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On Fire and Water: The Intersection of Wetlands and Burning Strategies in Managing the Anthropogenic Plant Communities of Yosemite National Park

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On Fire and Water: The Intersection of Wetlands and Burning Strategies in Managing the Anthropogenic Plant Communities of Yosemite National Park

DOUGLAS DEUR AND ROCHELLE BLOOM*

7.1 Introduction

Indigenous Knowledge combined with analysis of wetland habitat species provides novel insights into the ingenuity of Sierran tribal peoples in undertaking habitat-specific tending practices. Tribal accounts and ethnographic literature have long provided evidence that traditional burning allowed residents of Yosemite Valley to enhance various culturally preferred plants and plant communities, such as black oak (Quercus kelloggii) groves or meadows of herbaceous plants such as sedges (Carex spp.), mints (Mentha spp.), milkweed (Asclepias spp.), and deer grass (Muhlenbergia rigens) (Anderson, 1988, 1990, 1993a, b; Clark, 1894; Reynolds, 1959). Some sources, especially Anderson (1988, 1990, 1993a, b), also note that burning exists alongside a range of other practices, such as pruning, coppicing, weeding, and reseeding of native plant species, which together have shaped the plant communities of Yosemite in myriad ways (Bibby, 1994; Deur, 2007).

In spite of this robust record of Yosemite plant management, we contend that this literature misses certain key aspects of traditional Native American land management and provides an insufficient picture of traditional practices on multiple counts. Among those deficiencies, we argue that these past sources overlook the elevated importance of wetland habitats in the traditional Native American use and management of Yosemite plant communities. We find that wetland plants are disproportionately significant within the plant-use traditions of Yosemite tribes, yet receive little attention within the literature addressing Yosemite (Deur, 2007; Bloom and Deur, 2022; Deur and Bloom, 2022). Moreover, Native interviewees and archival

* Tribal members who contributed to this work include Jay Johnson, Bill Tucker, Bill Leonard, Shirley Forga, Sandy Chapman, and Les James, all of the Southern Sierra Miwuk Nation (formerly the American Indian Council of Mariposa County). Without them, this work would have been impossible. We also wish to thank Tricia Gates Brown for editorial assistance. This work was partially supported by the National Park Service (NPS) through Cooperative Ecosystem Studies Unit (CESU) Task Agreement between the NPS and the University of Washington and Task Agreements between the NPS and Portland State University, issued under CESU Cooperative Agreement H8W07110001.

sources suggest that the hydrologic conditions within the valley historically intersected with traditional fire management in a number of important ways. Traditional Native American fire managers intentionally burned in a manner that used wetlands and flooded riparian areas as firebreaks, allowing small-scale burning from late spring until fall and the containment of any potentially large and catastrophic fires. This involved sequential small-scale burning of wetlands and wetland margins through the dry season as dropping water tables permitted. Tribal members attest that this nuanced interplay of fire and water – this intricate level of pyrodiversity within a relatively circumscribed area – enhanced a wide range of culturally significant species in both upland and wetland environments. This likely contributed to the development of mosaics of culturally significant wetland margin habitats and, in turn, to the valley's overall biodiversity (Lewis and Ferguson, 1988; Jones and Tingley, 2021). While unreported in the existing literature pertaining to Yosemite, the practices we find at Yosemite have analogs and precedents. They bear certain resemblances to traditional burning practices of wetlands and wetland margins as reported in western and northeastern North America (e.g., Lewis, 1979, 1982; Anderson, 2009; Deur, 2009; Deur and Knowledge-Holders of the Quinault Indian Nation 2021), in the American South (Wharton *et al*., 1982), and in tropical contexts, such as Aboriginal Australia (Whitehead *et al*., 2003; Russell-Smith *et al*., 2009; McGregor *et al*., 2010). However, the use and traditional management of wetland plant habitats in Yosemite is unique in a number of respects and deserving of independent consideration; this is the principal objective of the narrative that follows.

The lack of wetland use and management practices at Yosemite mirrors the erosion of those habitats and the lack of Native American opportunities to access and manage such environments within what is today an internationally celebrated national park. Changes in wetland hydrology since the advent of park management have reduced floodplain connectivity and dropped water tables across much of the Yosemite Valley floor. This has negatively impacted many culturally significant habitats and reduced the potentials for traditional gathering and management – compounding the effects of other major interruptions such as park visitation and fire suppression. The displacement of Native peoples from the valley also contributed to the erosion of anthropogenic habitats – a phenomenon widely reported in US national parks (Bloom and Deur, 2020a; Deur and Bloom, 2020; Deur and James, Jr., 2020). The loss of wetland hydrology has amplifed the effects of fire suppression and the displacement of traditional managers, which together have allowed for the encroachment of a dominating conifer forest and have undermined the biological diversity and cultural values of the entire Yosemite region.

7.2 Methods

In an effort to understand traditional Native American plant and habitat management practices in Yosemite Valley, the authors undertook a series of research steps. Over an eighteen-year period, Deur has carried out intermittent ethnographic interviewing of and field visits with tribal members at Yosemite in relation to traditional land and resource use (Deur, 2007; Bloom and Deur, 2020a, b, 2022; Deur and Bloom, 2022). In addition, Deur has undertaken archival and literature reviews, expanding on earlier ethnographic studies by researchers like Bibby (1994) and Anderson (1988). While the objectives of each study varied over this period, Deur's interviews have consistently contained open-ended and inductive questions for tribal Elder, designed to identify the widest possible number of plants utilized in the living memory of tribal members. In turn, this corpus of largely unpublished reports and data has served to facilitate National Park Service (NPS) obligations to tribes, including the negotiation of possible future plant-gathering and land-management agreements between tribes and the NPS for lands within the park. These past ethnographic interviews have revealed a number of themes unreported or underreported in the existing published literature, including the traditional significance and management of wetland plant habitats. Reviewing this corpus of research materials, Deur has assembled the many references to wetland plant use and management in field notes and transcripts from his interviews with tribal members, in addition to data summarized in technical reports resulting from his work, although these are unavailable to the public due to their sensitivity, such as Deur (2007) and Bloom and Deur (2022). These original qualitative ethnographic data pertaining specifically to wetland plant habitat use and management are partially reported and summarized in the pages that follow.

Working in collaboration with Deur, Bloom mined the rich corpus of preexisting written historical and ethnographic material related to Yosemite Valley land and resource use to produce the Yosemite Ethnographic Database. This database consists of roughly 13,000 entries describing traditional Native American uses of Yosemite National Park lands and resources – primarily in Yosemite Valley (Bloom and Deur 2020a, b). This database incorporates most of the available ethnographic and historical literature – from the first written records of Yosemite in the 1850s to the ethnographic studies and tribal consultation notes of the present day – housed in park collections and other pertinent archival and library collections state- and nationwide. In compiling the database, a team of researchers and research assistants systematically reviewed written sources for references to lands and resources that were used, visited, or identified by tribal members as significant in Yosemite, as well as information relating to traditional management methods applied to the park's natural resources. This database incorporates information derived from approximately 600 preexisting sources, including historical reports, early historical accounts written by visitors to Yosemite, ethnographies, ethno-ecological studies, oral histories, park publications, park notes from contemporary tribal events, historical and contemporary newspaper articles, and a wide range of other archival materials. Also included are other materials, such as archived notes from formal NPS consultation meetings with park-associated tribes and meetings with these tribes specifically on matters of traditional plant community management. The database provides a wide range of searchable data, including information on archeological, hydrologic, botanical, and other natural and cultural resources with traditional cultural significance the Southern Sierra Miwuk, Mono Lake Kootzaduka'a, Tuolumne Band of Me-Wuk Indians, Bishop Paiute Tribe, Bridgeport Indian Colony, North Fork Rancheria of Mono Indians of California, and the Picayune Rancheria of the Chukchansi Indians tribal communities with ties to the park (Bloom and Deur, 2020b). This chapter avoids sharing sensitive information and limits discussion to materials already available in the public realm.

Using this database, the authors identified all reported traditional plant habitat management practices employed by tribes both historically and today, seeking to identify recurring references in tribal oral accounts, written historical accounts, and other documentation. We compared and cross-referenced these accounts with ethnographic and oral history information shared with both of the authors of this chapter by tribal representatives, especially members of the federally unrecognized Southern Sierra Miwuk Nation. We then compared the contents of this record with the published record of traditional resource use and management at Yosemite, specifically noting the information on traditional resource use and management that was available from these many unpublished sources but that was unrepresented or underrepresented in published sources. Noting that wetland plants and environments appeared as a recurring underrepresented theme, we carried out visits to traditionally managed riparian wetland environments with tribal members. We also analyzed data relating to wetland plants and habitats that had been reported as significant in the ethnographic interviews and in the available written record. As part of this analysis, we undertook an assessment of plants and habitats identified as "culturally significant" by tribal members in light of US federal wetlands criteria. On the basis of this multidisciplinary investigation – including topical ethnographic interviews with tribal members, field visits and analysis, and a nearly comprehensive review of the original archival and published record pertaining to traditional Native American resource use and management – we have identified certain consistent and recurring themes relating to the Indigenous management and uses of wetland plants and habitats, as summarized in the pages that follow.

7.3 Results

Traditional Uses of Fire in Yosemite

Before elaborating specifically on the roles of wetland plant habitats within Native American land and resource management practices, we first summarize pertinent information relating to the use of fire. Again, the Native American use of fire for clearing vegetation has been widely reported for Yosemite Valley, even in the earliest written accounts. The Mariposa Battalion, for example, reported seeing "picket fires" ignited by Native people upon their arrival in 1851 – the first recorded entry of any non-Native people into Yosemite (Bunnell, 1880: 73). In 1861, H. Willis Baxley visited Yosemite Valley and reported the following: "A fire glow in the distance, and then the wavy line of burning grass, gave notice that the Indians were in the Valley clearing the ground, the more readily to obtain their winter supply of acorns and wild sweet potato root (huch-hau) [*Brodiaea* spp.]" (Baxley, 1865: 467). Other early accounts suggest that the goals of this burning, while principally focused on plant procurement, were diverse. Galen Clark reported on traditional management practices in the late-nineteenth century:

> The Valley had then been exclusively under the care and management of the Indians, probably for many centuries. Their policy of management for their own protection and self-interests, as told by some of the survivors who were boys when the Valley was visited by Whites in 1851, was to annually start fires in the dry season of the year and let them spread over the whole Valley to kill young trees just sprouted and keep the forest groves open and clear of all underbrush, so as to have no obscure thickets for a hiding place, or an ambush for any invading hostile foes, and to have clear grounds for hunting and gathering acorns. When the forest did not thoroughly burn over the moist meadows, all the young willows and cottonwoods were pulled up by hand.
>
> *(Clark, 1894: 14)*

This practice of fire management is widely reported to have helped prevent destructive wildfires in densely settled parts of the central Sierras, including Yosemite Valley, through the combustion of litter and the containment of conifer encroachment. A late nineteenth-century article in the *Daily Alta California* noted that:

> [t]he Indians used fire and had none of the artificial means of confining it that we have, so that during their occupancy of the country the chance for fire, in use for cooking or signals, escaping and starting a disastrous conflagration was much greater than now, and it may seem singular that the forests were not all destroyed before the whites came. They were not, because the Indians used fire to make the forests fireproof . . . . He knew that if leaves and fallen wood were permitted to accumulate year after year they would finally form such a supply of fuel that when it was fired it would destroy everything inflammable. Therefore he carefully prevented such an accumulation by burning it every year.
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> *(Daily Alta California, 1889: 4)*

Likewise, in a report to the Secretary of the Interior on the park's fire suppression policies, Superintendent J. W. Zevely (1898: 1057) reported that, "prior to the

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inauguration of the present policy, fires occurred almost every year in all parts of the forest – in fact, they were frequently set by the Indians, but there was so little accumulation on the ground that they were in a great measure harmless, and did not in any sense retard the growth of the forest."

Similarly, the earliest accounts of Yosemite tribes by professional anthropologists depict the management of vegetation through fire and other methods as fundamental elements of traditional land use. Barrett and Gifford reported the extensive use of fire to clear vegetation, a process important in the enhancement and procurement of both plant and animal resources (Barrett and Gifford, 1933: 179, 182). Reviewing data compiled by Omer C. Stewart, Reynolds (1959: 139) listed the various reasons for which at least thirty-five California tribes utilized fire. The purposes of fire, in descending order of reported importance, included increasing the yield of desired seeds (including acorns), driving or creating habitat for game, enhancing the growth of vegetable foods and wild tobacco, improving access to food plants, improving visibility and open trails, and enhancing protection from dangerous species such as bears.

The work of M. K. Anderson (1988, 1990, 1993a, b) with the Southern Sierra Miwuk and that of Lewis (1973) addressing numerous California tribes confirmed these findings. Their work acknowledged that burning occurred at multiple scales. As Anderson (1993a: 18) observed, "The extent of burning varies from lighting individual plants on fire, to burning 'patches' of the plant, to burning whole hillsides." In addition, their work acknowledged other reasons for ground-clearing fires, as mentioned by tribal Knowledge Keeper including minimizing future fire potential and the reduction of pest insects, rodents, and oak mistletoe. Fire, they suggest, both clears away competing vegetation and temporarily imparts nutrients into the soil, fostering both the increased size and the quantity of culturally preferred plants. Such fires are also widely reported to improve hunting, creating productive and geographically predictable foraging places for such game as elk and deer and habitats for many other game and nongame animal species. Anderson also documented a number of plant management techniques used to enhance the output of culturally preferred species among Southern Sierra Miwuk Nation members. These methods principally involve pruning and coppicing, such as the regular pruning of willow (*Salix* spp.), redbud (*Cercis occidentalis*), and other materials used in basketry and other traditional crafts to enhance the output of long, straight shoots. Furthermore, Anderson documented the maintenance of plant communities through forms of tending and selective harvesting, such as selective digging of *Brodiaea* (Indian potato) bulbs (i.e., leaving smaller bulbs to grow for future harvests and possible transplanting) and the continuous revisiting of *Brodiaea* patches to turn the soil and remove competing vegetation. Taken together, these studies suggest that Native managers enhanced between 200 and 250 culturally important species of plants through the use of fire and other techniques.

Pollen studies conducted in Yosemite Valley in the 1990s highlighted the role of anthropogenic fire in the formation and maintenance of the valley's plant communities. Anderson and Carpenter (1991) identified a major change in the pollen assemblage, indicating that a significant shift in vegetation occurred approximately 700 years ago. Although climatic cooling and increased precipitation in that period should have favored an increase in conifers, the opposite happened. They noted "a decline in conifers and an increase in oak. Peaks in both charcoal, pollen, and sediment influx occur contemporaneously, indicating a period of erosion" (Anderson and Carpenter, 1991: 7). The authors attribute this change to a rapid increase in large-scale fires, probably of human origin. Large-scale fires would have had to occur regularly to maintain the oak woodlands indicated within the pollen record. However, between 1930 and 2003, no lightning-ignited fires occurred in Yosemite Valley, again providing strong support for the assertion that the relatively frequent fire intervals predating this period were the result of human intervention (NPS, 2002).

Plant communities resulting from traditional patterns of human management appear to have represented "mosaics" rather than the increasingly "monocultural" stands we see today (cf. Lewis and Ferguson, 1988). Meadow environments, riparian forests and wetlands, oak woodlands, and conifer forests of differing ages ensured a high level of biological diversity within a relatively small area on the Yosemite Valley floor. With this biological diversity came a diversity of resource procurement options for the valley's inhabitants. While Yosemite Valley and other nearby valleys were burned regularly, the surrounding highlands exhibited fire regimes more influenced by natural ignition sources, notably lightning, resulting in dense forests of conifers such as red fir (*Abies magnifica*) and lodgepole pine (*Pinus contorta*) (van Wagtendonk, 1986). Wildfire frequency on the valley floor arguably lagged behind natural ignition rates characteristic of these conifer-dominated portions of the Yosemite landscape. As such, these valleys with their mosaic of habitats became managed "islands" amidst surrounding conifer forests, which, while still utilized, provided resource-gathering opportunities that were much less enticing.

Most of the species identified as ethnobotanically significant in the current study are fire adapted in some way. Many of the tree and shrub species possess thick bark that is fire resistant in adult phases, such as species like incense cedar (*Calocedrus decurrens*) or gray pine (*Pinus sabiniana*). Repeat burning eliminates juveniles of these species while allowing the survival of adults (Show and Kotok, 1924). Fire suppression during the last century and a half has encouraged the proliferation of some tree and shrub species that would have been selected against, during their juvenile phases, if burning had been practiced. This is especially true in Yosemite Valley, where increasing conifer dominance has transformed the vegetation of the valley floor (Reynolds, 1959; Gibbens and Heady, 1964). Many of the plant species identified in the course of the interviews and literature review also exhibit rapid seed dispersal or germination following light ground fires. Some of these possess serotinous cones or seed pods that only open after fire scarification or have seeds that germinate well only on freshly exposed mineral soil. For example, manzanita (*Arctostaphylos* spp.) seeds germinate at much higher frequencies following the burning of the seed coating by light fire, and some manzanita species are largely dependent on fire for their reproduction, as they bear seeds that lie dormant in the soil until fire scarification occurs (Keeley, 1977). A number of the species identified in this study send out additional shoots or branches after being exposed to light to moderate fire. In some species, this process serves to enhance the abundance of culturally preferred plant parts. For example, some willow species exhibit rapid post-fire sprouting from the rootstock, resulting in the production of long shoots that are useful in basketry and other traditional crafts. In the case of black oak, many of these additional branches eventually bear acorns, often resulting in a denser concentration of acorn-bearing branches on specific trees, with acorns being a primary staple food for the Miwuk and other Native Californians (Lewis, 1973; Plumb and Gomez, 1983; Knowledge Keepers).

Evidence of Wetland Plant Use and Management

The uses and management of wetland plant habitats have received comparatively little attention in the available published record. Yet, from the beginnings of the written record, observers have commented on the biological richness of Yosemite's wetland and riparian habitats. In the first guidebook for Yosemite Valley, J. D. Whitney commented on the botanical variegation and diversity in these areas:

> Along the banks of the river and over the adjacent rather swampy meadows, we find a somewhat varied vegetation, according to the locality . . . . Where the Valley widens out and the river banks become lower, so that the sloughs and swamps are formed, the Balm of Gilead poplar (*Populus balsamifera*) comes in . . . . The meadows are swampy, with deep peaty soil; their vegetation consists chiefly of carices or sedges and a few coarse grasses.
>
> *(Whitney, 1869: 73)*

These observations reflect widespread, variegated wetlands on a hydrologically active valley floor. Historically, seasonal flooding caused localized inundation of the Merced River floodplain – an effect augmented by natural obstructions such as rock barriers, beaver dams, and logjams. Floods that inundated significant portions of the Yosemite Valley floor were not uncommon; indeed, tribal members have noted that floods coupled with inclement weather were among the reason for some

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families' descent from the valley to drier places like El Portal in the wintertime. Channel–floodplain connectivity and seasonal inundation of riparian and meadow environments restricted conifer growth near the river channel. Moreover, this fostered a diversity and abundance of riparian wetlands no longer seen in the study area. Riparian wetlands exhibited vertical biotic zonation associated with changes in frequency, depth, and velocity of inundation, but also considerable lateral differentiation, apparently influenced by varying flow velocities and sediment sorting, reflecting the gross stream morphology. Intermittent side channels, gravel bars, sand bars, and other riparian depositional features each possessed distinctive biotas that have been important in the traditional diet and pharmacopoeia.

Accordingly, in addition to fire-adapted plants, a large proportion of the gathered species identified in the literature review and a clear majority of the species reported by living Tribal Knowledge Keepers in the project interviews are wetland species (see Tables 7.2 and 7.3). To illuminate these findings, we assessed the full list of 101 plant species reported to us as "culturally significant in living memory" among tribal members (Deur, 2007; Bloom and Deur, 2022), referring to the wetland indicator status of these ethnobotanically significant species. US federal agencies identify specific "wetland indicator" plant species to guide the formal designation of wetlands, using a probabilistic assessment of the prevalence of particular plants within wetlands of a particular region. As defined by the US Fish and Wildlife Service (USFWS) and the US Army Corps of Engineers (USACE), all plants that may be diagnostic of the presence or absence of wetlands are assigned to five principal categories, as defined in Table 7.1: obligate wetland, facultative wetland, facultative, facultative upland, and upland (USFWS, 1988, 1997; USACE, 2021). The USFWS augments these indicator codes with a + or – symbol, the former indicating that a plant is typically found in wetter environments within its identified range and the latter indicating that a plant is typically found in the drier environments of the identified range. In addition, the USFWS identifies some species as "NI," meaning that their status as potential indicators has not been established.

Researchers assess the species compositions of plant communities on the basis of the criteria outlined in Table 7.1 as part of wetlands, including the delineation of "jurisdictional wetlands" holding special legal status. Jurisdictional wetlands are areas possessing the diagnostic conditions of wetlands and therefore fall under the jurisdiction of the USACE and other federal, state, and local agencies with mandates to regulate activities that might affect wetlands. Jurisdictional wetlands, by definition, must have a proportional dominance of species determined to be obligate wetland, facultative wetland, and/or facultative species, and must be cataloged accordingly in keyed species lists produced by the USFWS (USFWS, 1988, 1997; USACE, 2021).

A significant portion of the 101 vascular plants identified by tribal members in interviews with Deur (2007) are wetland species commonly occurring in riparian, freshwater pond, and wet meadow environments. Of the 62 species identified as potential indicators of wetland conditions in California by the USFWS's *National List of Vascular Plant Species that Occur in Wetlands*, a total of 44 (71 percent) are wetland species (i.e., identified as facultative, facultative wetland, or wetland obligate species). Table 7.2 reflects a selection of the wetland species identified by tribal members in interviews with Deur (2007), totaling one-quarter of the identified wetland species. (Note, the tables in this chapter merely present a few

Table 7.1 *USFWS classification of wetland indicator plant species*

Code	Habitat indicated	Characteristics
OBL	Obligate wetland	Almost always (estimated probability: 99 percent) under natural conditions in wetlands
FACW	Facultative wetland	Usually occurs in wetlands (estimated probability: 67–99 percent), but occasionally found in non-wetlands
FAC	Facultative	Equally likely to occur in wetlands or non-wetlands (estimated probability: 34–66 percent)
FACU	Facultative upland	Usually occurs in non-wetlands (estimated probability: 67–99 percent), but occasionally found on wetlands (estimated prob ability: 1–33 percent)
UPL	Upland	Occurs in wetlands in another region, but occurs almost always (estimated probability: 99 percent) under natural conditions in non-wetlands in the regions specified

Table 7.2 *Selected plants used in tribal Knowledge Keepers' living memory: USFWS wetland indicator plant species*

Plant species	USFWS wetland indicator status
Red willow (*Salix laevigata*)	FACW+
Wormwood (*Artemisia douglasiana*)	FAC+
Wild grape (*Vitis californica*)	FACW
Field mint (*Mentha arvensis*)	FACW
Rough sedge (*Carex senta*)	OBL
Showy milkweed (*Asclepias speciosa*)	FAC
Deer grass (*Muhlenbergia rigens*)	FACW
Flowering dogwood (*Cornus nuttallii*)	FACW
Cattail (*Typha latifolia*)	OBL
Hemp dogbane (*Apocynum cannabinum*)	FAC
Wild ginger (*Asarum lemmonii*)	OBL

Table 7.3 *Selected plants used in tribal Knowledge Keepers' living memory: USFWS upland indicator plant species*

Plant species	USFWS wetland indicator status
White oak (*Quercus lobata*)	FACU
Hazelnut (*Corylus cornuta* var. *californica*)	FACU
Gumweed (*Grindelia nana*)	FACU
Harvest brodiaea (*Brodiaea elegans*)	FACU
Blue elderberry (*Sambucus mexicana*)	FACU
Sourberry (*Rhus trilobata*)	FACU

key examples, chosen from among the better-known species in each category; the bulk of each plant list is protected out of respect for the security and intellectual property of Native plant users.) Table 7.2 identifies the wetland indicator status of these culturally preferred species specifically from the California column of the USFWS's *National List of Vascular Plant Species that Occur in Wetlands: 1996 National Summary* (USFWS, 1997).

Of the forty-four wetland plant species identified in interviews, only eighteen of the species identified by living tribal Knowledge Keepers (or roughly 29 percent of the diagnostic species identified) are classified as being facultative upland or upland species in California by the USFWS. A third of those upland species are listed in Table 7.3 as a sample of the larger list. Still, it is important to note that some of the most important plants within tribal gathering traditions are upland species – such as oaks, hazel, elderberry, gumweed, harvest brodiaea, and sourberry. The species list in Table 7.3 identifies the wetland indicator status of culturally preferred species from the California column of the USFWS's *National List of Vascular Plant Species that Occur in Wetlands: 1996 National Summary* (USFWS, 1997).

Cumulatively, these findings suggest that a significant portion of plants gathered by tribal members of the last century are associated with wetland environments, particularly riparian wetlands and seasonally flooded wet meadows. This is reflected in a variety of statements by tribal members made in the course of this study and others. Riparian wetlands, in particular, were depicted as being "our supermarket, our drugstore . . . all those little flowers and grasses were our food and medicine. Everything we needed was there" (Deur, 2007: 51).

This is hinted at by past studies as well. Others have noted, "You can go down by the creeks, people don't realize it, they got their very own garden right there in the creeks" (Cramer, 1997: 3). Anderson also supports this characterization, describing the importance of these flood zones in the production of basketry materials:

> Floods are regarded by Southern Sierra Miwuk basketmakers as an essential force in revitalizing the sandbar willow habitat and the sedge habitat. Plant populations are said to need periodic flooding from the river if they are to remain healthy. The best willow with the most flexible stems grow with their "feet" (roots) wet. Areas with sandbar willow which do not have active sand depositing yearly, such as abandoned flood plains where the river no longer travels, are undesirable gathering sites providing lower grade plant materials than the revitalized stands nearer the river.
>
> *(Anderson, 1988: 55)*

Although underrepresented in the written literature, such descriptions of wetlands' significance – and of highly nuanced traditional ecological knowledge relating to the hydrologically dynamic wetlands of the valley floor – are consistent with the accounts of tribal members in the present study.

Intersection of Burning and Wetlands on the Valley Floor

Wetland habitats were not only significant as a source of plants within Yosemite tribes' ethnobotanical traditions, but also integral to their traditional plant management practices. In describing traditional burning practices, contemporary tribal members describe a system characterized by pyrodiversity – a complex and sophisticated burning process and schedule with fires occurring at different scales and in different wetland and wetland-margin environments over the course of a year. Burning patterns fluctuated, involving modifications to their timing, frequency, scale, and intensity in order to produce and maintain favored mosaics of habitats and species. Moreover, the accounts of living tribal members describe the historical use of riparian wetlands and saturated floodplains as natural firebreaks, which shifted in accordance with seasonal changes in valley floor hydrology, allowing for the containment of anthropogenic fires and the avoidance of large-scale wildfires.

To a limited extent, the complexity and sophistication of specialized burning in mosaic environments have been reflected in broader regional studies related to the Sierra Nevada, referencing practices of a range of ethnolinguistic groups (e.g., Anderson, 1988, 1993a; Anderson and Rosenthal, 2015). Particularly important to the current study, however, is the manner in which the specific characteristics of Yosemite Valley hydrology and the cultural preference for species reliant on both water and fire conditions were key in shaping fire regimes and the biodiversity of the valley.

Tribal members correctly note that traditional management of plant communities, including the use of fire, once played out on a far more complex and dynamic valley floor than one beholds at Yosemite today – the reasons for these changes, relating to park management over the last century, are addressed later in this chapter. Formerly, the valley floor was more intricately braided than it is today, with numerous riparian-influenced wetlands and ephemeral side-channels, and the water table was significantly higher. Then, and this happens to a more limited extent now, the water table of the valley would drop as the season dried, as did the water level of the Merced River – from peak runoff in late winter and early spring through the very dry season in late summer and early fall. This was reflected not only in a general drop in river levels and floodplain saturation, but also in the gradual downward movement of groundwater. This resulted in places with saturated soil or surface water drying out through the season, with wetlands and wetland margins exhibiting diminished soil saturation until precipitation rebounded in the winter. Following this pattern, all else being equal, vegetation tends to become dry at the high points first on alluvium and then lower in the alluvial terrain over the dry season until rains and snows resume. Most of the valley floor consists of alluvium, with areas of hydrologically integrated colluvium. Each year, as early-spring peak-stream flows dissipated and surface waters receded, the water table slowly dropped below the surface of the valley floor, even in wet meadows and ephemeral river channels. On the hummocky and irregular terrain shaped by this fluvial action, "islands" of relatively dry meadow emerged, surrounded by relatively saturated areas. As spring gave way to summer, these islands grew larger, connecting and ultimately encircling the low riparian areas, wet swales, and ponds that remained wet throughout the year (Heady and Zinke, 1978: 17; University of California Merced, n.d.; Yosemite National Park, n.d.) (Figure 7.1).

Inhabitants of the valley appreciated the burning opportunities fostered by these natural processes. Some Knowledge Keepers recalled oral traditions describing burning methods applied to this complex alluvial matrix of riparian and wet meadow habitats on the Yosemite Valley floor (Figure 7.2). Traditional burning, they suggest, began the moment that certain high places on the floodplain became sufficiently dry to ignite. This allowed fires to commence early in the season, but at small scales – the fires atop individual rises and hummocks, with drier conditions, being effectively contained by the saturated areas that encircled them. Anthropogenic fires then moved into lower elevation portions of the alluvium matrix through the rest of the season as conditions dried out (Lewis, 1973: 79). Accounts from living Elder align with certain written accounts too, such as that of Joaquin Miller, who reported in 1887 that:

> [i]n the Spring . . . the old squaws began to look about for the little dry spots of headland and sunny valley, and as fast as dry spots appeared, they would be burned. In this way the fire was always the servant, never the master . . . . By this means, the Indians always kept their forests open, pure and fruitful, and conflagrations were unknown.
>
> *(Miller, quoted in Biswell, 1968: 46)*

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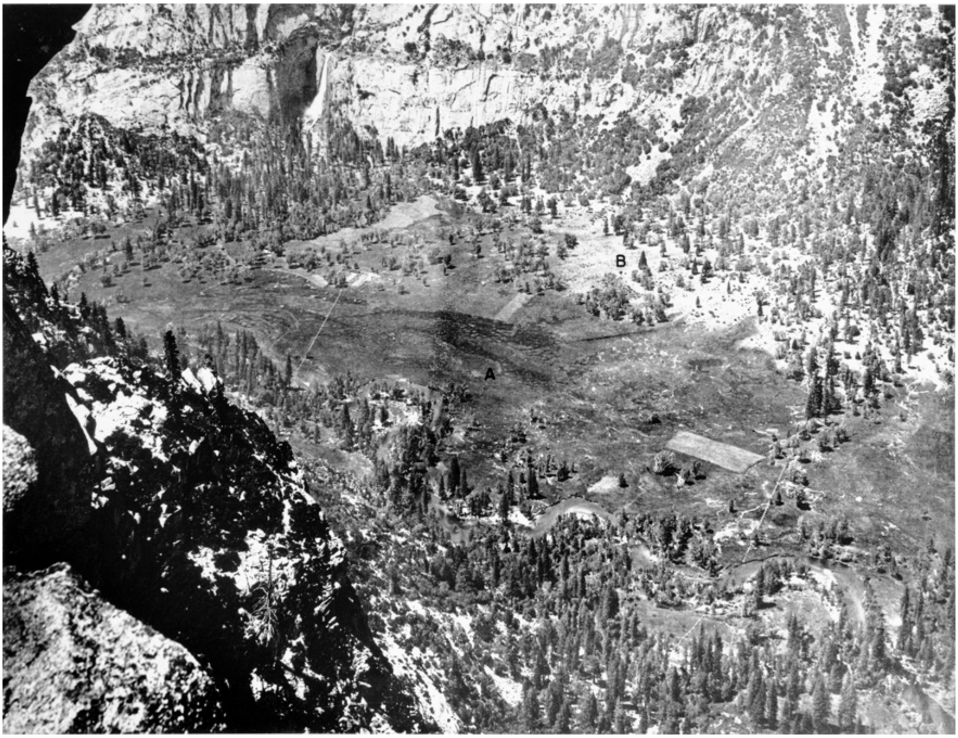

Figure 7.1 A detailed view of Yosemite Valley from Glacier Point by Carleton Watkins in 1866, a mere fifteen years after first Euro-American documentation of the valley's existence. The image hints at the extent of herbaceous plant communities and the complexity of the active Merced River floodplain prior to major hydrologic changes in the decades that followed – with riparian wetlands, ephemeral river channels, and freshly deposited sediments. By the time of this photo, early agricultural development was apparent on the valley floor. (Photograph by Carleton E. Watkins, from Gibbens (1962) [Figure 1A], courtesy of Yosemite National Park Archives.)

As the water table dropped into the early summer, traditional harvesters appear to have ignited a succession of fires in areas interdigitated between previously burned areas and the zone of enduring soil saturation. Here too, the fires remained contained; the spread of these fires into wet areas downslope was typically contained by poor ignition, while a lack of fuel in recently burned areas upslope restricted fire movement into those areas. In the late season, in summer or early fall, only lower elevation areas remained in the alluvium to burn – the drying plants of wetlands and intermittent river channels now being flammable enough by this time for these plant communities to be burned too, encouraging the growth particularly of herbaceous wetland species. Interviewee accounts suggest that Native

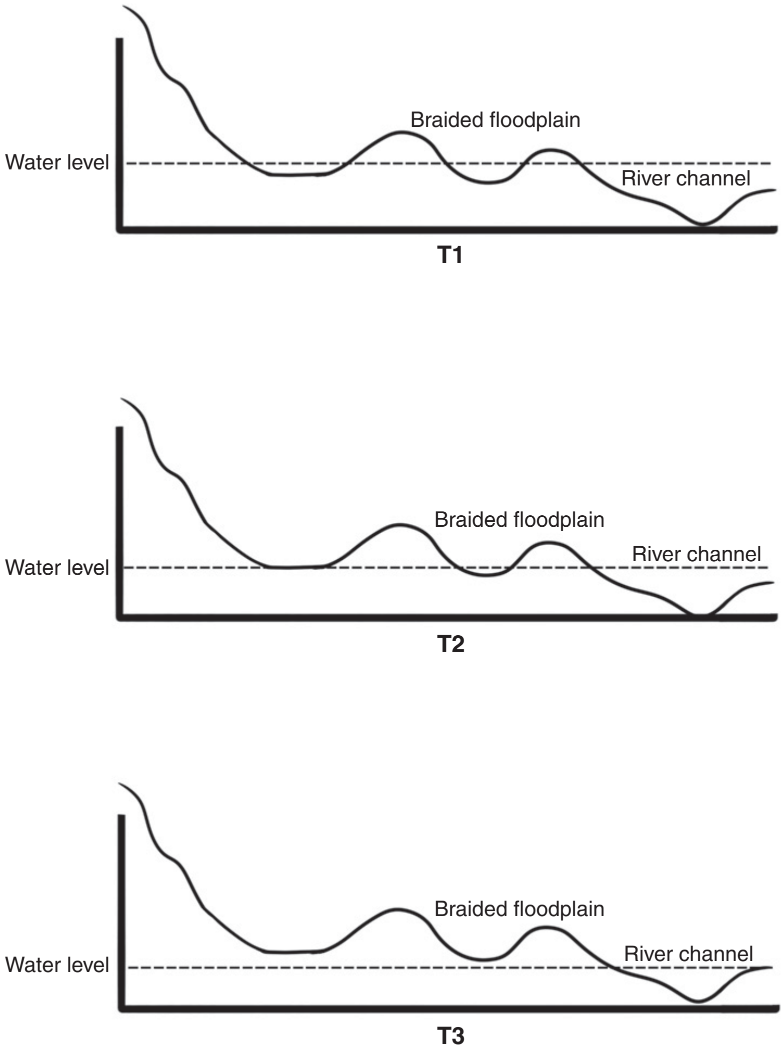

Figure 7.2 A highly idealized cross-section of the Yosemite Valley floor, with uneven alluvial deposits, swales, ephemeral channels, and other wetland environments. As described by tribal interviewees, traditionally burned areas were positioned to burn drying areas in response to the descending surface water and water table through the season, shown here diagrammatically on the Yosemite Valley floor, from time 1 (T1, spring) to time 2 (T3, summer) to time 3 (T3, late summer/fall).

burners repeated fires in this way until, cumulatively, much of the valley's alluvial zone had been burned. In places where soil moisture or other factors inhibited burning, woody species such as seedling pines (*Pinus* spp.), incense cedar (*Calocedrus decurrens*), Douglas fir (*Pseudotsuga menziesii*), or buckbrush

(*Ceanothus* spp.) were commonly pulled out by hand to maintain wet meadow environments (Clark, 1894: 14–15). The result was a mosaic of places burned at different times and a mosaic of plant communities of cultural significance – contributing to the apparent diversity of wetland species utilized by Yosemite tribes.

At the end of the year, after the gathering of staple acorn crops, as people prepared to descend from Yosemite Valley to communities at lower elevations east and west of the park, burning specialists ignited final large-scale clearing fires. While this probably included portions of the alluvial zone discussed here, much of this final burn was centered on the colluvial margins of the valley floor. By this point, moisture was no longer a factor in attempts to ignite other, often lower, parts of the valley floor. Interviewees attest that burning earlier in the season had sufficiently eliminated fuels at the surface, especially in the alluvial zone close to habitations and key plant-gathering areas, such that these late-season burns were easily controlled (Clark, 1894: 14; Reynolds, 1959: 134, 151–2). Additionally, the fires allowed a final clearing of unused plant materials from habitats such as the dampest wetland swales, which were finally dry enough to burn. Many of the oak prairies and isolated conifer stands of the valley margins were maintained by these fires too.

As such, the burning strategies for Yosemite Valley described by tribal Knowledge Keepers might be broadly categorized as "alluvial," centering on the riparian area and associated wetland and wet meadows on the valley floor, or "colluvial," centering on the areas lying on the valley edge outside the zone of principally riparian landforms. With a few exceptions (Lewis, 1973; Anderson, 1993a; Anderson and Rosenthal, 2015), the vast majority of the ethnographic literature tends to center almost exclusively on colluvial patterns, ignoring the complexity of the dynamic annual practices and their reliance upon hydrologic processes in wetlands, wetland margins, and active floodplains. Clearly, however, the alluvial patterns of traditional burning were no less significant in Yosemite Valley and suggest highly nuanced understandings and methods for traditional fire management among Native harvesters historically.

Together, as tribal members attest, the combined burning strategies enhanced the productivity and diversity of culturally preferred species in the following year. By practicing these management strategies every year, interviewees attest, Yosemite's precontact inhabitants maintained mosaics of culturally preferred species that allowed them to meet their needs for food, medicine, housing, implements, and basketry, among many other needs. This sophisticated and dynamic system allowed each season's fires to be contained by adjusting to moisture availability and incrementally burning down into wetter areas as conditions allowed. This is key to understanding many points: the variegated vegetation patterns described by nineteenth-century writers such as Whitney, the richness and wetland orientation of documented ethnobotanical practices, the apparent contradictions we see in many written accounts of burning scale and timing, and the many ways that the extirpation of fire *and* water affected Native use and management of the landscape. As one tribal member noted, "it is not just about using fire . . . it is about how we used fire and water." Through this manner of burning, harvesters could restrict each fire from engulfing villages or other inhabited places. Burning in such a constrained and densely populated valley was a delicate matter indeed. Anthropogenic burning of alluvial and wetland environments, within the dynamic Merced River floodplain, was one of the key ingredients that allowed Yosemite Valley tribal communities to inhabit the valley successfully for generations.

Fire Suppression and Hydrologic Modifications: Interconnected Factors in the Loss of Anthropogenic Plant Habitats

Today, a combination of state and federal fire suppression policies and changed hydrologic conditions have severely disrupted this complex system of traditional management. In turn, this has negatively impacted anthropogenic landscapes, plant communities, available plant and animal resources, and the endurance of many cultural practices. The suppression of fire, and especially the encroachment of dense conifer forests throughout much of Yosemite Valley, has resulted in reduced genetic diversity and a reduced range of resource-gathering opportunities. Fire suppression policies arrived with early park management – within only a few years of President Abraham Lincoln signing the Yosemite Valley Grant Act, making Yosemite a park on June 30, 1864 – and from that time forward most forms of traditional management were discouraged or prohibited, burning in particular. As early as the 1880s, park managers recognized that the meadow environments of Yosemite were disappearing under rapidly encroaching trees and brush – principally due to the suppression of both anthropogenic and natural fires. In a report to the Commissioners, dated May 20, 1882, William H. Hall reported:

> The area of meadow is decreasing, while young thickets of forest or shrub growth are springing up instead. Members of your Board have observed this change; it is very marked, and it may be regarded as in a degree alarming, sufficiently so, at least, to prompt measures calculated to check it. The cause is alleged to be the abolition of the old practice of burning off the thickets, which practice formerly made new clearings almost every year for grass growth.
> *(Hall, 1882: 15–16)*

The Secretary of the Commission, M. C. Briggs, reported in a letter dated December 18, 1882, that "[w]hile the Indians held possession, the annual fires kept the whole floor of the valley free from underbrush, leaving only the majestic oaks and pines to adorn the most beautiful of parks. In this one respect protection has worked destruction" (Briggs, 1882: 10–11). These observations resulted in modest changes in park vegetation management, although forest encroachment on the Yosemite Valley floor continued relatively unchecked. By the 1930s, the transformation of Yosemite Valley plant communities, especially the encroachment of dense conifer forests on meadows and oak groves, became the focus of modest press attention (Crowe, 1931; Taylor, 1931). The 1940s brought renewed attention to the issue within the NPS, particularly through the work of Emil Ernst (1943, 1949, 1961). In the years that followed, the causes and effects of fire suppression within Yosemite Valley gained attention from a broadening range of applied and academic researchers, fueled significantly by concerns regarding the aesthetic impacts of these changes (Reynolds, 1959; Gibbens and Heady, 1964; Heady and Zinke, 1978). Today, tribal Knowledge Keepers lament: "They [the plants] are all disappearing. Everything is overgrown, all those places we gathered plants are all covered with pines. They can't grow under brush and pine needles" (in Deur, 2007: 46; cf. Turner, 1991) (Figure 7.3).

The loss of fire in Yosemite Valley, however, is only half the story. The loss of culturally significant wetland environments in the last century has had interrelated and equally damaging effects, including a reduction in the quantity and quality of

Figure 7.3 An aerial view of Yosemite Valley from Glacier Point by Ralph Anderson in 1943. By the early twentieth century, conifer encroachment on the Merced River floodplain and associated wetlands was widespread, reflecting not only fire suppression policies of the NPS, but also significant engineered changes to valley hydrology. (Photograph by Ralph H. Anderson, from Gibbens (1962) [Figure 1B], courtesy of Yosemite National Park Archives.)

many culturally significant wetland species. Specific historical impacts included park demolition of two rock barriers that historically impeded surface runoff, contributing to wetland hydrology on the valley floor, namely the El Capitan moraine and the rock obstruction just below Mirror Lake on Tenaya Creek. The El Capitan moraine formed "a nearly straight dam across the valley just below El Capitan meadow" that impeded ancient Lake Yosemite across the valley floor during the early Holocene (Matthes, 1930). This moraine marked the downstream end of Yosemite Valley's 5.5-mile-long "central chamber," the valley's largest hydrologic unit, which includes the upper valley as far upstream as Tenaya Creek Pass. As the Pleistocene glaciers retreated, alluvial and lacustrine deposits accumulated behind this moraine, gradually producing the level valley floor in the millennia that followed. Galen Clark noted that, in the 1870s, the Merced River channel crossed the moraine but that "[t]he river channel at this place was filled with large boulders, which greatly obstructed the free outflow of the flood waters in the spring, causing extensive overflows of low meadow land above, greatly interfering with travel, especially to Yosemite Falls and Mirror Lake" (Clark, [1907] 1927: 15). The damming effect of this moraine appears to have not only kept river flows impeded and the water table "perched" through this central chamber of the valley, but also contributed materially to the complete flooding of the valley floor in high runoff years – a phenomenon noted in 1864, 1867, and 1871. Thus, the meadows of the valley floor visible in the photographic collections of C. E. Watkins of the 1860s appear to be differentiated by oxbows, sloughs, scour channels, natural levees, and fresh alluvial deposits from flooding and elevated water tables upstream from the moraine – geomorphic features that are much reduced and all but invisible to contemporary park visitors (Watkins, n.d.).

Not only were floods a threat to growing park infrastructure and proposed agricultural operations in the valley, but the perennially muddy conditions of the valley floor were a source of complaints among the rising tide of affluent park visitors. In 1879, in an effort to reduce flooding and lower the water table on the valley floor, Galen Clark demolished the El Capitan moraine at the point where the Merced River transected it. Almost instantly, this opened new land for agricultural use in the central valley and expanded the viable window of visitor access into the springtime, a season when floods and muddy conditions had previously been an obstacle. Using explosives, he eliminated the large boulders and leveled the remaining rock fragments, dropping the natural dam by an estimated four to five feet. The water table in the valley upstream from the moraine dropped proportionately (Clark, [1907] 1927; Milestone, 1978).

Additional park development soon compounded these impacts, such as the dredging and revetment of the Merced River under early NPS management (including the use of dynamite, in some cases, to produce visually appealing flat waters that

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reflect the mountain scenery), the dredging of sand from Mirror Lake, and the filling or development of wetland areas to foster park development. Beyond this, the park witnessed concentrated visitor activity along the riparian zone, gravel mining, and confinement of the river by bridge crossings. Removal of large woody debris to reduce the threat of floods to park facilities resulted in channel widening and disconnection of the river from its once-active floodplain. Flooding, which once occurred annually, today occurs only during significantly larger river flows, and much less frequently, as a result of these many changes (Booth *et al*., 2020).

Combined with the impacts of Clark's blasting, these events produced an approximately 1- to 1.5-meter drop in the mean water table within many portions of Yosemite Valley, eliminating the hydrology necessary to maintain a number of historical wet meadows and swales. As tribal members note, as wetlands went dry in many parts of the valley, wetland plants disappeared, while declining soil saturation invited conifer encroachment into former wetland environments that was well beyond what would have occurred solely due to fire suppression (Ernst, 1943: 55). Only with the dewatering of certain wetlands were conifers able to expand their range across the valley floor. The combination of both anthropogenic fire and soil saturation had restricted conifer encroachment into wet meadow environments historically. Accordingly, most of the dense forests in the valley are said to date from approximately 120 years ago, suggesting a decade or two of succession in the meadows before the conifer forest became established. Most of those areas arguably could not have supported trees before the dewatering of the meadows. Even without factoring in the effects of global climate change, Reynolds explains that Yosemite's meadows "once remained wetter for longer periods than they do today . . . water tables in meadowland fall more rapidly and farther today after the spring runoff period than they did during aboriginal times" (Reynolds, 1959: 57). Wetlands and alluvial complexity have been compromised, but the traditions of burning linked to these dynamic landscapes are undermined: The scale and timing of flooding no longer foster staged wetland burning on a historical scale. Visitor traffic also increased in these dewatered areas – diminishing remnant plant communities due to trampling, soil compaction, the inadvertent introduction of invasive plant species, and other impacts – as formerly wet lands became dry and navigable, and visitor numbers skyrocketed in the decades that followed.

While, over the course of the twentieth century, NPS policy exhibited an increasing reluctance to modify the valley's hydrology, a policy of reducing flooding and groundwater levels to protect visitor structures and visitor access continued into the 1970s. Only in the early 1970s did regular dredging at Mirror Lake and other scenic waterways cease; by this time, over 14,500 lineal feet of stream bank and riverbank had been lined with revetments, principally of riprap, in Yosemite Valley (Milestone,

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1978). Although provisions of the Clean Water Act effectively ended direct wetland impacts, and although the park has taken an active role in wetland restoration in recent decades, a concern with flood control has persisted in attenuated form (Milestone, 1978; Madej *et al.*, 1991; Booth *et al.*, 2020).

Another cause for changing Yosemite Valley water tables was fire suppression itself. Reynolds noted that the increase of second-story vegetation under old-growth forest stands – which the cessation of anthropogenic fire precipitated – intercepted rainwater that would otherwise have percolated into the ground, causing it to be transpired or evaporated into the atmosphere. He describes this as "probably the most important single factor which has contributed to the desiccation of most central Sierra meadows during the past one hundred years" (Reynolds, 1959: 57). Another impact of fire suppression was the replacement of shallow-rooted herbaceous plants with deeper rooted species. This invasion of woody species with deeper roots decreased the quantity of groundwater storage in the meadows (Reynolds, 1959: 58). Therefore, in some parts of the valley, conifer encroachment and hydrologic change have been mutually reinforcing components in a positive feedback loop (Figure 7.4).

Recently, park researchers have established that meadows that dried out due to the historical changes in valley hydrology are also more prone to invasion by non-native

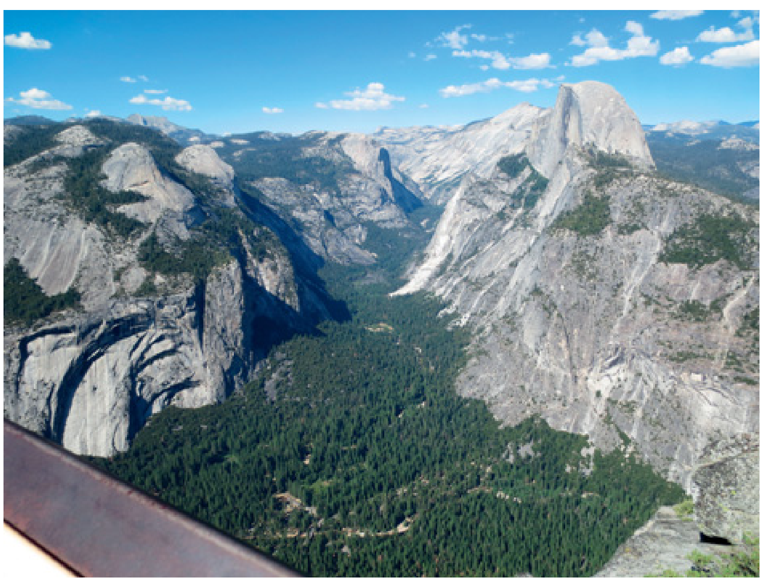

Figure 7.4 A view of Yosemite Valley from Glacier Point in the twenty-first century showing a nearly complete encroachment of conifer trees across undeveloped portions of the Yosemite Valley floodplain. (Image from Monument-Fruede [2013], courtesy of Wikimedia Commons.)

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plant species. These places also experience more ground disturbance and predation on California black oak acorns and seedlings by such species as mule deer, pocket gophers, several birds including the acorn woodpecker, and insects such as filbert worms and filbert weevils than was apparently the case historically or when compared with the same variables in the valley's remnant wetlands (Yosemite National Park, 2011: 45). In turn, the presence of small mammals in these dewatered areas has been demonstrated to correlate with poor germination and survival of certain native, culturally important plant species, including California black oak, following predation (Yosemite National Park, 2011: 48, 68, 72; M. Downer, 2017, personal communication).

As a result of these many impacts on culturally significant plant habitats, tribal members suggest that many of the wetland species used historically are no longer used today (and are therefore not included in the tabulations presented here or in Table 7.2). In these areas, the plants are simply no longer available for use. In other contexts, they are so limited in their quantity and quality that they are no longer used. For example, Knowledge Keepers indicated that the best fern (especially *Pteridium aquilinum*) and sedge (*Carex* spp.) roots for basketry come from alluvial sand deposits near the upland–wetland margin. These species are adapted to rapidly colonizing fresh alluvial deposits with lateral rhizomes and do so annually in the riparian zone of the Merced River and its tributaries. Certain places, known for their abundant annual sand deposits, were historically important root-gathering areas for this purpose, with gathering places sometimes shifting from year to year in response to changing patterns of deposition. Today, traditional basket makers find very few active sand deposits and they describe the roots found in rocky soil matrices to be gnarled, short, difficult to extract, and difficult to use for traditional basket making. Some suggest that, as a result of that environmental change, the quality of modern baskets made from Yosemite Valley materials lags behind that of historical baskets. The cessation of the sophisticated annual cycle of burning practiced by tribal managers in these hydrologically dynamic places has adversely affected a number of traditionally gathered species such as sedges, rushes, ferns, cattails, and deer grass. For instance, tribal members observed that many desired wetland plants were producing desired leaves, shoots, flowers, or other parts only in spring, and that burning those areas in spring would actually have destroyed the plants and plant parts, making them unusable to Native harvesters. This, too, created strong incentives to burn incrementally, place by place, following the hydrology and creating managed mosaics across the Yosemite Valley floor.

7.4 Discussion and Conclusions

The Native peoples of Yosemite Valley and their caretaking practices have been the focus of generations of scholarly writing and firsthand accounts, and the tribes of

Yosemite increasingly tell their own story (Traditionally Associated Tribes of Yosemite, 2021). In spite of this, there are still aspects of Yosemite's heritage that have escaped the attention of the wider world. Among these is the centrality of wetland plants in the ethnobotanical traditions of Yosemite's Native peoples and the sophisticated methods employed by these peoples historically to modify wetland environments to enhance the output of culturally preferred wetland species. We contend that the traditional resource and environmental management of Yosemite tribes cannot be fully understood without considering this wetland specialization. We also anticipate that the practices described by Yosemite tribes, such as sequential burning of floodplain environments, may prove to be widespread upon more careful investigation of other Native traditions and landscapes across California and elsewhere in the Americas.

In Yosemite Valley, wetland species – sedges, rushes, milkweed, cattail, wormwood, and deer grass, to name but a few (see Table 7.2) – represented a large proportion of the plants utilized historically, and remain among the most valued and utilized species among modern tribes of the Yosemite region today. Of some of the species identified as being actively harvested within the living memory of tribal Knowledge Keepers in past ethnographic studies (Deur, 2007; Bloom and Deur, 2022), some 71 percent of the diagnosable sample qualified as wetland species, that is, were designated as wetland obligates, facultative wetland, and facultative species, using the US delineations of wetland areas and species (USFWS, 1988, 1997). Most are herbaceous species, well suited to growing in riparian wetlands and wet meadows situated in highly dynamic floodplains and alluvial soils, and also tolerant of regular burning. While certain upland species hold elevated significance in tribal traditions, they represented only some 29 percent of the species mentioned by living Knowledge Keepers. While these proportions are striking, they are also consistent with the historical condition of the Yosemite Valley floor, with formerly seasonally flooded riparian areas and other wetlands far more extensive than what can be observed in the valley today. In light of the prominence of wetlands and alluvial deposits throughout the valley prior to the major hydrologic changes engineered by the park in the late nineteenth and twentieth centuries, this nuanced focus on wetland habitats and environments is to be expected.

While anthropogenic fire clearly has been important in shaping the vegetation of Yosemite Valley, and this point has been celebrated in past studies (Anderson, 1988, 1990, 1993a, b), we find that many of Yosemite's culturally significant plants and plant habitats rely on a specific interplay of both fire and water. The strategies of traditional burning described by tribal members of the last generation provide a tantalizing glimpse into how harvesters navigated this damp and dynamic environment. Wetlands, rivers, and saturated floodplains served as important firebreaks within the larger fire-managed landscape. Early in the burning season, traditional fire managers focused on the drier, isolated high points on the valley floor where both surface water and groundwater had subsided, allowing for fires that were at once geographically focused and contained. As flooding ceased and the water table dropped through the summer season, these managers burned intermediate places that had dried in the interim – burning with a footprint that was significantly contained downslope by saturated areas and contained upslope by the absence of fuels in previously burned sites. Late in the dry season, with the water table dropping further and the higher places in the hummocky alluvial terrain cleared of fuel, these managers could burn remaining swales and wetlands. At each step, the fires remained contained and focused on a different range of species characteristic of the wetlands and wetland margins of Yosemite Valley. Tribal members attest that the abundance of culturally significant species was enhanced as a result: that the cattail and willow, wormwood and sedge, deer grass and milkweed, and countless other species that sustained their ancestors for food, medicine, materials, and more were made more predictably abundant in places known and accessible to Native peoples (Deur, 2007; Bloom and Deur, 2022). While these practices are not described in such intricate detail within the available archival record, there are tantalizing if fragmentary references in that archival record that cohere with these practices. In part, this may reflect the fact that these practices were clearly being suppressed and marginalized by park management prior to the arrival of professional anthropologists and the emergence of detailed written accounts of Yosemite tribes in the first half of the twentieth century.

In diverse and interconnected ways, colonization transformed not only the record of Yosemite's tribes, but also the landscapes, the plant communities, and the many cultural practices linked to the unique environments of the Yosemite Valley floor (Spence 1996). While fire suppression has been widely cited as a source of riveting cultural and environmental change, this is a necessary but insufficient explanation for the changes witnessed in the last century and a half. Instead, the expulsion of Native harvesters and managers had numerous measurable effects on the landscape. And yet, that is not the full story either; instead, tribal members point toward the combined effects of fire suppression and hydrologic changes occurring in tandem – the simultaneous removal of both fire and water across large swathes of the Yosemite landscape. With the demolition of the El Capitan moraine, the hardening of the Merced riverbank, and many other changes meant to improve visitor access to the new park, park managers effectively reduced river–floodplain connectivity and prompted changes in soil moisture and a drop in water table levels. This resulted in the rapid disappearance of wetland and riparian margin plant communities across the Yosemite Valley floor. While it is true that, as some authors have noted, fire suppression allowed conifers to encroach on historical meadows, we concur with the observation of living tribal Elders: that it was this rapid drop in the water table coupled with fire suppression that allowed conifers to occupy former floodplains, riparian wetlands, and many other habitats formerly utilized and managed by Native peoples. Together, these changes in land management eliminated opportunities for Native harvesting of a diverse range of wetland species and precluded the traditional management of habitats according to seasonal changes in the water table. In turn, these monumental changes in land management adversely affected a constellation of traditional cultural practices linked to the use of plant foods, medicines, and materials, as well as the many educational, cultural, and spiritual uses of plants traditionally harvested in the wetlands and wetland margins of Yosemite Valley.

While tribal members continue to gather plants at Yosemite today, the habitats that sustain these plants have been much eroded and degraded, undermining both the biological and the cultural integrity of Yosemite Valley while also raising the risk of wildfire on the valley floor and beyond. The implications of these findings for environmental restoration of culturally preferred habitats are compelling – at Yosemite and beyond. Prescribed burning programs are warranted in suitable settings. Yet, these programs require a consideration of seasonality, scale, and hydrologic conditions, informed by the recollections of tribal members and the teachings of ancestors who engaged and managed the landscape with fire across deep time – an approach that has been termed "ecocultural restoration" or "ethnoecological restoration" (Senos *et al*., 2006).

These changes are underway at Yosemite, albeit slowly. These changes are also being made delicately in a valley that is now visible to worldwide audiences and contains buildings and infrastructure in places once flooded and burned annually. In recent years, Yosemite hydrologists have implemented restoration efforts including the removal of riprap, revegetating the riparian zone with native species, and increasing in-channel roughness, all to restore river structure and floodplain connectivity (Booth *et al*., 2020: 10–11; Fong, 2020: 10) (Figure 7.5). In a few places, wetland restoration has also received separate and focused attention. Tribal members have suggested the water flow would have to be impeded again – dammed at El Capitan moraine or nearby – to allow a higher water table and the reestablishment of wetland environments throughout Yosemite Valley. In light of the potential effects on park infrastructure and visitors, the NPS is unlikely to embrace valley-wide restoration of floodplain connectivity and wetland hydrology. However, it continues to consider restoration activities interdigitated with park facilities, such as riparian wetland restoration involving limited grading to reconstruct swales and ephemeral river channels.

The NPS has also implemented prescribed burning in response to deteriorating vegetation communities and vistas and to the increased risk of destructive wildfire (Tait, 1999; Vasquez, 2019: 40–4) (Figure 7.6). These new burns often mimic conditions of traditional burning and are conducted with varying levels of tribal

Figure 7.5 Although dredging and the destruction of the El Capitan moraine have reduced flood heights and frequency throughout the valley, occasional floods still cover the Merced River floodplain, including lands traditionally managed by Native harvesters through sequential fires, including this major flood event in May 2018. (Photograph by R. Bloom.)

involvement. Native participants suggest that, in creating modern analog fires, the NPS has misinterpreted the timing and scale of their traditional burning practices, often with detrimental impacts on preferred species. They state that traditional burning was highly nuanced and dynamic, with careful attention to the interrelation between timing, scale, and habitat – including paying much attention to the effects of burning on the plants of wetlands and wetland margins. They have been critical of the NPS burning to date, describing these introduced methods as taking a "one-size-fits-all" approach, by burning most areas all at once, and avoiding some of the traditional burning times through the summer due to effects on views and visitors – often with unintentional negative consequences for culturally preferred species. Clearly, continued discussion and collaboration will be needed to find common ground and to develop ways to carry out traditional fire management in a landscape so transformed by the extirpation of anthropogenic fire, culturally important

Figure 7.6 NPS fire crews now actively burn the floodplain as part of "prescribed fire" programs that are meant to reduce the wildfire risk and impede conifer encroachment in the wake of a century and a half of park-mandated fire suppression and hydrologic change. Native burning traditions have served as inspiration for modern fire management, and the park sometimes consults with tribal experts in prescribed fire planning – yet, the complex interplay between floodplain hydrology, groundwater, and fire remains a significantly unexplored dimension in park land management. (Photograph by Kelly Martin [NPS], courtesy of Yosemite National Park Archives.)

wetlands, and the Native harvesters and managers who have long called this place home.

While these lessons are linked to the unique peoples, geographies, and habitats of Yosemite, they have broad implications for the wider world. Native harvesters clearly managed many montane valleys and other hydrologically active interior valleys across western North America (Lewis, 1973; Blackburn and Anderson, 1993; Boyd, 1999). While our understandings of traditional burning practices are thin in places, in some contexts Native knowledge holders have been able to recall such practices with precision – often revealing details that will be key if burning will continue to serve as a mechanism for landscape-scale plant habitat management into the future. Researchers are well advised to seek evidence of wetland and wetland margin burning, of nuanced methods for burning in wet and hydrologically active environments, and of the pyrodiversity and mosaic environments fostered by such practices when sustained by generations of traditional land managers. Such well-watered places are numerous and have idiosyncratic properties that require

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specialized knowledge to manage them successfully, as the traditional plant managers of Yosemite have known so well. With the guidance of Native harvesters and knowledge holders, we might yet recover aspects of these traditional practices and foster the restoration of biologically and culturally significant habitats. We might, as the NPS is compelled to do by the terms of its Organic Act (16 U.S.C. / 2–4), help preserve the natural and cultural legacies of these special places and – through the continuation of active traditional management – "leave them unimpaired for the enjoyment of future generations."

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