CARING FOR CULTURALLY SIGNIFICANT PLANTS IN THE MIDST OF RECORD-SETTING DROUGHTS

The Karuk Tribe–University of California Berkeley Collaborative
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The Klamath River Basin (Basin) encompasses the Aboriginal territory of at least seven different Tribal communities, including the Karuk Tribe. As of August 9, 2022, 99 percent of the Basin was under severe drought; of that, 80 percent was in extreme drought (National Drought Mitigation Center 2022). Local and national media spotlight megafires and ongoing water wars among farmers, Tribes, and environmentalists. However, the quiet vulnerability of the Basin's unique plant biodiversity, which is so vital for culturally significant plant food, fibers, and medicines, goes largely underreported.

This article aims to share Karuk cultural practitioner and academic researcher observations of heat and water stress on culturally significant species in the middle Klamath River Basin, as well as co-developed botanical monitoring and educational approaches to support adaptation and resilience of forests, plants, and people to climate change. In doing so we bring attention to the dire circumstances posed by the "new normal" of environmental change, as a climate crisis

Above: Lisa Morehead-Hillman, Karuk practitioner, gathering beargrass near Orleans, CA. Photo: Shawn Bourque

as well as the adaptive capacity of Indigenous plant gathering and stewardship to the growing climate crisis (Mucioki et al. 2021).

Over three years, the Karuk Tribe–UC Berkeley Collaborative (2022) team co-developed and carried out a collaborative research assessment and monitoring protocol in Karuk gathering areas, focusing on 19 culturally significant species (Karuk Tribe–UC Berkeley Collaborative 2023).

Here, we focus on two fern species (*ikritápkir*, five finger or black fern [*Adiantum aleuticum*] and *tíiptiip* or woodwardia, specifically giant chain fern [*Woodwardia fimbriata*]), and two shrubs (*súrip*, California beaked hazel [*Corylus cornuta* ssp. c*alifornica*] and *pâarak* or grey willow [*Salix exigua*]), all of which are used for basket weaving. In addition, we focus on two edible nuts (*páhiip*, pepperwood nuts [*Umbellularia californica*] and *sunyíththip*, chinquapin [*Chrysolepis chrysophylla*]); and two berry species (*patúruupveen* or blackcap raspberries [*Rubus leucodermis*] and *fath'úruhsa* or green leaf manzanita [*Arctostaphylos patula*]), to exemplify climate impacts on culturally significant plants, and the tribal people who care for them.

BASKETRY

Baskets are an important component of food preparation and security, ceremony, and culture. Weaving is interwoven with Tribal identity and is an art passed on through generations. Baby baskets and basket caps are highly sought after for childrearing and connection with identity and culture, so much so that the current weavers in the Basin are challenged to meet the demand (Lisa Morehead-Hillman, Indigenous Ecological Knowledge conveyed on August 2, 2022).

Kathy McCovey and Lisa Morehead-Hillman, expert gatherers, weavers, and cultural practitioners, with basketry materials, and various types of baskets under way. Photo: Sophie Weinstein

Basketweavers are at the forefront of advocating for Tribal sovereignty and self-governance over land and land management using mixed-intensity fire to enhance productivity, and quality of basketry species. Karuk basketweavers are highly experienced gatherers and land stewards, as basket structures and designs require hundreds of strong sticks and fibers from a range of species.

Ferns for basketweaving

Commonly referred to by weavers as black fern for the color of its stem, and used in overlay designs, *Adiantum aleuticum* is rarely found far from a source of water. Its propensity to flourish in unstable wet and rocky soils high up along steep creek banks may be the reason one of its Karuk names is *yumaareekritápkir*, or dead man's black fern, owing to the difficulty of harvesting it.

Mature stems are traditionally harvested in the late spring at lower elevations and into the early summer at higher elevations. Weavers look for healthy emerald-green fronds, and shiny black and red stems before snapping these off at ground level for harvest. The fern frond heads are nipped off at the neck and left close to a source of water on site to support propagation through frond spores. The stems can be bundled and stored without much processing, but before being used as overlay material, they must be split lengthwise and scraped, removing the red-brown side of the stem and its interior pulpy mass.

As drought conditions continue into a second decade, weavers report that the black fern is often brittle early in the harvest season—the stems buckled over with the weight of their foliage during a harvesting trip in 2020 (Lisa Morehead-Hillman and Verna Reece, Indigenous Ecological Knowledge, August 2, 2022). The leaves themselves often reflect poor growth and a dull, light green color. The black side of the stem is used as an overlay material—purportedly the most difficult material to use, even in the best of conditions; when brittle, it will "fray" or break off of the root weft. Additionally, some of the Elder weavers note that the stems are "not turning as dark as usual": Their color is mottled or a dull dark brown, and the fern's fronds do not develop their signature rich green, remaining a light olive or avocado hue. Fronds are also being burned by the intense heat, especially in

areas recently torched by wildfire (Weaving workshop, Indigenous Ecological Knowledge, June 28, 2022).

Furthermore, fern reproduction is greatly compromised without water, as ferns must have adequate water to reproduce as a medium to connect the male and female gametes, and to assist in spore dispersal. Water stress caused by unusually hot and dry seasons is complicating the quality and timing of the black fern harvest:

> *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, January 15, 2019).

Like black fern, the presence of woodwardia is indicative of soil moisture (Rossier 2019). Woodwardia thrives under dappled sunlight and gentle disturbance such as seasonal harvesting and pruning. It is often found at mid-level elevations flanking creek banks, water drainages, seeps, and springs. Large multi-lobed, serrated, deep-green leaves, and stout, long, stems are ideal, harvest-ready plants. Throughout the summer and fall, weavers gather woodwardia ferns, breaking the stems at soil level, stripping them of their foliage and leaving this on site.

Within hours of harvesting, the two strong inner fibers are removed from the stem. After drying, the strands are soaked in water thick with the masticated inner bark of mature alder for about an hour (or more), then dried again before storing for later use. Its abundance in the "upriver" mid-Klamath Basin may indicate ongoing stewardship and propagation by Karuk basketweavers since time immemorial.

The heat and drought typical of current climate conditions seem to have less effect on woodwardia than black fern, yet weavers note the direct correlation between forest management and material health. In patches where the overstory has completely shaded the forest floor—with fierce competition for water sources and light prevailing—the woodwardia stalks show brown spots, leaves often yellowing, that are mirrored in the inner strands. Even after dyeing, these spots will inevitably break when used as overlay.

Sticks for basketweaving

The backbones of Karuk basketry are sticks from California beaked hazel, grey willow, red willow or *kufipfúrax* (*Salix laevigata*), mountain willow (*Salix eastwoodiae*), or *kíthriip* or ceanothus (*Ceanothus integerrimus*). Sticks are harvested in the spring as these shrubs reignite their metabolism for the growing season and sap is actively flowing: "*When the sap's running, the sap will allow you to take the bark off of the stick in one fell swoop*" (Kathy McCovey, Indigenous Ecological Knowledge, March 13, 2020). At this time the outer bark is easily stripped off, an essential step in stick processing for weaving. Spring weather fluctuations from unseasonably warm to cold have resulted in unpredictable growth and development patterns.

Lisa Morehead-Hillman and her granddaughter, Vunsiip, gather black ferns for basketry. Photo: Leaf G. Hillman

> *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, January 15, 2019).

Two vascular bundles of woodwardia stems are harvested and dyed red with alder cambium. The drying basket made by Lisa Morehead-Hillman showcases the use of "red fern" or woodwardia used in Karuk basketry patterns. Photos: Lisa Morehead-Hillman and Megan Mucioki

The peeling of the sticks usually occurs at the beginning of bud development, which ensures strong and aesthetically and mechanically desirable sticks. However, budding is now often occurring before the sticks are peeling. This creates lumpy, weak sticks.

One elder has observed hazel shrubs grow in more shaded areas as the region has warmed:

> *[Hazel] didn't [like shade] before, because it was cooler. First, I thought they disappeared, because I'm getting blind. I don't walk around in the woods no more, because I'm blind. Then they cleaned out the place out here, I went out there and looked and there's hazel just growing up along up underneath there. Underneath the canopy where it never used to grow. I guess because it's cooler. Probably the roots of the trees bring water up. We don't have as many hazel nuts, either* (Cultural practitioner, Indigenous Ecological Knowledge, October 20, 2010).

A recent study of hazel in the Basin found that shaded areas are better for hazel basketry sticks; eastern aspect plants produced almost two times more basketry material than southern aspect plants (Marks-Block et al. 2019).

Historically, willow stick management and quality were aided by the scouring of high Klamath River flows during the winter months that would prune the bushes, take away dead materials, clean the shrubs of insects and other pests, recruit new seedlings and rhizomatous sprouts, and prevent water stagnation at the base. Annual harvest, pruning, and cultural burning also ensured high-quality materials were available for both the warp and weft of countless baskets—particularly long, straight, and strong sticks. The long and whip-like branches of a specific willow species are also used for men's ceremonial "brush."

> *When I was young, the Klamath River flooded and had more high-water winters which ripped the willow out and allowed the new shoots to grow. River*

Kathy McCovey and Megan Mucioki evaluate and document the harvest of willow sticks. In the background tall willow shrubs line the Klamath River, most of them not harvestable for basketry. Photo: Jennifer Sowerwine

> *bars are now overly crowded with willows and other vegetation. When I was growing up, the river bars were more open as well as the edge of the riverbanks. I attribute the change to the mega-drought that we are in right now. There is no rain to raise the water levels enough to even wash the sand out so I can get willow roots.* (Kathy McCovey, Indigenous Ecological Knowledge, September 14, 2022)

For over a century, however, water diversions and dam construction in the Basin have reduced and regulated the flow of water, resulting in the steady (over) growth of river willow—as well as colonies of destructive pests that have always existed and been managed through high river flow. Since then, water flows have been acutely low and in the last decade aggravated by repeated droughts with less precipitation in the form of snow and rain and higher evapotranspiration rates. Furthermore, historically cultural burning activities, which can clean and stimulate new growth, were banned and outlawed for over a hundred years. Today, weavers manually coppice old-growth willow along the river and prune their gathering areas. Although willow is not a fire-dependent species, it is well adapted to disturbance (Kathy McCovey, Indigenous Ecological Knowledge, September 14, 2022). Weavers lament the state of willow materials:

> *I don't bother harvesting in the spring. The willows are too buggy. I look in the fall* (Verna Reece, Indigenous Ecological Knowledge, 2022).

> *It's hard to find decent sticks. I'm finding that I end up replacing about a quarter of my sticks as I go along [weaving]. It's a pain in the ass and hard to hide. Bug holes are everywhere —even in good sticks* (Sophie Weinstein, Indigenous Ecological Knowledge, 2022).

Ceanothus sticks are currently used more frequently, as quality willow sticks are increasingly difficult to find:

> *I am tending to use these (ceanothus sticks) much more frequently given their willow-superior qualities of less taper, strength, small diameter, and length. The type of close-weave baskets I weave are*

improved with these materials. More importantly, the willows are so full of bugs and drought-induced growth deficiencies that it's almost not worth spending time trying to gather anywhere outside fire footprints (Lisa Morehead-Hillman, Indigenous Ecological Knowledge, August 2, 2022).

Low-intensity burning and pruning disturbance are important for basketry sticks. Burning increased basketry stem production by seven- to tenfold in hazel, while the cutting treatment increased production by fourfold (Marks-Block et al. 2019). Burning also improves structural strength (Rentz 2003), an essential characteristic of weight-bearing baskets such as burden and baby baskets.

NUTS

Both pepperwood and chinquapin trees are observably experiencing stress and dying. These nut trees, compared to the prolific acorns of California's oaks, are often under-recognized and -documented. They are consumed for food and medicine by the Karuk Tribe and are impacted by prolonged water stress and heat in this region. Older pepperwood trees are typically found on moist hillsides or outer riparian areas, and chinquapin on moist soils of mixed evergreen forests.

For both species, we have observed dead lower limbs and yellowing and curling leaves, particularly in older individuals. Extremely hot days in June during pepperwood leaf emergence have burned the new leaves, causing them to curl up as they emerge. These are signs of water stress that lifetime resident of the Basin and expert plant steward Kathy McCovey has never seen before (Kathy McCovey, Indigenous Ecological Knowledge, June 14, 2022):

> *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, Indigenous Ecological Knowledge, July 28, 2020).

During this period of prolonged drought, pepperwood trees are observed dying and altering reproduction (through minimal to no nut production) in season. The pepperwood "down-river," in the territory of the Yurok Tribe, are doing better because there is more fog and moisture from the coastal influence (Kathy McCovey, Indigenous Ecological Knowledge, June 14, 2022).

Exposed older chinquapin trees are being damaged by sun, wind, and snow blowdown. For multiple years, chinquapin reproduction has been scant. In May and July 2019, there was no evidence of flowering or fruiting on younger trees 20 to 30 years old. Some nuts produced but did not develop correctly, with no or small nuts inside their external prickled fruit casing. In one patch, chinquapin trees produced a massive number of nuts. "*We picked up, I think it was about three pounds in a half hour between the two of us. Yeah, they were just lying there. It was just hundreds of them. Thousands of them*" (Kathy McCovey, Indigenous Ecological Knowledge, December 10, 2019). The following year the younger trees in that patch appeared to be dying. A cultural practitioner suspected that the previous crop may be a response to stress; a last-ditch effort to reproduce itself.

BERRIES

Blackcap raspberries are generally not particularly productive under the current forest structure and condition, as they thrive in large, exposed areas opened up by logging or fire (Calscape 2021a). Kathy McCovey (December 16, 2019) remembers visiting one particular area as a child: "*We were eating blackcaps all over and we had big buckets full of them*." The patch we monitored during this project did produce berries that were small and soft. The berries ripened asynchronously on a single plant, which could be attributed to the unusually hot and cold weather during the first few weeks of June.

> *There was the ripe ones, then there was the red ones, then there was the hard-green ones, then there was the one 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, Indigenous Ecological Knowledge, December 10, 2019).

In 2019, blackcap raspberries started to age and dry up on July 27, which was about two weeks earlier than expected. Blackcaps are associated with a variety of bird species as dispersal agents; spatial mismatch of birds and shrubs may influence dispersal of seeds (Sandor 2018). However, bud break, ripening, and flowering dates have been previously observed to vary between years, something that is likely due to differences in weather and temperature (Finn et al. 2003). Yellowing leaves and aborted berries indicated water and heat

Left: Blackcaps at various stages of maturity at a Karuk gathering area. Behind this patch, the darker green leaves are patches of Himalayan blackberry, invasive and prolific to this area, encroaching on the native blackcaps. Photo: Megan Mucioki

Opposite page, top: Vikki Preston harvests manzanita berries at a monitoring site on a hot August day in 2020, that was hazy with wildfire smoke. Photo: Daniel Sarna-Wojcicki

Opposite page, bottom: Team members conduct the Agroecosystem Condition Assessment surveys at designated sites in Karuk Aboriginal Territory. Jennifer Sowerwine records Kathy McCovey's assessment of the Indian potato (*Dipterostemon capitatus*) harvest. Megan Mucioki and Daniel Sarna-Wojcicki run transects through a plot. Photos: Jennifer Sowerwine and Daniel Sarna-Wojcicki

stress in August 2019. Drought impact on production can influence two consecutive years of berries:

> *Look at the sprays. The sprays…In the former drought we had all those basically shriveled up and so you lost that year's berries and then you lost—because of that one-year cane, that would be next year's berries didn't develop, you lost the next year's fruit too* (Frank Lake, Indigenous Ecological Knowledge, October 29, 2020).

The tips of the first-year canes (primocanes) grow downward to the soil in the fall and take root and form tip layers that become new plants (Calscape 2021a). In this same area, blackcaps are being overcrowded by Himalayan blackberry (*Rubus armeniacus*) and suppressed by downed Douglas-fir (*Pseudotsuga menziesii*) limbs.

Green leaf manzanitas are more frequently dying throughout Karuk Aboriginal Territory. In recent years, manzanita berry harvest has been influenced by the spring cycles of warming and cooling, making flower to berry development, production, and ripening erratic. Torrential rains in the spring have knocked 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." The berries that are produced 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, Indigenous Ecological Knowledge, 2020).

Manzanita commonly occurs in xeric environments, can withstand summertime temperatures in the high 90s (Hauser 2007), prefers full sun (Calscape 2021b), and has deep roots that can penetrate bedrock (Hauser 2007). However, even this species has been observably damaged by extreme heat events as early as May. In July and August 2019, many flowers and berries were aborted during harvest time—hypothesized to be a result of heat. Some berries were also sunburnt with yellow/brown leaves and dried berries. Other patches were not producing berries at all.

THE RESILIENCE OF INDIGENOUS RELATIONSHIPS WITH PLANTS

The mid-Klamath River has a remarkable diversity of nut-producing species including pepperwood, chinquapin, hazelnut, tanoak (*Notholithocarpus densiflorus*), white oak (*Quercus garryana*), and black oak (*Quercus kelloggii*). As failed years of reproduction become more consistent, pivoting uses among nuts may be a strategy of resilience (Kathy McCovey, Indigenous Ecological Knowledge, June 14, 2022). While Karuk people prefer tanoak acorns, if those are not available or become limited in storage stocks, black oak acorns could be used; although, black oaks are on the brink of mass mortality in many forests, due to grave under prioritization in forest management for the last hundred years. While chinquapin and pepperwood nuts are usually gathered in lesser quantities than acorns by people in this region, they remain an important component of medicinal use and diet, as well as the ecosystem at large as an indicator species of health, fire, and management (see Karuk Tribe 2019).

Weavers report that there are still sufficient quantities of most basketweaving materials in the area, although it remains critical to gather when available, as each year poses new challenges to materials and gathering sites. In addition, pressure on supplies may be increased, and weavers report that they cannot rely solely on their family's traditional gathering sites to fulfill their needs.

Many weavers worry that the difficulty of using mediocre materials will discourage new weavers and hamper cultural revitalization. Many of the fern and stick patches suffer from overgrowth of dead material, pests or diseases, and water stress resulting from (federal) mismanagement of waterways and forests. The resulting growth is stunted and weak, but the most dire concern is possible root and stick infestation. *"We never like to come home with bad stuff"* as it can then influence other materials in a weavers' stock, creating bug infestations (Lisa Morehead-Hillman, Indigenous Ecological Knowledge, August 2, 2022).

Although lower-intensity wildfires can play a role in reinstating critical ecological processes and reducing fuel loads, depending on wildland fire for management outcomes to support forest and plant health is not a tenable solution. Many plants described in this article continue to be available in limited volumes because of restricted cyclical management with mixed-intensity as the Western Klamath Restoration Partnership (the Karuk Tribe is a co-lead) and recent

Kathy McCovey prepares to teach students at Orleans Elementary School about basketry materials, and the climate impact that these plants are experiencing. Photo: Megan Mucioki

initiatives by federal and state governments related to prescribed and cultural fire funding and supportive regulatory policy, changes in liability laws, emission categorization, Indigenous Knowledge integration, meaningful Tribal consultation, and memorandums of understanding for co-management stewardship strategies.

There are a vast number of benefits from gathering and from the intersection between this cultural activity and the environmental spaces it takes place in. This includes cultural identity; vital experiences such as community tranquility, inspiration, or spirituality; greater physical and mental health, food security/sovereignty, social bonds, and the transfer and exchange of knowledge; the provision of food, medicines, and weaving materials; and diversity of habitat and species (Mucioki et al. 2021). Threats to these benefits can cause physical and mental stress, particularly for individuals, families, and households who are responsible for providing for their loved ones and community.

Undoubtedly, centering forest management around Indigenous relationships with culturally significant plant species, improving access, abundance, and health will support the vitality of Tribal basketry traditions, and improve household food security and nutrition for Tribal households in this region. According to a Tribal household food assessment of the Basin, only 7 percent of households had their desired amount of Native foods, with access to Native foods being predictive of overall household food security (Sowerwine and Mucioki et al. 2019).

XÚUS NU'ÉETHTI WE ARE CARING FOR IT

To support the Karuk Tribe in achieving their climate adaptation and ecocultural revitalization goals (Karuk Tribe 2019), the Karuk–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 to 2022 (Karuk Tribe–UC Berkeley Collaborative 2023). The overarching goal of this four-year research and extension project was to promote and

The team gathered at the University of California Jepson Herbaria to build on our voucher specimen collection and preservation skills to continue to grow and manage the Karuk Herbarium. Photo: Jennifer Sowerwine

Chinquapin nut developing on a tree monitored by the Karuk-Berkeley collaborative team. Photo: Megan Mucioki

enhance the resilience of cultural agroecosystems under variable land management and climatic conditions within the Karuk Aboriginal Territory. In partnership with the Karuk Department of Natural Resources, this project integrates Indigenous and Western science perspectives to assess climate change impacts on cultural use of food and fiber species and associated habitats

and develop strategies and tools for long-term monitoring and management.

When our team chose the title for our current work, Lisa Morehead-Hillman suggested a Karuk phrase, *xúus nu'éethti,* meaning "we are caring for it." This phrase is full of hope and confidence for the future as we care for plants together. Culturally significant plants need to be tended, gathered, and used to remain healthy, and Indigenous Peoples are vital to meeting this need. Tribal community members are active agents in increasing the resilience and adaptive capacity of forests and cultural use plants to climate change stressors and impacts. We hope that sustained monitoring and research, which integrates both Karuk and Western science approaches to understanding forest health, will aid in communicating what is needed to care for and sustain forest ecosystem health and cultural plant biodiversity, which ultimately will benefit all people.

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