BEAUTY, BOUNTY, AND BIODIVERSITY: THE STORY OF CALIFORNIA INDIANS' RELATIONSHIP WITH EDIBLE NATIVE GEOPHYTES

by M. Kat Anderson and Frank K. Lake

California supported a great diversity of plants with edible underground storage organs available to Indian tribes. Together, plant foods, fish and meat made up an indigenous diet that was well-rounded, diverse, and relatively secure. The edible underground parts possessed by these plants are classified as bulbs, corms, taproots, tubers and rhizomes, and when conditions turn unfavorable (too cold or too dry), the above-ground stems die back and the underground organs remain alive. Botanists and ecologists call the plants that employ this strategy *geophytes*. Indians often call them Indian potatoes or "root foods" because they are hidden under the ground. Geophytes were an important source of food for indigenous people throughout California.

STAPLE FOOD CROP

In pre-contact California there were dozens of species of geophytes gathered for their edible underground storage organs in multiple plant communities from the salt marshes, to the deserts, to chaparral, to the open understories of coniferous forests and oak woodlands. For example: the Ohlone dug the bulbs of harebell *(Campanula prenanthoides)* in winter and early spring for food in the vicinity of tan oaks; the Wailaki and Pomo harvested the bulbs of the fawn lily (*Erythronium oregonum*) in the openings amongst interior live oaks; and the Kashaya Pomo unearthed the tubers of elegant piperia (*Piperia elegans)* in dry areas between California black oaks. Some of the most important genera gathered by many

TOP: Raw camas (*Camassia* sp.) bulbs and brodiaea (*Brodiaea* and *Triteleia* spp.) corms on a bed of Pacific big leaf maple leaves prior to baking them in an earth oven. Photograph by Frank K. Lake, 2005. • BOTTOM LEFT: A bounty of camas (*Camassia quamash* subsp. *breviflora*) for food. Photograph by Heron Brae, 2012. The camas bulb, found several inches below the earth's surface, is about the size of a large hazelnut, but can grow as large as a walnut. Camas (*C. leichtlinii* subsp. *suksdorfii* and *C. quamash* subsp. *breviflora*) produces few offsets, but Native people note that when dug repeatedly and encouraged, they tend to divide. • BOTTOM RIGHT: Cooked camas (*Camassia* sp.) bulbs and brodiaea (*Brodiaea* and *Triteleia* spp.) corms wrapped in a bed of Pacific big leaf maple leaves after baking them in an earth oven. Photograph by Frank K. Lake, 2005.

tribes include *Allium*, *Brodiaea*, *Camassia*, *Chlorogalum*, *Calochortus*, *Dichelostemma*, *Lilium*, *Lomatium*, *Perideridia*, *Sanicula*, and *Triteleia*.

Indian potatoes were not only diverse, but also provided a variety of tastes to please the palate from slightly bitter, to mildly nutty, to sweet. They were eaten raw, boiled, baked, or steamed and then mashed, made into cakes similar to a frittata, bread or biscuits. Many of these geophytes were stored in their raw state in great quantities for later cooking and consumption or stored after baking, roasting and/or drying them.

The use of geophytes as part of the regular human diet in California

ABOVE RIGHT: Alferetta and Grapevine Tom, Achomawi, digging the edible, medicinal, and ceremonial tubers of *búlidum'*, (*Lomatium californicum*). A hardwood digging stick was the most common digging implement used up and down California to pry millions of plump, juicy bulbs, corms and tubers from the earth. Photograph by J.P. Harrington, Catalog number JPH-CA-AC-18. Courtesy of the Santa Barbara Museum of Natural History, circa 1931-32. • ABOVE LEFT: A close-up of the tubers of *búlidum'* (*L. californicum*), one of eight lomatiums with edible tubers eaten by California Indian tribes. Others include Wasatch desertparsley (*L. bicolor* var. *leptocarpum*), Canby's lomatium (*L. canbyi*), Gray's lomatium (*L. grayi*), bigseed biscuitroot (*L. macrocarpum*), Nevada biscuitroot (*L. nevadense*), Indian biscuitroot (*L. piperi*), and nineleaf biscuitroot (*L. triternatum*). Photograph by J.P. Harrington, Catalog number JPH-CA-AC-19. Courtesy of the Santa Barbara Museum of Natural History, circa 1931-32. • RIGHT: Edible, dried, peeled taproots of bigseed biscuitroot (*L. macrocarpum*), some of which have been ground into flour. They will be combined with dried huckleberries and pine nut flour to make pinch cakes. Photograph by Heron Brae, 2013.

TOP: **Columbia lily (*Lilium columbianum*) and other lilies have bulb scales which readily separate and scatter in the digging process. The bulbs of this species and at least three other lilies were eaten by California Indian tribes including leopard lily (*L. pardalinum*), alpine lily (*L. parvum*), and Washington lily (*L. washingtonianum*). •** BOTTOM: **The larger bulbs of checker lily (*Fritillaria affinis*) were roasted in ashes or baked in earth ovens, and mashed and made into cakes by various tribes. It has numerous rice-grain bulblets that scatter when dug. At least three other fritillarias were gathered for food: brown bells (*F. micrantha*), yellow fritillary (*F. pudica*), and scarlet fritillary (*F. recurva*). Photographs by Fred Sharpe, 2007.**

is very old. The archeological record shows that geophyte harvesting is at least 10,000 years old on the Channel Islands and that bulbs, corms, and tubers were more or less harvested in most if not all regions of the state during the last several thousand years. This storage organ had its own month in many tribal calendars, denoting a predictable, renewable food source. For example, one of the 12 moons of the Central Pomo year *Putitcda* (our May) meant "edible bulbs ripening." These storage organs also have high nutritional value, containing significant amounts of fiber, and complex carbohydrates.

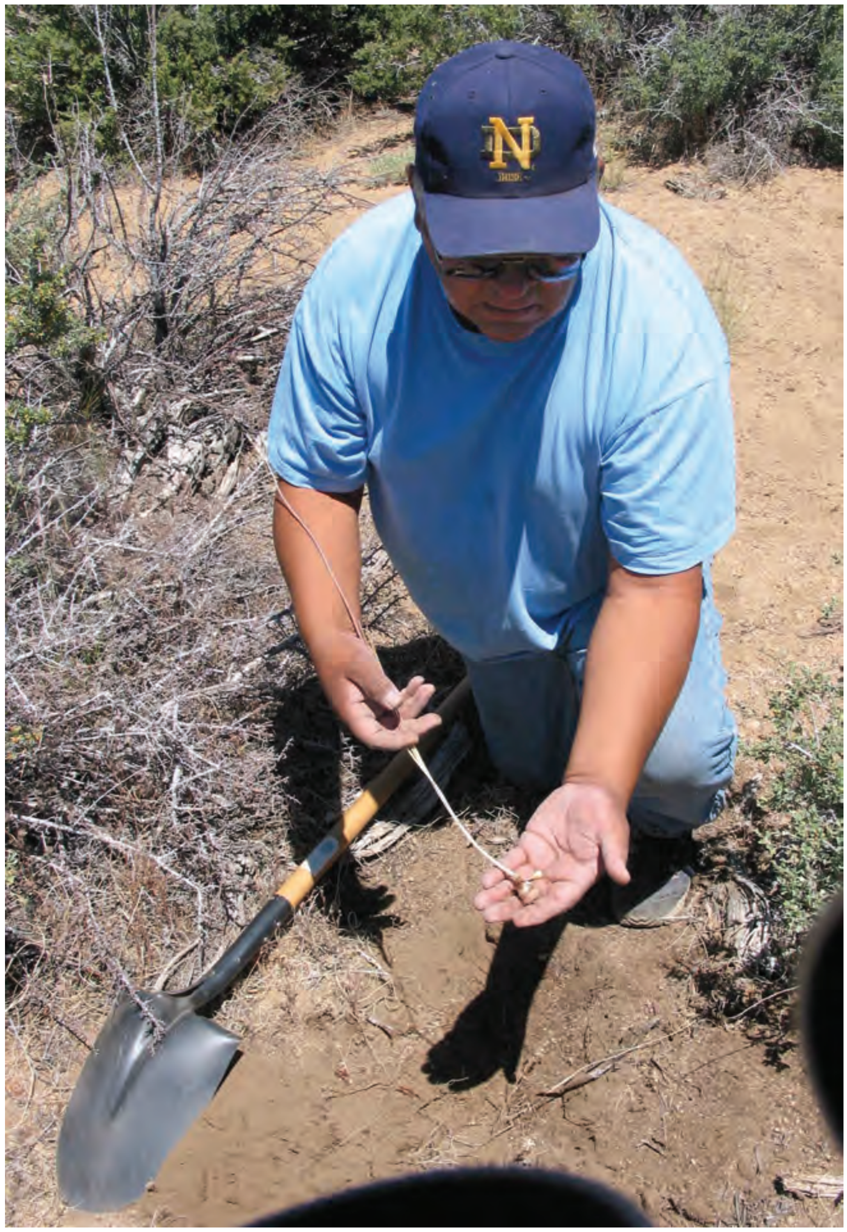
Before the substantial ecological changes brought by European settlement, many of the geophytes of California had all of the attributes of a staple food crop: they were abundant, widespread, storable, intensifiable, and nourishing. As little as 200 years ago, many areas in California were clothed in geophyte flowers during the spring and summer—purple patches of blue dicks, orange swaths of tiger lily, yellow carpets of common goldenstars, and snowy areas of wild carrots. Early reports suggest that wildflowers with storage organs were much more prevalent historically and gathered in prodigious amounts. As will be discussed, the abundance of edible geophyte populations observed in certain areas around the time of contact (circa AD 1840–1850s) may have been due, in part, to human management of the plants and their habitats.

THE HARVEST

Gathering the edible parts of geophytes, hidden below the surface of the soil, required extraction with a digging stick sharpened to a point. While digging time spanned the whole year, May to late October was the peak season. Harvesting different genera of geophytes differed by tribe and area. For example, among the Karuk, of northwestern California, *Brodiaea*, *Calochortus*, *Dichelostemma*, and *Triteleia* were dug in the spring to summer and *Lilium* species in the fall. Traditional gathering sites were visited annually, and areas were specifically owned and maintained by particular families and passed down intergenerationally.

Despite relatively intensive, annual gathering, populations of geophytes remained robust. This was due in part to the gatherers' awareness of harvesting methods and how they affected the plant's regeneration and the overall health of the habitat. Always thinking about the harvest into the future, tribes made sure that the harvest would help increase future yields.

When indigenous people harvested geophytes, they did more than just retrieve the largest storage organs for consumption. They replanted the smaller bulblets, cormlets, tuber fragments, and bulb scales; they tilled the soil to facilitate the growth of the new plants; weeded non-desired plants; and they scattered the seeds contained within the dried seed pods to enhance reproduction. A grassland or coastal prairie subject to this kind of management might not show overt signs of human manipulation, but the valued foods would likely have broader distributions and higher population numbers than would be the case in the absence of any tribal manage-



UPPER LEFT: Blue dicks has dozens of different names in Indian languages and was probably the most widely eaten geophyte in California. The corms are eaten raw, boiled, or roasted in ashes. Photograph by M. Kat Anderson, 1988. • LOWER LEFT: A single blue dicks plant can produce a large number of both corms and cormlets. This and other underground swollen stems were eaten in great quantity and gathered at the same sites year after year by employing harvesting and management strategies designed to benefit populations and ensure their continuation. One of these techniques was to replant the cormlets after digging, while another is described by Mono elder Melba Beecher to ensure re-seeding: "The bulb [*Dichelostemma capitatum*] is harvested in late summer or early fall when the blooms are gone." Photograph by Kat Anderson, 1992. • RIGHT: Ross Stone, Big Pine Paiute, gathering *nahavita*, also known as blue dicks (*D. capitatum*) corms, a favorite traditional Paiute food on the east side of the Sierra Nevada. Photograph by Bill Helmer, 2005. All of the four other *Dichelostemma* spp. were also dug and eaten by California Indian tribes including fork-toothed ookow (*D. congestum*), firecracker flower (*D. ida-maia*), wild hyacinth (*D. multiflorum*), and twining brodiaea (*D. volubile*).

ment. Many tribal harvesters learned from, or emulated the digging-related disturbances of wildlife, such as gophers or bears.

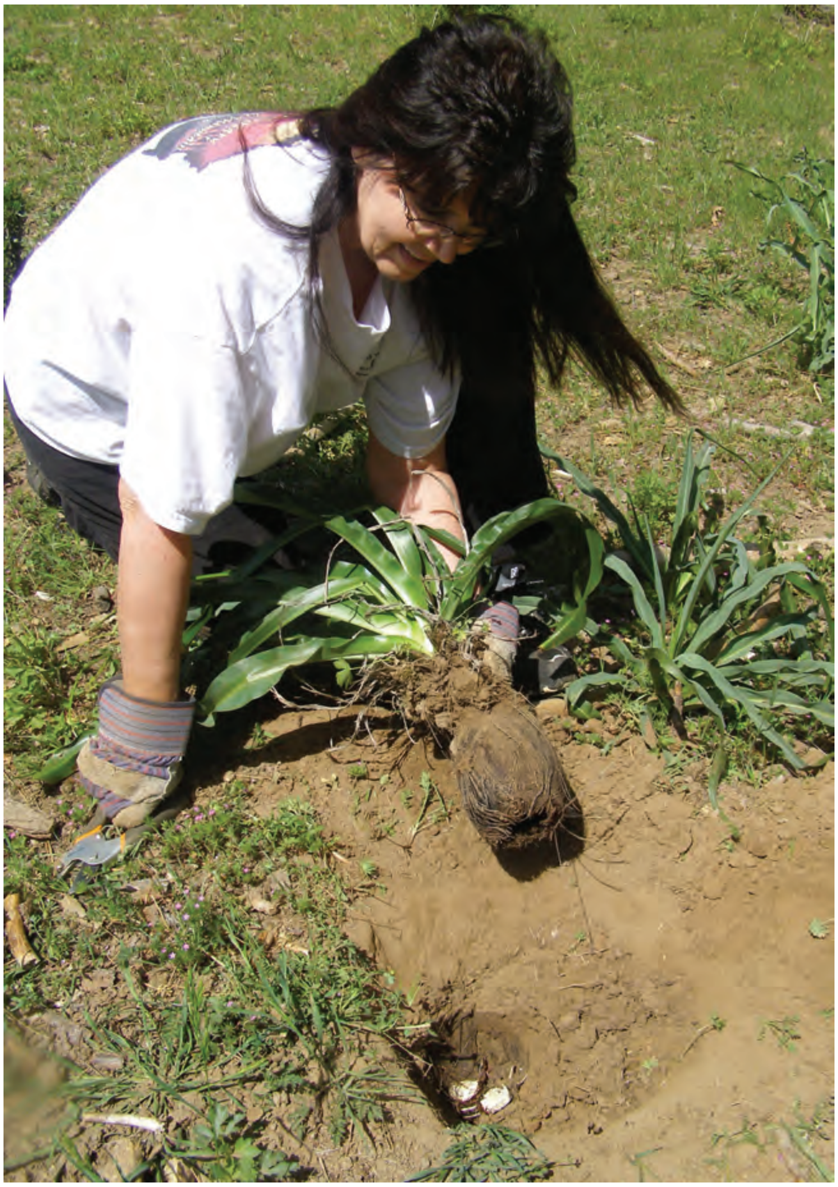
The harvest of geophytes could be coupled closely with propagation because of the nature of their reproductive adaptations. Evolving in environments in which drought, fire, and herbivory were common, geophytes all developed clonal structures—offsets or propagules in the form of scales, bulbils, bulblets, or cormlets—which if severed or otherwise separated from the parent structure could grow into genetically identical plants. With these adaptations, disturbances, especially herbivory, that might threaten the existence of the parent plant were also likely to separate and disperse the propagules—thus ensuring the continuation of the genome. In feasting upon these highly nutritious foods, gophers, voles, moles, bears, deer, or elk would simultaneously be acting as predators and dispersers. Native people who exploited geophytes as food were taking advantage of the pre-existing adaptations that made most geophytes excellent subjects for food intensification strategies.

Aerated and loosened with digging sticks, the soil had a higher moisture-holding capacity and became a better environment for seed germination and propagule growth. Native people also managed plant density, preferentially harvesting the densest patches to keep the plants from getting too clumped and thus maximizing production. Perhaps, most importantly, indigenous people made conscious decisions about what to harvest and what to leave behind, based on accumulated knowledge about the plants' reproduction and adaptive traits. In the case of blue dicks, for example, Leah Harper, Nor-Rel-Muk (pers. comm. 2003) explained how she harvested the largest organs and left in the soil the immature ones: "Grandma told us how to take the big bulb and leave the babies. And put them back in."

Ruby Pomona, North Fork Mono, with the edible *tana* or turkey pea (*Sanicula tuberosa*) dug in open black oak and ponderosa pine stands in Sierra National Forest. According to Ruby (pers. comm. 1989), *tana*, as well as a brodiaea with a purple flower, and wild carrot (*Perideridia* spp.), "came up better after a burn." The small tuber was gathered widely by the Mono, Nisenan, Pomo, Salinan, Sierra Miwuk, and Wailaki and it is still relished today and generally eaten raw. Already by 1932, Salinan consultants, Maria and David Mora, relayed to interviewer John P. Harrington that *tr'ôtêmák* (*Sanicula tuberosa*) is "scarce now." Photograph by M. Kat Anderson, 2006. At least two other sanicles were dug for their edible tubers, sharptooth blacksnakeroot (*S. arguta*) and poison sanicle (*S. bipinnata*).

Human geophyte harvesters could also benefit the plants' sexual reproduction by properly timing the harvest. When dug after seeds had matured, this process could facilitate dispersal of the seeds, which were more likely to find safe germination sites in tilled soil. It was a common practice to take this facilitation a step further by placing broken stems with seed pods into the holes before covering them. Undesirable plants were also weeded out to favor geophytes at many gathering sites—thus reducing competition and increasing site productivity.

Through observation and experimentation, Native Americans in California learned a great deal about the ecological requirements of the edible geophytes. The most important conclusion they came to was that fire was good for many of the "root foods," which included checker lilies, leopard lilies, sanicles, and wild carrots, among others. By burning geophyte habitats, Indians could maintain the sunny environments that most required, eliminate competition, reduce accumulated leaf litter and duff, that could block or hinder their emergence each year, and thus enhance reproduction. The results were manifested at both the individual and population levels: individual plants grew more vigorously, producing larger or more numerous underground storage organs, and populations were enlarged rela-

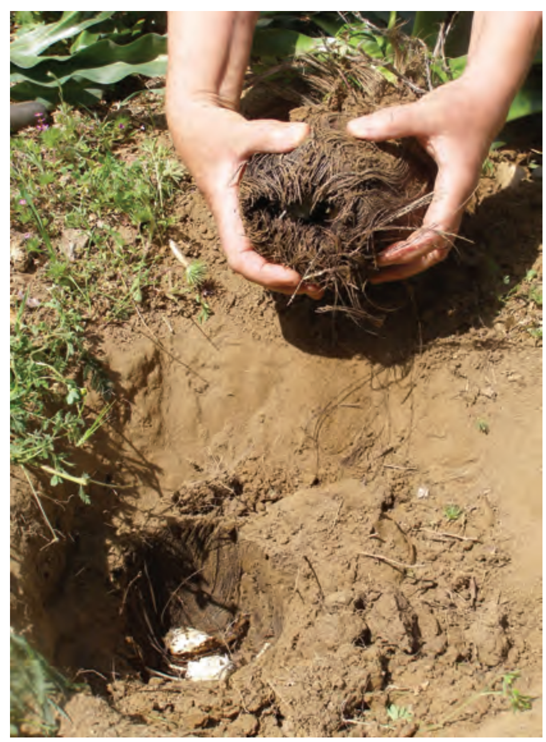


tive to what would have been the case without fire.

In the historical and ethnographic record there are accounts of Indians burning to enhance the geophyte harvest. For example, anthropologist J.W. Duncan equated the Maidu burning of oak areas with motive of fostering more bulbs and greens. Linguist Alice Shepherd (1989:411) recorded for the Wintu: "Where the ground has been burned, wild potatoes grow in bunches and ripen big...They go to find things there." Today Native elders equate productive bulb collection areas with deliberate burning or wildfires.

Because of their underground storage organs, geophytes are well adapted to withstand the effects of fire. Growing deep in soil, the bulbs, corms, and rhizomes are protected and insulated from the heat. Fire benefits geophytes in a number of ways, and are actually dependent on its regular occurrence.

One hypothesis is that for some geophyte species, fire confers its beneficial effects directly to the plants through heat. Their underground storage organs have contractile roots, and thus can pull themselves down deeper in the soil when stimulated by the heat of a fire. When this happens, the scales, bulblets, or cormlets attached to the main "mother" organ are stripped off. While attached, the growth of these clones is suppressed; when separated, they grow into new plants. In this direct way, therefore, fire promotes asexual reproduction and enlargement of population sizes. Geophytes receive



ABOVE: Lois Conner Bohna (North Fork Mono/Chukchansi) sustainably harvesting wavyleaf soap plant (*Chlorogalum pomeridianum*) bulbs, another traditional food, by breaking them off at the root crowns and leaving them behind to grow into new plants. This was also a common practice among various Sierra Miwuk and Yokuts cultural groups. Photograph by M. Kat Anderson, North Fork, 2008. At least three other soap plants were harvested for food including narrowleaf soap plant (*C. angustifolium*), smallflower soap plant (*C. parviflorum*), and Santa Lucia purple amole (*C. purpureum* var. *purpureum*). • RIGHT: Lois Conner Bohna (North Fork Mono/Chukchansi) taking two additional conservation-minded steps. She scattered the seeds into the hole and covered them and the remaining root crowns with additional soil. This North Fork site had been burned the year before. She remarked: "Where it has been burned I find plants that are doubles, triples, and bigger clusters, and the bulbs are huge." Photograph by M. Kat Anderson, 2008.

Tanya Spoonhunter, Dorothy Stewart, Jannah Terrazas, and Margaret Romero of the Big Pine Paiute tribe, displaying *nahavita* (*Dichelostemma capitatum*) corms that they will plant on their reservation in a large community garden plot and for a conservation field trial, October 2005. This effort is an example of diverse tribes bringing back traditional stewardship practices in various parts of California. Photograph by M. Kat Anderson.

most of the benefits of fire indirectly, however, through fire's effects on the environment or habitat in which they live. Thick layers of leaf litter and duff can inhibit or even prevent geophyte growth. The bulbs remain alive in the soil, but the accumulated dead biomass blocks the heat and light that would stimulate growth, and may even act as a physical barrier for sprouting. In overgrown areas, bulbs can sit in the soil bank for decades without growing. After the leaf litter and other biomass covering the soil are eliminated by fire, however, the plants are able to push through the blackened earth.

When fire reduces duff and litter, the sun can warm the soil thoroughly where the warming effect may increase by the light-absorbing black color of the carbon that results from burning. Such warming is necessary for both vegetative growth and flower bud differentiation, and it also provides the sequence of cold–warm–cold temperatures that most edible geophytes in California need for good bulb development. Warmer soil temperatures in the spring promote more flower buds, and this means more dry fruits with seeds that can grow into new plants. Fire's cleansing properties, are therefore, a mechanism which promotes larger and denser geophyte patches.

Fire also impacts geophytes through its effects on the soil. Burning releases a flush of nutrients, but Indian burning may also have changed the soil's texture or physical properties in ways that benefited geophyte growth and/or facilitated harvest by humans. The bi-product of burning woody material results in the production of charcoal or "biochar" that serves to increase soil porosity, nutrient retention and moisture holding capacity in addition to increasing soil texture complexity. Today, the traditional beneficial uses of biochar are being investigated and technologically developed for modern garden and agricultural uses.

Probably the most important effect of fire on geophytes is to maintain (or increase) the size of the areas in which the environmental conditions are suitable for geophyte growth. To a great extent, this means simply eliminating or suppressing the growth of plants that compete with geophytes for light. Most edible geophytes require full or partial exposure to the sun to grow and reproduce properly. The flowering and bulbing of wild onions (*Allium* spp.) and wild lilies (*Lilium* spp.), for example, are greatly affected by how much light they receive. In the lily family, low light intensities usually result in flower abortion. The high light requirements of most geophytes are a primary reason for their occurrence in open habitats. When trees or brush encroach on open lands and create unfavorable shaded conditions, camas (*Camassia* spp.), leopard lily (*Lilium pardalinum*), wild onions, and other geophytes remain as a corm and bulb bank in the soil, their growth suppressed. With fire, plants are released from the shaded environments, and grow and flower vigorously. Flowering greatly benefited insects and other pollinators. Botanist Mark Skinner (pers. comm. 2007) said: "Burning definitely encourages (the growth of) many North American *Lilium* taxa. Some are adapted to frequent fires (*L. pyrophilum, L. iridollae, L. catesbaei*), some proliferate after fires (*L. washingtonianum*). I'm sure it's nutrient availability to some degree, but mostly it's light availability that drives that phenomenon."

CONCLUSIONS

Tribal gathering secured huge quantities of subterranean plant parts by revisiting the same traditional gathering sites. Tribal harvesting and management strategies were designed to benefit populations and ensure their continuation with ecological consequences for species, populations, and plant communities. The Native gathering and management systems have been in place long enough to influence what constituted fitness for evolving geophyte species. Over the last two centuries, there has been a general decline in geophyte populations, and today there are numerous rare and endangered geophyte taxa in California; this decline may be tied not only to habitat loss and fragmentation, but also to the termination of the former indigenous disturbance and management regimes under which the geophytes most recently evolved.

While few indigenous people gather or manage root foods today, this is changing. Tribes are renewing their gathering rights and practices, forming new collaborations with land management entities, setting up ethnobotanical gardens, creating their own land trusts, restoring digging, and returning fire to their reservations, rancherias, and other traditional lands. Many tribes are incorporating food security interests with landscape restoration strategies. An example is thinning of dense trees and shrubs and prescribed burning to meet the dual objectives of hazardous fuels reduction and the re-establishment of edible geophytes aligned with broader tribal resource objectives. These efforts are helping to restore the beauty, bounty, and biodiversity of California landscapes.

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