring in Karuk Aboriginal Territory.

Forbs: a herbaceous flowering plant, excluding grasses.

***Ikxariyátuuyship* initiative:** A proposed initiative led by the Karuk Tribe including fuels treatments and prescribed fire to revitalize cultural use species and restore fire adapted landscapes to *Ikxariyátuuyship*, a mountain sacred to the Karuk peoples, also known as Offield Mountain.

Jackpots: concentrated areas of fuels leading to high fire intensity and severity and rapid spread of fire.

KDNR: Karuk Department of Natural Resources.

Landfire: is a platform of landscape scale geo-spatial products used by the the wildland fire management programs of the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior to support cross-boundary planning, management, and operations.

Legacy trees: old growth trees, often the legacy of long term cultural stewardship and use.

Line Intercept Method: a method used to measure tree and shrub cover along transects or a long-straight line in a plotted area.

NIFA: National Institute of Food and Agriculture. Administers the AFRI grant program.

Phenology (of plants): the timing of recurring plant life-cycle events (e.g. leaf emergence, budding, flowering, fruiting).

Prescribed fire: the intentional use of fire for fire management, fuels treatment, habitat enhancement or other purposes.

Quadrat: a framed, enclosed area (e.g. .5 x.5 m), often a square, which is used to study the distribution of herbaceous plant species using a sampling method designed to represent a larger area.

RACCCA: Resilient Agroecosystems under Changing Climate Condition Area, a program of the NIFA-AFRI grant-making initiative of the US Department of Agriculture.

Relevé protocol: a method to estimate herbaceous plant cover by species within a quadrat using cover class categories and visual estimates.

Rematriate: the process of returning or giving back with the intent to restore, decolonize, address historical and contemporary injustices, and build a better future.

Riparian: riparian areas are the zone of transition between any aquatic feature and adjacent uplands, not just the area along riverine systems with woody vegetation (CRAM).

Somes Bar Integrated Fire Management Project: The Somes Bar Integrated Fire Management Project (SBIFMP) is a demonstration project for the Western Klamath Restoration Partnership (WKRP). The project aims to integrate anthropogenic tribal fire use practices with emergent fire management analysis applications to foster greater collaboration among scientists, managers, and indigenous peoples. The objectives are to promote community values, human safety and culturally-significant natural resources vital to the preservation and perpetuation of Karuk culture. The project contains four focal areas, known as Donahue Flat, Patterson, Rogers Creek, and Ti Bar, which cover ~5500 acres in total. See: https://www.wkrp.network/orleanssomes-bar for more information.

TEK/ITEK: Traditional Ecological Knowledge/Indigenous Traditional Ecological Knowledge.

THPO: Tribal Historic Preservation Officer, authorized by Section 101(d)(2) of the National Historic Preservation Act.

Transect: biological sample area, usually in the form of a long continuous strip.

Voucher specimen: pressed and dried section of plant, usually including flowers and fruits, mounted on heavy paper using methods and materials for long-term storage and preservation.

WKRP: Western Klamath Restoration Partnership.

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8 APPENDIX: FOCAL PLANT PHOTOS FOR IDENTIFICATION

Beargrass (*panyúrar, Xerophyllum tenax*)

Photo credit: Keir Morse, CalPhotos.

Blackcap raspberry (*paturúpveen'ippa, Rubus leucodermis*)

Photo credits: Ben Saxon, KDNR and Keith Morse, CalPhotos.

Black oak (*xánthiip, Quercus kelloggii*)

Photo credits: Zoya Akulova, Jean Pawek, and Keir Morse, CalPhotos.

Blue Dick potatoes (*táyiith, Dichelostemma capitatum*)

Photo credit: Keir Morse and Barry Breckling, CalPhotos.

California bay laurel (*páhiip, Umbellularia californica*)

Photo credit: Frank Lake, USFS; Keir Morse and Zoya Akulova CalPhotos.

California beaked hazelnut (*súrip /áththip, Corylus cornuta ssp. californica*)

Photo credit: Keir Morse, Zoya Akulova, Barry Breckling, and Jorg Fleige, CalPhotos.

California blackberry (*attaychúrip, Rubus ursinus*)

Photo credit: Keir Morse, Zoya Akulova, and Jean Pawek, CalPhotos.

Evergreen huckleberry (*purith'íppan, Vaccinium ovatum*)

Photo credit: Ben Saxon KDNR; Zoya Akulova, CalPhotos.

Five-finger fern (*ikrittápkir, Adiantum aleuticum*)

Photo credit: Ben Saxon, KDNR; Keir Morse, CalPhotos.

Giant chinquapin (*sunyíththip, Chrysolepis chrysophylla*)

Photo credit: J. Maughn, Flickr.

Green leaf manzanita (*pahav'íppa, Arctostaphylos patula*)

Photo credit: Keir Morse and Barry Breckling CalPhotos.

Pacific yew (*xuppáriish, Taxus brevifolia*)

Photo credit: Keir Morse, Jean Pawek, and Steve Matson, CalPhotos.

Red huckleberry (*mîithipar, Vaccinium parvifolium*)

Photo credit: Jean Pawek and Zoya Akulova, CalPhotos.

Rope iris (*achviv'ápkaas, Iris purdyi*)

Photo credit: Ben Saxon, KDNR.

Sandbar willow (*pâarak, Salix exigua*)

Photo credit: Keir Morse, CalPhotos.

Sugar pine (*ússip, Pinus lambertiana*)

Photo credit: Frank Lake, USFS; Keir Morse, CalPhotos; S. Rae, Flickr.

Tanoak (*xunyêep, Notholithocarpus densiflorus*)

Photo credit: Zoya Akulova and Vernon Smith, CalPhotos; Ben Saxon, KDNR.

Tanoak mushroom (*xáyviish, Tricholoma magnivelare*)

Photo credit: BoleteBill, WikiCommons.

Woodwardia/chain fern (*típtiip, Woodwardia fimbriata*)

Photo credit Keir Morse and Barry Breckling, CalPhotos.

Yerba buena (*champínnishich, Clinopodium douglasii*)

Photo credit: Jean Pawek and Steve Matson, CalPhotos.