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Wetlands

Official Scholarly Journal of the Society
of Wetland Scientists

ISSN 0277-5212

Wetlands

DOI 10.1007/s13157-020-01323-3



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Eco-cultural Restoration of Riparian Wetlands in California: Case Study of White Root (*Carex barbarae* Dewey; Cyperaceae)

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Received: 27 February 2019 / Accepted: 13 May 2020

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Abstract

This study defines the cultural and ecological significance of white root (*Carex barbarae* Dewey; Cyperaceae), and presents a template for eco-cultural restoration, drawing from both Traditional Ecological Knowledge and Scientific Ecological Knowledge. *Carex barbarae* is an herbaceous perennial understory plant in valley oak riparian woodlands, endemic to California and southern Oregon. Referred to as white root, *C. barbarae* is an indicator species of both cultural and ecological health. Two-thirds of the California Indian tribes within the range of white root historically tended and managed these sedges for basketweaving. Traditional management by Indian groups resulted in the creation and maintenance of homogeneous patches throughout low-elevation riparian forests of California, maintaining a lawn-like understory and a park-like physiognomy. Gathering and tending practices significantly influenced the distribution, quality and abundance of white root beds on species, community, and landscape scales. Understanding how indigenous people shaped their environment using Traditional Resource Management practices and related ecological effects is integral to successful contemporary restoration of riparian habitats. Understanding the reciprocal relationships between California Indians and their sovereign landscape is important to contemporary indigenous cultures and their identity, resilience, and vitality.

Keywords Traditional resource management · Traditional ecological knowledge · *Carex barbarae* · California basketweaving · Eco-cultural restoration

Introduction

This case study highlights the importance of white root (*Carex barbarae* Dewey; Cyperaceae), a cultural keystone species and important riparian gallery forest understory dominant species. This paper illustrates the relationship between diverse California Indian traditions and the distribution, management, and ecology of a culturally and ecologically important riparian wetland plant. Restoration ecologists refer to the deliberate incorporation of cultural aspects into ecological restoration as eco-cultural restoration (Cuerrier et al. 2015; Kimmerer 2011; Martinez 2014; Senos et al. 2006). Cultural keystone species are defined as “culturally salient species that shape in a major way the cultural identity of a people, as reflected in the fundamental roles these species have in diet, materials,

medicine and/or spiritual practice” (Garibaldi and Turner 2004). White root is one of the most ethnobotanically important plants to California Indian basketweavers (Stevens 1999, 2004a).

California Indian peoples had an important role in the historic distribution and abundance of white root beds for cultural use (Stevens 1999, 2003; Stevens and Zelazo 2015; Zedler and Stevens 2018). They annually harvested hundreds of thousands of rhizomes in riparian areas on a scale that probably influenced species diversity and distribution, as well as ecosystem function at both the local and landscape scale (Ibid). Sedge beds were managed through selective seasonal harvesting, thinning, weeding, and digging to stimulate growth of rhizomes of the desired length and morphology (Ibid).

Traditional Resource Management (TRM) of white root played a significant role in riparian wetland ecosystem functions and services. My thesis is that Traditional Ecological Knowledge (TEK) and TRM played a significant role in maintaining sustainable ecosystem functions. This paper contrasts Scientific Ecological Knowledge (SEK) and TEK to evaluate

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the cultural and ecological significance of traditional cultural uses and management of white root (*Carex barbarae*), with human tending of these beds creating a cultural keystone relationship.

Ford and Martinez (2000) describe TEK as “the knowledge held by indigenous cultures about their immediate environments and the cultural management practices that build on that knowledge.” They also refer to TEKW, which adds “wisdom” to reflect the moral, ethical and spiritual dimensions of TEK. Berkes et al. (2000) define TEK as “a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environmentan attribute of societies with historical continuity in resource use practice.” Senos et al. (2006) refer to TEK as a “holistic integrative approach that incorporates the metaphysical with the biophysical.”

Cultural knowledge informs TRM strategies. TRM reflects deep knowledge transmitted from generation to generation that is specific to place and the ecosystems and species being managed. Management practices include multiple species management, resource rotation, managing for different successional stages, facilitating optimal disturbance regimes and patch dynamics, and other ways to respond to and manage environmental uncertainty to optimize sustainable resource production (Stevens 1999, 2004a; Stevens and Zaloza 2015; Zedler and Stevens 2018). Fire is a common traditional ecosystem management tool used throughout the world. Several California authors have documented historical ecology and traditional management systems in wetland, riparian and aquatic ecosystems (Anderson 1991, 1997, 2005; Grossinger et al. 2007; Martinez 1995; Hankins 2009, 2013; Houde 2007; Senos et al. 2006; Stevens 2004a, b, c; Whipple et al. 2012; Yoshiyama et al. 2001).

Cultural diversity and ecological diversity are strongly related, and the maintenance of biodiversity by indigenous people has been well-documented (Anderson and Moratto 1996; Berkes et al. 2000; Blackburn and Anderson 1993; Deur 2000; Folke 2004; Ford and Martinez 2000; Gadgil et al. 1998; Garibaldi and Turner 2004; Huntington 2000; Minnis and Elisens 2001; Mistry and Berardi 2016; Pierotti and Wildcat 2000; Turner et al. 2000). A decline in ecosystem functions and biological diversity often means a loss of cultural diversity (Garibaldi and Turner 2004).

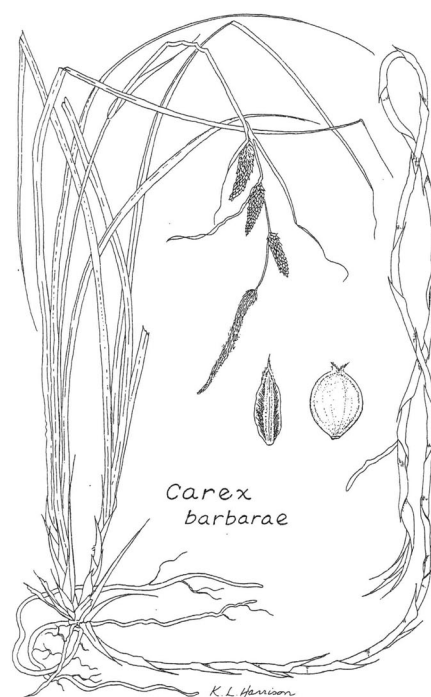
Restoration of white root habitat is a high priority from both ecological and cultural perspectives. I postulate California's riparian wetlands are cultured ecosystems. From an ethnobotany perspective, white root is culturally important and difficult to access along California river corridors and wetlands. Over 95% of California's riparian wetland corridors have been converted to urban or agricultural uses, fragmented, and degraded from the historic

pre-European settlement landscape in California (Barbour et al. 2007; Sawyer and Keeler-Wolf 1995). Riparian forest restoration efforts have focused on restoring trees and shrubs, while overlooking the understory component (Moore et al. 2011). Understory species often fail to colonize restored forests, resulting in loss of native understory species in remnant patches of riparian habitat. Most important for this paper, areas where California Indians can gather culturally significant resources are extremely scarce (Stevens 1999; Zedler and Stevens 2018). Many threatened ecosystems, such as riparian wetland corridors, have important cultural values (Anderson 1999, 2005).

Cultural Use of White Root

I use the term “white root” in this paper to represent several rhizomatous sedges potentially used in basketweaving. The most commonly documented basketweaving sedge is *Carex barbarae*, a grass-like herbaceous perennial understory plant in valley oak riparian wetlands of California. Figure 1 illustrates the long rhizomes used for basketweaving.

Basketweaving continues to be a significant part of contemporary ethnic and spiritual identity for many California Indian people, and provides a critical connection to the land. Prior to European settlement, white root



Note the long rhizome, used for basketweaving. Note also the awned scale subtending the perigynium, a diagnostic feature distinguishing *C. barbarae* from other *Carex* species. The culms are 3–10 dm tall.

Drawing by Kathleen Harrison.

Fig. 1 Botanic Illustration of *Carex barbarae*

was used by over one-third of California tribes for basketweaving (Merrill 1923). The long white rhizomes were and still are used for the sewing strands in coiled baskets. Baskets and basketweaving were central to the daily lives of California Indians and contributed to over 50% of the entire material culture (Ibid).

California Indian tribes display a great deal of diversity in their TEK, TRM, and folk classification systems. TRM of white root includes the following: prayer, asking permission to harvest and ceremonial blessing; thinning and weeding rhizomatous plant populations to lower densities; removing senescent vegetation; and stimulating new shoot production (Stevens 1999). TRM traditions vary between the season of harvest, intervals between harvesting periods, plant materials harvested and processed, and specific basket styles and designs (Ibid). Riverine habitats are dynamic, shifting and changing along sinuous corridors. When white root gathering sites eroded, or new sand bars formed, white root was transplanted and tended to sustain prolific amounts of materials in multiple gathering sites.

Ecologically, *Carex barbarae* is also a very important plant in riparian plantings for contemporary floodplain restoration (Moore et al. 2011). *C. barbarae* provides the following ecological functions: bank stabilization, erosion control, enhancement of aquatic habitat quality, and water quality improvement. The plant can produce 100–200 rhizomes per growing season, and is noted by floodplain engineers and ecologists as one of the best plants to use for riparian and wetland restoration (Stevens 1999). The environmental plasticity and resiliency of the plant to withstand droughts and flooding increases its efficacy in streambank restoration.

This paper provides a case study of white root (*Carex barbarae*), a specific important wetland/riparian plant, as a template for sustainable eco-cultural restoration projects. The thesis of this case study is that both cultural and ecological knowledge and management practices contribute to the long-term sustainability and resiliency of riparian corridors. Inclusion of cultural practices in restoration also contributes to the recognition and respect for California Indian cultures. This paper is organized as follows: a) Herbarium search; b) Map of range of *Carex barbarae*; c) Map and literature review of California Indian peoples using white root; d) Ethnobotany and ethnoecology; e) Literature review; f) Quantitative assessment of material culture; White root biology and riparian habitat; Results – a) White root comparative systematics, taxonomy and folk classification; b) California Indian basketry traditions; c) Traditional resource management of basketry materials; d) Traditional resource management – tending white root; e) Conservation ethic: prayer, thanksgiving and asking permission to harvest; f) Ecological effects of TRM of white root; Discussion – White root TRM had significant ecological effects on riparian wetland ecosystem functions and cultural services; and Conclusion.

Materials and Methods

The materials and methods section describes research used to evaluate the thesis of this case study, e.g., that both cultural and ecological knowledge and management practices contribute to the long-term sustainability and resiliency of riparian corridors and California Indian cultures. I compare and contrast cultural and ecological restoration using Traditional Ecological Knowledge (TEK), Traditional Resource Management (TRM), and Scientific Ecological Knowledge (SEK). What were the ecological effects of these traditional management practices on riparian wetland ecosystems? How have human hands tending white root for basketweaving formed a reciprocal keystone relationship? A cultural icon is an artifact that is identified by members of a community as representative of their culture, such as California Indian baskets or the Marsh Arab mudhif (traditional reed house). How did these tending and managing practices support the cultural icon of traditional basket making for California Indian people?

Herbarium Search To evaluate the taxonomy and distribution of *Carex barbarae*, I reviewed available herbaria and systematic treatments focusing on *C. barbarae*, as well as other *Carex* species with rhizomes that may have been suitable for basketweaving (Baldwin et al. 2012; Hickman 1993; Jepson Flora Project 2019; Mason 1957; Munz 1959).

Documented locations of *Carex barbarae* came primarily as specimens from the following herbaria: the California Academy of Sciences; California State University (CSU), Chico; CSU Fresno; CSU Humboldt; CSU Sacramento; the Carl Sharsmith Herbarium at CSU San Jose; CSU Sonoma; Santa Barbara Botanic Garden; University of California (UC), Berkeley; UC Davis; and UC Santa Barbara. I obtained 110 collections from California herbaria and accessed records from the *Carex* Working Group of the Oregon National Heritage Program Rare Plant Conference.

The ranges and taxonomy of the following rhizomatous *Carex* species were also determined from herbaria collections: *Carex nebrascensis* Dewey, *C. senta* Boott, *C. schottii* Dewey, *C. mendocinensis* Olney, *C. obnupta* L. Bailey, *C. lasiocarpa* Ehrh, *C. lyngbyei* Hornem, *C. utriculata* Boott, *C. simulata* Mackenzie, and *Cladium californicum* (S. Watson) O'Neill.

Map of Range of *Carex barbarae* I mapped the range of *Carex barbarae* to determine the historic range and distribution of sedges used for basketweaving, using ArcGIS, a computer-based GIS interface (Fig. 2). The *Carex barbarae* distribution map results from data from the Calflora taxon report and California Native Plant Society Calscape database using public websites. All base layers were compiled in ArcGIS by Dr. Miles Roberts, GIS Lab, Geography Department, California

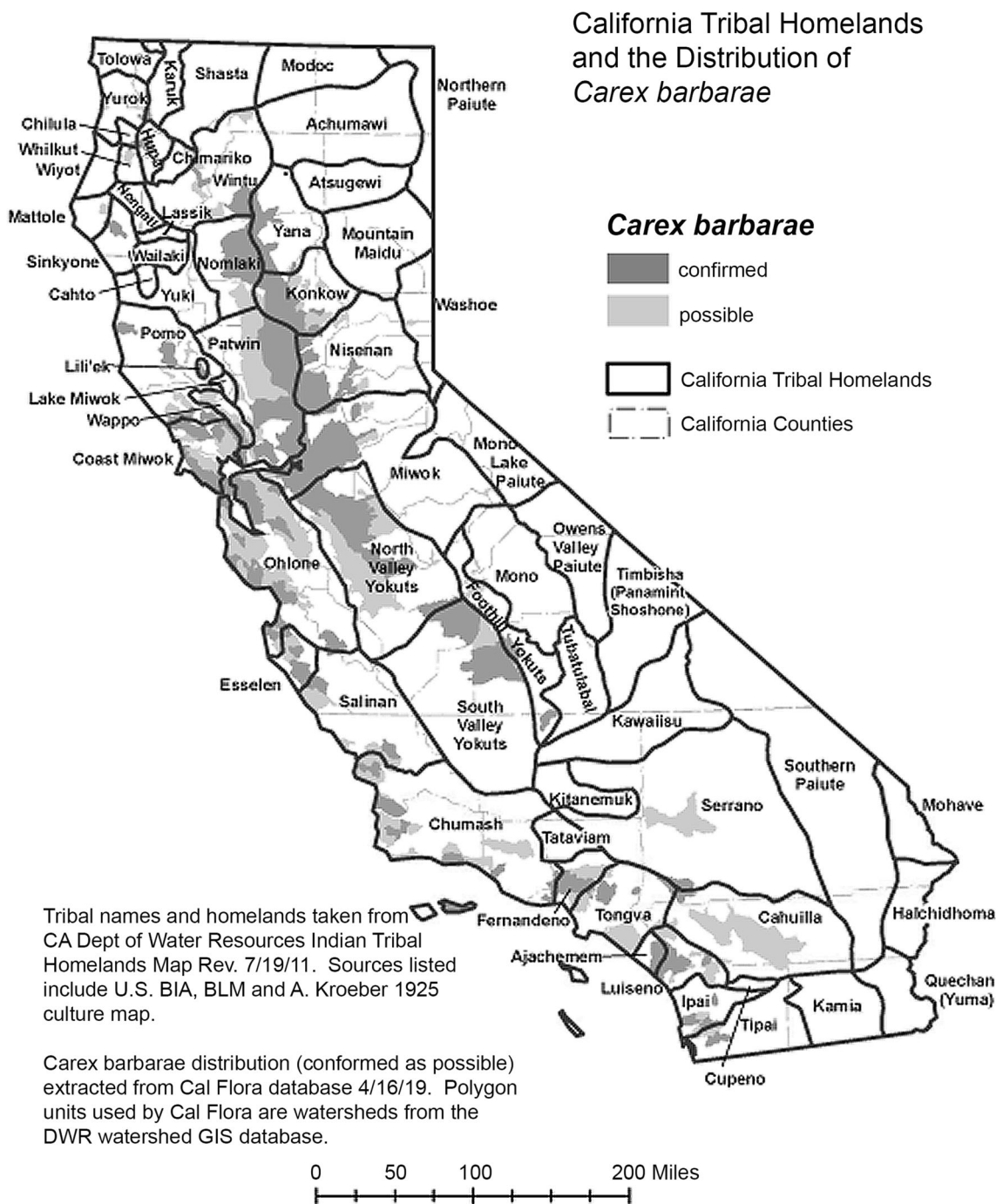


Fig. 2 California Tribal Homelands and the Distribution of *Carex barbarae*

State University Sacramento. This figure was created in Photoshop and saved as a pdf.

Map and Literature Review of California Indian Peoples Using White Root To estimate the original overlap between the distribution of *Carex barbarae* and the California tribes who used rhizomatous sedges in their basketweaving, I digitized the boundaries of the territories of Native Californian groups

from a map in *Handbook of North American Indians, Volume 8: California* (Heizer 1978) (Fig. 2).

Information on tribal groups using white root in basketweaving was derived from the ethnographic literature, conference communications, and personal communication with basketweavers (Abel-Vidor et al. 1996; Allen 1972; Barrett 1906; Barrett and Gifford 1933; Barrows 1977; Bates 1982; Bates and Lee 1990; Best et al. 1996; Bibby

1996; Brown and Andrews 1993; Chestnut 1902; Dixon 1905; Drucker 1937; Duncan 1963; Elsasser 1978; Essene 1942; Gayton 1948; Goodrich et al. 1980; Heizer and Elsasser 1980; Hudson 1893; James 1972; Keator et al. 1995; Kroeber 1925; Latta 1977; Loud 1918; Margolin 1978, 1998; Mason 1902; McMillan 1963; Murphy and Allen 1959; Newman 1974; Ortiz 1991; Peri 1978; Peri and Patterson 1976, 1979; Peri et al. 1980, 1982; Powers 1877; Purdy 1901; Schulz 1954; Sturtevant and Heizer 1978).

Ethnobotany and Ethnoecology Indigenous management systems, gathering practices, and ethnobotanical uses of white root by California Indian people were investigated and described through the following procedures:

During a 36-month period, I conducted more than 25 semi-structured interviews of Mono, Ohlone, Pomo, Miwok, Maidu, and Euro-American basketweavers and elders to understand indigenous management systems, gathering practices, and ethnobotanical uses of white root by California Indian people (Stevens 1999). Field notes from ethnographic interviews and participant observations at traditionally harvested sedge beds were recorded and compiled in unpublished field notes (Ibid). Participant observations were made over a two-year period (1995–1997) (Ibid).

Literature Review Archival investigations of original botanical notes are the basis for documenting the historic distribution and cultural uses of white root. Investigations of ethno-historic and ethnographic materials housed in libraries, museums and archives, and particularly of basket collections, provided information regarding indigenous wild plant management in California as applied to white root and other culturally valued species.

Extensive ethnographic research and white root transplant experiments were conducted during construction of the 1983 Warm Springs Dam-Lake Sonoma project (Bean and Hirtle 1974; Parrish and Parrish 1980; Peri 1978, 1985; Peri et al. 1982; Theodoratus et al. 1975). Before the filling of *Lake Sonoma* behind Warm Springs Dam, the area was intensively studied by a team of archaeologists, cultural anthropologists, architectural historians, ethnobotanists, historians, and Native American traditional scholars. The U.S. Army Corps of Engineers had insufficient funds to distribute this study as widely as intended, and the *Before Warm Springs Dam: A History of the Lake Sonoma Area* report is now available on the Sonoma State University Anthropological Study Center website (<http://web.sonoma.edu/asc/projects/warmsprings/>). This valuable ethnographic cultural information conveys both cultural knowledge and ecological data on white root harvesting practices. Peri et al. (1978, 1982) provided the Warm Springs Dam ethnographic case study, allowing me to evaluate photographs, reports, and interviews from master basketweavers. Anthropologists Lowell Bean and Eugene

Hirtle conducted surveys of ethnohistoric and ethnographic literature in the area (Bean and Hirtle 1974), and Dorothea Theodoratus implemented an extensive interview program (Theodoratus et al. 1975). Knowledgeable local Indians “spanning five generations and ranging from fourteen to one hundred and thirteen years of age” were interviewed to record both historic and contemporary Native American use of the area (Ibid).

From the archaeological record coupled with ethnographic information, the Lake Sonoma reservoir flooded traditional gathering sites that had been tended and harvested for multiple generations by the Cloverdale and Dry Creek Pomo people. The Dry Creek-Warm Springs Valleys Archeological District contains 85 prehistoric, 24 historic, and 8 ethnobotanical sites. This archaeological and ethnographic information is extremely valuable, as many of the Cloverdale and Dry Creek Pomo basketweavers have passed on since that time.

I used the archaeological and ethnographic information from the Warm Springs Dam project to inform my assessment of the quantity and quality of plant materials used by a reference group of basketweavers. I then used this information to calculate the quantity of plant materials harvested in an area of use. This information was used to translate number of rhizomes and plant quantity per unit area, in order to evaluate the ecological effects of harvesting on ecological functions and sustainable resource harvests (Bean and Hirtle 1974; Parrish and Parrish 1980; Peri 1978; Peri et al. 1982; Theodoratus et al. 1975).

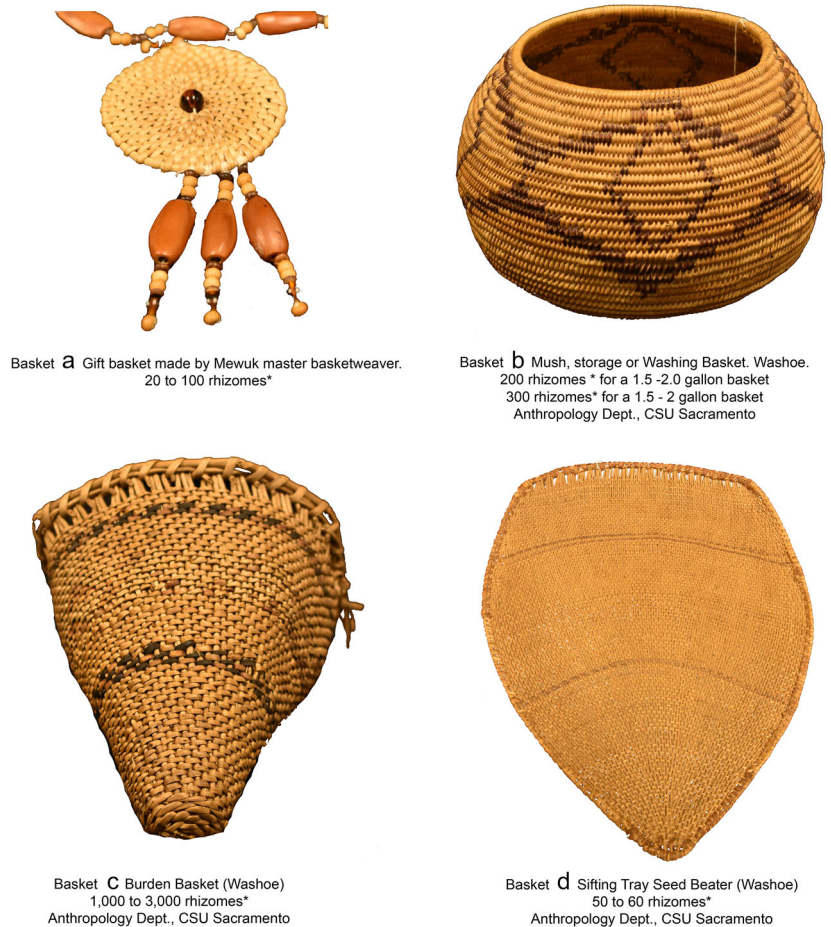
Quantitative Assessment of Material Culture

Craig D. Bates, Curator of Ethnography at the Yosemite Museum, Yosemite National Park, assisted me in identifying the number of rhizomes in different types of baskets from the collection at Yosemite National Park, enabling me to estimate the number of white root rhizomes in each basket (Craig Bates pers. comm, 1996–1998, In: Stevens 1999). The purpose of this study was to address key questions about the quantity and quality of white root rhizomes used for different sizes of baskets. Knowing the number of rhizomes for different sizes of baskets allowed me to calculate the number of plants and area tended, in order to evaluate ecological effects of tending (see Fig. 3 for examples of numbers of rhizomes used for different types of baskets). Ten different basket types, representing variations in size, age, style, and function were evaluated for numbers of rhizomes per basket.

White Root Biology and Riparian Habitat

Carex barbarae is an herbaceous perennial understory dominant of the valley oak woodland gallery riparian forest along

Fig. 3 Number of white roots Rhizomes in different basket types



with *Elymus triticoides* (Buckley) Pilger and *Carex praeegracilis* W. Boott (Holland 1986; Hickson and Keeler Wolf 2007; Sawyer and Keeler-Wolf 1995). The oak woodland gallery riparian community type is a physiognomically complex, broad-leaved, winter-deciduous riparian forest (Fig. 4). Dominant species include valley oak (*Quercus lobata* Nee), Fremont cottonwood (*Populus fremontii* S. Watson), and Goodding's black willow (*Salix gooddingii* C.R. Ball). Understories are dense, with abundant vegetative

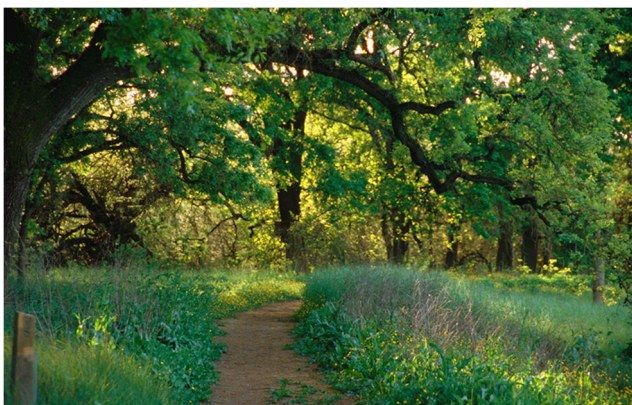


Fig. 4 Mature Valley Oak Riparian Woodland

reproduction of woody canopy dominants plus box elder (*Acer negundo* L.), California black walnut (*Juglans californica* S. Watson), Northern California black walnut (*Juglans hindsii* Jeps. ex R.E.Sm), Oregon ash (*Fraxinus latifolia* Benth), California sycamore (*Platanus racemosa* Nutt.), narrowleaf willow (*Salix exigua* Nutt.), Pacific willow (*Salix lasiandra* Benth.), red willow (*Salix laevigata* Bebb), and arroyo willow (*S. lasiolepis* Benth.). Shade-tolerant shrubs like common buttonbush (*Cephalanthus occidentalis* L) are also present. California wild grape (*Vitis californica* Benth.) and poison oak [*Toxicodendron diversilobum* (Torr. & A. Gray) Greene] are the most conspicuous lianas (Atwater 1980; Barbour et al. 2007; Conrad et al. 1976; Hendrix 1984; Holland 1986; Holstein 1984; Katibah et al. 1984; Roberts et al. 1980; Sawyer and Keeler-Wolf 1995; Thompson 1957, 1961, 1982; Warner 1984).

Site conditions include fine-grained alluvial soils near perennial or nearly perennial streams that provide subsurface irrigation even when the stream channel is dry in the late summer and fall. Sites are inundated nearly every spring, resulting in annual inputs of nutrients and sediment, and creating new seed germination sites. Fig. 4 illustrates California Valley Oak gallery riparian forest with *Carex barbae* as a dominant understory species.

Results

The results section is organized into the following sub-headings: a) White Root – comparing systematics: taxonomy vs. folk classification; b) California Indian tribes – white root basketry traditions; c) Traditional Resource Management – basketry materials; d) Traditional Resource Management – tending white root; e) Conservation ethic: prayer, thanksgiving, and asking permission to harvest; and f) Ecological effects of Traditional Resource Management of white root.

White Root – Comparing Systematics: Taxonomy VS. Folk Classification

Carex barbarae (Fig. 1) is characterized by long rhizomes that can extend horizontally nearly 2 m. Taxonomically, this species has a distinctive long golden brown awn or hairy tip covering each pistillate flower (perigynium) (Baldwin et al. 2012; Hickman 1993; Jepson Flora Project 2019). *Carex barbarae* is distinguished from other sedge species by having ovate-lanceolate to ovate female scales that are narrower than the perigynium, with an awn or bract extending beyond the perigynium. During herbarium collection analyses, the *Carex* species I found with long rhizomes that could potentially be confused with *C. barbarae* included *C. senta*, *C. schottii*, and *C. nebrascensis*.

According to the botanical literature *Carex*, in the Cyperaceae, is the largest genus of flowering plants in California and, with more than 1000 species, and is one of the largest genera in the world. Hickman (1993) recorded 134 *Carex* species in California, Calflora (2018) records 171 *Carex* species in California, and Baldwin et al. (2012) lists 226 *Carex* species in California. Scientific taxonomic classification systems are based on genetic and evolutionary (phylogenetic) relationships. There have been many recent changes to plant systematics due to improved genetic technology. In the absence of floral parts, *Carex* species are notoriously difficult to identify.

Carex barbarae grows from Ventura County in southern California to southern Oregon (Hickman 1993; Jepson Flora Project 2019). The distribution of *Carex barbarae* includes the mountains of coastal southern California, the San Bernardino Mountains, Channel Islands, and the Coast Ranges from Ventura County north to Del Norte County, the Great Central Valley, Sierra Nevada foothills from Fresno County north to Shasta County, and southern Oregon (Fig. 2). The plants grow in riparian areas, seasonal wetlands, bordering marshes, and along streams, slopes or valley bottoms that are wet in the spring. Plants have been recorded from sea level to just over 900 m.

White Root – California Indian Perspectives My herbarium search revealed two viewpoints on the taxonomic status of

Carex barbarae. Western taxonomists historically relied on morphological flowering and above-ground traits, and rarely collect field notes on rhizomes. On the other hand, California Indian people have called taxonomically different sedge species “white root” based on the presence of long, straight rhizomes suitable for basketweaving; the flowering spikelets or perigynium were not mentioned as part of their folk classifications. Also, western taxonomists refer to the underground stems of *Carex barbarae* as ‘rhizomes’, while Native people refer to them as ‘roots’.

From a Native American perspective, it is likely that rhizomes of 11–13 *Carex* species were used for basketweaving, and each is often referred to as “white root” (Stevens 1999). In finished baskets, it is impossible to tell the different species of white root apart in any practical and non-destructive way. The exception is *Carex obnupta*, which has little bumps or protuberances on the rhizomes, which make them distinctive (Ibid).

Folk Classification of White Root Some California Indian people further distinguish or classify white root by the color of the rhizomes and the location in which they grow. Plants typically growing along the Russian River and its tributaries were called “river roots,” and plants growing along the coast were called “coastal roots” (Peri and Patterson 1976). Within the categories of “river” and “coastal” roots, three sub-categories are based on where the plants grow in “sand root beds,” “dirt root beds,” and “heavy clay beds.” The color of the rhizome is an important distinguishing feature; most basketweavers prefer white-colored rhizomes (Stevens 1999). Sand root beds are preferred, as they produce the longest and the whitest rhizomes, which are used in weaving fine coiled ceremonial or gift baskets (Theodoratus et al. 1975). Basketmakers prefer that all the rhizomes used in a single basket grow in sandy soils, as they darken evenly with age and do not “spot” or darken unevenly in finished baskets. Rhizomes from dirt soils yield a less preferred darker colored rhizome (from off-white to brown). Heavy clay beds are not used due to impenetrable, fine-textured soils yielding only short, kinky rhizomes, not suitable for basketweaving.

California Indian Tribes– White Root Basketry Traditions

California Indian baskets are a refined art form, renowned throughout the world. They are a cultural keystone artifact, essential to cultural and spiritual identity, and to deep affiliation with a sense of place. Cultural and linguistic groups, physiographic regions, and biodiversity of pre-European California were highly complex (Elsasser 1978). There was remarkable variation in basket size, shape, type, manufacturing technique, and in design elements used among different California Indian traditions (Ibid). Preferences in selection of materials, types of baskets made, and availability of materials

were highly variable within small geographic areas; these basketry preferences, styles and sizes have also changed dramatically over time.

Basketry originally reflected the availability of plant materials in the local ecosystem. In general, plants were used where they occurred (Bates 1982). However, for prized basketry plants like white root, materials and baskets were often traded or gifted to other basketweavers. According to Bates and Lee (1990), baskets and basket materials were a trade commodity and have been found among native people more than 100 miles from their point of origin. Collections of baskets from Miwok people contain numerous examples of baskets made by Paiute, Washoe, western Mono, Yokuts, and other groups (Ibid).

California is a cultured landscape, and important basketry plants were managed extensively for appropriate materials. (I use past tense when referring to an assessment of historic TRM effects; present tense is used when discussing contemporary Native California TRM). White root rhizomes yield a thread-like material highly desirable for weaving finer baskets. White root was used preferentially by people in whose territory this plant is plentiful (Barrett and Gifford 1933). Several other plants were managed and harvested for coiled baskets by the Miwok, Pomo and Yokuts basketweavers (Kroeber 1925). Redbud (*Cercis occidentalis*) was used for a reddish brown design element; the black design element was created from the rhizome of bracken fern (*Pteridium aquilinum*); additional weaving strands were derived from maple (*Acer macrophyllum*) shoots and gray pine (*Pinus sabiniana*) split branchlets (Ibid). Basket foundation materials are provided by willow (*Salix* species), deer grass (*Muhlenbergia rigens*), buckbrush (*Ceanothus cuneatus*), deer brush (*Ceanothus integerrimus*), sourberry (*Rhus trilobata*) and creek dogwood (*Cornus californica*) (Bates and Lee 1990).

There is a strong overlap between tribes that use white root and the distribution of *Carex barbarae* (Fig. 2). Twenty-two tribes within the range of *C. barbarae* use white root in coiled baskets. These tribes are grouped in central California from the coast to the foothills of the Sierra Nevada, primarily along the riparian corridors bordering the rivers flowing through the Central Valley. The Yuki are the northern-most group and the northern Chumash are the southern-most group of California Indians using white root for basketweaving (Timbrook 1997).

Altogether, 14 Northern California tribes have territories that overlap the range of *Carex barbarae* and prefer the use of conifer roots rather than white root for coiled baskets (Fig. 2). Two Southern California tribes (the Gabrieliño and Luiseño) use the following alternative basketry materials: deer grass (*Muhlenbergia rigens*), dune rush (*Juncus lescurii*), Brewer's rush (*J. breweri*), and/ or sourberry (*Rhus aromatica*) for their baskets (Barrows 1977; Timbrook 1993, 1997).

Traditional Resource Management of Basketry Materials

“Every household in California had dozens of baskets for cooking, eating, serving, and storage; for cradling babies, collecting seeds, carrying firewood, catching fish, trapping birds and many other uses. Each community had to harvest - continually - tons of material: stalks, twigs, roots, dyes and so on. Yet far from depleting supplies, native weavers and their families gathered these valued resources in ways that protected them and in many cases increased their numbers” (Margolin 1998).

The Native Californians, with their ~5000-year-old culture, densely populated the lower elevation California landscape (Zedler and Stevens 2018). Stevens and Zaloza (2015) reported: “Tending of the landscape by indigenous Californians is expected to have increased production and abundance of native fishes, sufficient to supply one-third of the Plains Miwok (Mewuk) diet for as many as 57 individuals per square mile along the streams and sloughs in the study area (lower Cosumnes River) for at least 1,100 years.” According to Stuart (2016a, b), the San Joaquin River supported villages with ~200 persons 5–10 miles apart and a combined population of ~1300 or more people. Decimation of California Indian populations, traditional knowledge systems and traditional management of cultural resources created a traumatic change for people, as well as altering landscape, ecosystem functions, and vital cultural services.

Due to decimated California Indian populations, basketweaving and other intrinsic cultural practices and traditions began disappearing. Kroeber (1925) wrote that there were no more Ohlone (San Francisco Bay area) baskets remaining. In 1995, Linda Yamane, an Ohlone descendant and artist, discovered some Ohlone baskets in an exhibit and began looking for more of her ancestor's traditional Mission baskets (Keator et al. 1995; Yamane 1995; Yamane and Aguilar 1997). “When I found out there were some of our baskets, I began a quest. I started to find out what our baskets were like. We haven't had any basketweavers for years and years. We have not had any basketweavers in my lifetime. Finding there were no living basketweavers to learn from, I found baskets in museums. Baskets to me are a part of the life that was here and can still be here.” (Yamane pers. comm, 1997, In: Stevens 1999).

Locations of present-day, traditionally tended white root beds are a good indicator of historic continuity. Where there is a continuous legacy of tending, there is also basketweaving and other traditional uses of and relationship to plants. David Peri, who is Pomo, writes, “The basket is in the roots, that's where it begins. Basket designs provide cultural revitalization” (Peri and Patterson 1976). Large areas of white root were historically tended in riparian habitats, but as noted, these habitats have been almost completely eliminated, invaded by

non-native species, or are unavailable for basketweavers to gather materials. Basketweavers struggle to find materials to gather and tend. Today, tended beds are so scarce that some basketweavers have stopped weaving or have substituted ethno-traditional materials, such as raffia. The Tending and Gathering Garden at Cache Creek Conservancy, eco-cultural restoration at Bushy Lake, and proposed Tasman Koyom Maidu Cultural Park provide materials and traditional gathering sites for indigenous Californians. A resurgence of eco-cultural restoration projects benefit sustainable ecosystems and California Indian cultures.

Basketry: Uses of White Root White root is used in many different kinds of baskets (see Fig. 3). Originally, baskets were made primarily for utilitarian purposes. At least eight different types of baskets figured into the gathering, processing, cooking, and eating of acorns. Burden baskets were often very large baskets used for transporting and storing materials. Seed beaters, often used with burden baskets, were used to collect seeds from the many grasses and forbs of the indigenous California landscape. The seeds were cooked and made into a staple food called pinole, which could be eaten immediately or stored for later. Baskets were used for cooking, as mush bowls or soup baskets for eating, and trays for winnowing (Bibby 1996; Smith-Ferri 1990, 1993).

Baskets are also made for ceremonial use and for doctoring (spiritually curing illness). Mabel McKay, Pomo basketweaver and doctor, prayed over each of her baskets, and dreamed the basket and prayed for healing for the person she made it for (Sarris 1994). These baskets were often very tiny; some in the California Indian Museum are so small they can fit through the eye of a needle.

Basketry Materials: Changing Uses over Time Basketry styles changed over time (Bates and Lee 1990). By the mid-1890s – 1930s, Miwok and Paiute women of the Yosemite region were industriously manufacturing baskets of finer weave for sale, stimulating a market for Indian basketweaving (Bibby 1996). The market for baskets provided an economic incentive for women to create new styles of baskets made specifically to sell (Bates and Lee 1990).

Given this market, esthetic qualities took precedence over utilitarian concerns. Many new basketry forms and innovations began during this period, as well as continued use of traditional native materials, technologies, and designs. Baskets became more innovative, artistic, decorative, and smaller, stimulating an increased demand for white root. Modern baskets contain finer sewing strands and more stitches per inch. For example, made-for-sale baskets were often more than 15–20 stitches per (horizontal) inch (compared to 9–10 stitches per horizontal inch in earlier baskets). White root rhizomes permitted an emphasis on finer basketry, as it is preferred for the very fine baskets made for sale or gifts.

Also, most white root rhizomes are about half as long as the traditionally tended rhizomes, so at least twice as many rhizomes are needed today (Stevens 1999).

Sadly, from 1930 to 1980, few girls or young women were learning how to weave even though there continued to be a steady market for baskets. Fortunately, the 1992 formation of the California Indian Basketweavers' Association (CIBA) has promoted a resurgence and pride in traditional California Indian baskets (CIBA 2020). CIBA has worked to provide access to materials for basketweavers, prevention of pesticide application on basketry and food materials, and education of youth, support for elders and education of the public (Bibby 1996). CIBA also has provided the support for its members to teach new members to learn how to gather basketry materials and weave.

Traditional Resource Management – Tending White Root

White root beds were managed through selective harvesting, thinning, weeding, and digging in such a manner as to stimulate desired rhizome length and morphology (shape, width, color, flexibility). Traditionally tended white root plants have rhizomes as long as two meters, whereas untended plants have short, twisted rhizomes. Fig. 5 illustrates the long, straight, peeled rhizomes gathered from traditionally tended sedge beds, compared to the shorter rhizomes from untended beds. Roots are harvested with a digging stick of mountain mahogany (*Cercocarpus betuloides*). Digging is part of the process of aerating the soil, thinning the sedge beds, removing debris and undesirable species, and creating more space for rhizomes to grow. Table 1 outlines the steps used for Traditional Resource Management practices used to tend white root rhizomes for basketweaving.

Sedge bed management results in loose, homogeneous soil that allows free expansion of the rhizomes (underground stems). White root plant density is maintained at approximately 0.5–1 m spacing. “Extra” plants are removed and often



Fig. 5 White roots Rhizomes prepared for Basketweaving

Table 1 Ten Steps to Tend and Use White Root (Stevens 1999)

Before tending, offer prayers and request permission from Spirit to gather and tend the sedge beds.

1. To harvest, cut live leaves and stems to ~30 cm to keep sharp-edged leaves from cutting hands.
2. Dig up rhizomes, following them through the soil; at the same time, remove extra plants and debris.
3. Use digging stick to loosen, aerate, and homogenize the soil.
4. Seasonally harvest rhizomes after winter and spring rains moisten the soil.*
5. Thin and weed all plants to maintain spacing at ~0.5–1.0 m.
6. Pull extra sedge plants and transplant them nearby.
7. While they are fresh, de-bark outer sheaths, and split rhizomes in two.
8. Coil 50–100 split rhizomes and tie; store and dry for ~1 yr.
9. When ready to weave baskets, scrape and sort rhizomes
10. Basket-weaving techniques using White root are specific to tribal traditions. *Harvesting occurs every 2–4 years. Only one-third of plants are harvested at a time, to conserve all age classes (“grandmother, mother, and child”) at the site.

transplanted into adjacent areas. Competing native species such as field sedge (*Carex praegracilis*), beardless wild rye (*Elymus triticoides*), poison oak (*Toxicodendron diversilobum*), Oregon ash (*Fraxinus latifolia*) and other undesirable non-native species are removed. Tending practices aerate the soil and may stimulate rhizome growth through pruning. Plants are harvested every two to four years, and less than one third of the plants are removed in any given harvest. Plants in different size classes are purposely left. Among the Miwok, the rhizomes of sedge plants with multiple runners are called “family roots”; the longest root is the grandmother, the next longest is the mother, and the shorter rhizomes are the children.

The season for harvesting sedge rhizomes differs among California Indian traditions, and depends on the plant’s location and its substrate. Rhizomes two or more seasons old are collected in the spring (Stevens 1999). Rhizomes are harvested “generally in early spring” after the rains have subsided and while the ground is still moist (Elsie Allen 1972). Chestnut (1902) recorded that ‘river roots’ were collected by some Pomo after the early fall rains when the soil has loosened up.

The ideal rhizome age for basketry is between two and four years. Rhizome length and quality depends on the duration and frequency of flooding, the texture of the soil, and the availability of nutrients. Rhizomes produced in very wet, flooded soils grow slowly and are weak (particularly if they are growing in fine textured soils such as silt or clay loam). Plants growing in low nutrient conditions produce fewer but much longer rhizomes (Stevens 1999). Rhizome length, strength, pliability, and color change with age. The ideal age for harvesting rhizomes, or ‘ripe roots’ is when they are older than the new season’s growth but younger than those that have become brittle. These are mature for basketry purposes.

Basketweavers know that if they carefully dig out the older rhizomes, leaving the spring runners behind to mature, that white root beds can be harvested regularly without danger of depletion (Stevens 1999). When digging, weavers are careful to replant short pieces of rhizomes and accidentally unearthed young plants, and have at times transported these to other locations for the establishment of new sedge beds (Peri et al. 1982; Theodoratus et al. 1975).

Conservation Ethic: Prayer, Thanks Giving, and Asking Permission to Harvest

A conservation ethic is practiced in traditional ecological management of sedge beds in order to both maintain an adequate rhizome supply for basketweaving and to ensure continuous sedge bed viability. To accomplish this, weavers use a harvesting and collection strategy regulated through cultural sanctions and taboos that are compatible with the reproductive mechanisms of white root. Proscriptions, taboos, and the weavers’ specialized knowledge of the requirements of sedge plants ensure the survival of the plants and sustainable supply of rhizomes for basketry. Highly specific, supernaturally sanctioned “rules” exist in two different stages of the collection process – those in force before leaving for the beds and those in force while collecting. The extent and degree of observance varies among individuals and different California Indian groups (Theodoratus et al. 1975).

Prayer, thanksgiving, and asking permission to harvest sedge rhizomes are intrinsic components of TRM. Common elements include respect for life and recognition of the spirit and power in the plants. Specifics vary among individuals and among local Indian traditions. The following quotes from California Indian basketweavers illustrate the connection between sustainable harvesting of basketry materials and the cultural attitudes and beliefs of a traditional relationship with the land.

One Pomo basketweaver says, “You can’t separate the prayers and ceremonies and how you feel inside from the basket. Plants say, ‘I want human beings, when they harvest me, I want them to give me prayer. They have to sing songs for me, give me a ceremony.’ Ceremony is too important not to pass it on. All that information must be passed on to the younger generation.”

Susan Billy, who is Pomo and the grandniece of noted basketweaver Elsie Allen, says, “She (Elsie) taught me about the wholeness of life. You cannot separate the different parts of your life. We build a relationship with plants. They are living things. We talk to them, sing to them. Elsie taught me that there are a lot of levels in a relationship. Remembering. Honoring. Having a purpose” (Susan Billy 1996, pers. comm. In: Stevens 1999).

Ecological Effects of Traditional Resource Management of White Root

To what extent were specific basketry materials used among different California Indian tribes, and how significantly did these people's uses of basketry materials effect the historic riparian wetland landscape? To calculate that extent and impact, I have determined: 1) how many rhizomes per basket were used; 2) how many baskets per household and per tribe were made; and 3) how large an area would it take to produce that much basketry material.

Number of white root per basket Many sedge rhizomes and other plant materials were used for basketweaving. Different types and varieties of basket shapes, sizes, and designs require variable numbers of rhizomes. Fig. 3 illustrates the number of rhizomes counted in different types of baskets housed in the Yosemite National Park museum (Bates 1996, pers. comm, In: Stevens 1999). Construction of baskets using white root typically included from 20 to 100 split rhizomes for a small gift basket to 1000–3000 split rhizomes for a cooking basket. Each plant has approximately two rhizomes of a length suitable for basketweaving. Since each rhizome is split in half, one plant would produce four sewing strands suitable for use. Therefore, a cooking basket requires approximately 250–500 plants with two rhizomes each.

Number of baskets per household Pomo elder and basketweaver Elsie Allen states that each household made approximately 20 baskets in a year (Allen 1972). In historic photographs of baskets around California Indian homes, at least 20 different baskets were in use at one time. Originally, baskets were made primarily for utilitarian reasons. Fig. 6 is a historic photo showing a large burden basket filled with coils of white root rhizomes, representing a harvest of thousands of plants.

Baskets per Area of White Root Harvested Per Year I calculated the area necessary to harvest materials for basketry from the following information:

- The number of rhizomes necessary for a finished basket,
- The number of materials (rhizomes, stems) required to make different types of baskets,
- The number and types of baskets utilized in each household,
- The need for continuous basket renewal and replacement, and
- The area required to harvest the materials required for the different types of baskets.

Table 2 illustrates how I calculated the area of white root harvested each year. Each small group of Pomo



Fig. 6 Maggie "Tabuce" Howard, Paiute Basketweaver with Burden Basket in Yosemite Valley

basketweavers used approximately 600 coils of white root per year (Peri 1978; Peri et al. 1982; Theodoratus et al. 1975). While conducting participant observations, I observed that the plant density averaged approximately one plant per square meter for tended sedge beds. This would be equivalent to approximately 24,000 m² per year (Stevens 1999). The area would be equal to 2.4 ha (5.9 acres). In actuality, the available sedge beds along the winding and serpentine riparian corridors were long and narrow, rather than square.

The tended sedge bed area included all available white root beds with suitable sand or sandy loam soils. An area would be tended intensively once every two to four years, depending on the tradition and local site conditions (Gladys McKinney 1995 pers. comm, In: Stevens 1999). Preferred white root sites would be tended each year by the same family group. Others could harvest in these areas only with permission. Ownership

Table 2. Area of White Root Harvested Per Year.

Tribelet (Pomo Weavers – Warm Springs Dam Data).
600 coils per year per tribelet.
80 rhizomes per coil.
48,000 rhizomes = 24,000 plants.
24,000 m ² per year per tribelet.
2.4 (5.9 Acres) Harvested per Tribelet per Year

of sedge beds promoted careful tending and long-term sustainable harvests. The area was cared for from generation to generation, and accountability was both to the ancestors and future generations (Ibid).

Discussion – White Root TRM Had Significant Ecological Effects on Riparian Wetland Ecosystem Function and Cultural Services

California Indians tended a significant portion of the riparian forest understory before European settlement (Stevens 1999). Hundreds of thousands of white root rhizomes were harvested annually by California Indian people, at an intensity that influenced local plant species abundance and diversity. “In their harvesting of such runners, California Indian people were cultivating the sedge bed and enhancing the habitat for the production of new runners and plants. Mature beds showed a density of about one plant per m², with almost no other plants present” (Peri et al. 1982).

Small homogeneous patches of white root occur throughout the low-elevation riparian systems of California. Areas with desirable rhizomes were sustainably harvested every two to four years. There were significant uses of white root for numerous styles and sizes of baskets. Weavers gathered throughout these areas because white root was an important component in the many baskets used in all aspects of daily life.

Interviews with basketweavers and data from the Warm Springs Dam/Lake Sonoma study indicate that the gathering and tending of white root beds influenced riparian structure and function at a landscape scale (Stevens 1999). Indigenous tending practices maintained a lawn-like, grassy appearance under California riparian forests. Tribal groups were densely populated throughout the landscape. I conclude that the serpentine corridors of California riverine and riparian floodplains were sustainably tended and maintained with an open and parklike physiognomy for thousands of years due to conscious application of Traditional Ecological Knowledge sustaining important cultural resources.

Conclusion

White root (*Carex barbarae*) can be seen as a cultural keystone species, and remains one of the most ethnobotanically important plants in California. In addition, riparian and riverine ecological restoration projects utilize *Carex barbarae* extensively as an understory dominant species, used to stabilize banks and provide fish and wildlife habitat. The complexity in physiographic regions in pre-European California was mirrored by the diversity in California Indian peoples, traditional management practices, and traditional knowledge systems.

The cultures that originally tended the landscape have changed dramatically, as have the landscapes themselves. Tended sedge beds and riparian woodlands have been converted to agriculture, constricted by levees, or lost to urban development. The modern challenge is to restore cultural and ecological health through understanding the relationship between humans and their ecosystems. Cultural health includes maintaining cultural practices and living traditions for California Indian people, including honoring the elders, honoring the ancestors, and teaching cultural practices for future generations. Tending traditional materials helps to maintain traditional and accustomed gathering sites, and is a spiritual relationship of world renewal and connection to plants, animals, community, the ancestors and future generations. Fig. 7 shows Maya Austin (Pascua Yaqui and Blackfeet) when she was a young girl, ceremonially gathering white root and practicing Traditional Resource Management at the Cosumnes River. She resides in Sacramento CA and is an Arts Program Specialist, with the California Arts Council.

White root is one of the most ethnobotanically important and difficult to obtain basketry materials in California. Because most California tribes often do not have their own land base, or even federal recognition, gathering basket materials has become increasingly difficult. On both public and private lands, many prime gathering sites are inaccessible for harvest.



Fig. 7 Traditional resource management of white root by the Cosumnes River. Joyful tending of sedge beds and celebrating eco cultural restoration.

White root can be obtained in trade and for sale, with the average price per coil increasing over time with a scarcity of materials and increased demand. The cost of materials is often prohibitive for many traditional basket weavers. Due to the lack of available gathering sites, many modern basketweavers are growing their own materials in back-yard gardens. The vision of the California Indian Basketweavers Association is “to preserve, promote and perpetuate California Indian basketweaving traditions while providing healthy physical, social, spiritual and economic health of basketweavers.” This includes providing access to tending and gathering the necessary basketry materials.

Eco-cultural restoration of traditional practices is important to the Miwok people who once tended the beds of the Cosumnes River, to the Ohlone people now tending sedge beds along the Salinas River, to the Pomo people on the Russian River watershed, and to the Mono people on the Kings River watershed. Restoring traditional lands and gathering sites is vitally important to many California Indians. Traditional knowledge and management systems also contribute to the ecological health of remnant riparian wetlands.

Acknowledgements In the timeless past, Miwok ancestors cared for and tended their ecosystem and conducted specific world-renewal ceremonies. I present this information in recognition and in honor of the California Indian cultures in the Cosumnes River watershed. In particular, I am deeply grateful for the elders, friends and basketweavers who shared their precious knowledge with me. Deep gratitude to the Deuchsky family, the Denton family, the Baugh family, the Bunting family, Sage LaPena, Gladys Dick McKinney, Julie Dick, Florence McKinney, Susan Billy, Craig Bates, Linda Yamani, Don Hankins, Frank Lake and other teachers who are no longer with us. I intend for this information to be used to honor California Indian cultures, as well as indigenous people around the world, the original stewards and caretakers of this precious Mother Earth. Special thanks to my friend Linda Storm for her patient advise and editing on this document. I would also like to give special thanks to ethnobotanist Kathleen Harrison for the Fig. 1 botanic illustration, which I have treasured for 20 years. Kathleen is the founder of the Occidental Center for the Arts, and home of Botanic Dimensions Ethnobotany Library. I would also like to give special thanks to M Kat Anderson for her guidance, inspiration and knowledge while I was working on my doctorate. Thank you also to Miles Roberts, CSU Geography Dept., for maps in Fig. 2, Terri Castaneda CSU Anthropology Dept. for access to basket collections; Meredith Sierra for photography for Fig. 6; D Merritt for editing; Tawatchai Kodsuntie, Areawest Environmental Inc., for graphics; and anonymous reviewers for helpful comments.

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