

# What the Natives Know

## Wild Mushrooms and Forest Health

By Rebecca Templin Richards

**W**hat is often missing from ecosystem management is the knowledge that local people have about their forests. Native American communities in particular may possess exceptionally long oral records of ecosystem components and functions and have strong traditions for using the resource. Native Americans' knowledge of ecological dynamics is often reflected in prescribed ways of digging edible corms and bulbs to increase production, for example, and pruning shrubs to encourage shoots for basketweaving (Blackburn and Anderson 1993).

Determining the relationships between ecological dynamics and Native American cultural practices is especially important for managing the plants that tribes have gathered for generations. Since many species are now commercially collected for the floral, herbal, or culinary markets (Schlosser and Blatner 1994), forest managers need to understand the ecological requirements for sustaining these plants.

**Traditional tribal practices of the Karuk tribe, whose ancestral lands follow the Salmon and Klamath Rivers, included sustainable harvesting of tanoak mushrooms.**

### Western Forest Fungi

The harvesting of forest products for culinary, household, and medicinal purposes by Native American tribes has been documented in pioneer diaries and by anthropologists and ethnobotanists. Despite the vast number of plant species known to have been used by western Native Americans, however, few accounts mention tribal use of wild mushrooms (Tevis 1952; Weber et al. 1992). Many edible species of mushrooms fruit during late fall or early spring, when other wild plant foods—berries, acorns, roots, greens—are not available. Raw mushrooms are rich in niacin and provide some protein and carbohydrates; they are also exceptionally high in such trace minerals as phosphorus and potassium (Watt and Merrill 1963). Nevertheless, in western North America, only a few mushroom species have been documented as an important component of tribal diets (*table 1, p. 7*). The lack of anthropological records may reflect phobias about wild mushrooms (Arora 1991) more than the degree to which tribes actually harvested and used them.

Many edible fungi grow in western North America (USDA-FS 1993). In recent years, these mushrooms have attracted commercial pickers who supply domestic and international markets

(Lipske 1994). The boom may pose risks to forest health, since fungi serve critical ecosystem functions as mycorrhizal associates that extend tree root systems and provide water, nutrients, and other benefits (O'Dell et al. 1992). Ecological concerns over commercial harvesting have not been thoroughly addressed because of the lack of long-term scientific studies on fungus regeneration and forest ecology (USDA-FS 1993). In particular, research has not identified how fruiting is initiated in most species, how the fruiting bodies are distributed in time and space, or what ecological role edible mycorrhizal fungi play in maintaining forest health and productivity (USDA-FS 1993, 1996).

Native American elders' knowledge of fungus fruiting patterns and fluctuations, habitat conditions, and responses to disturbance over many decades may be useful. The objectives of this study were to describe Karuk use of tanoak, or matsutake, mushrooms and indicate how the tribe's knowledge could benefit forest ecosystem management.

### The Tanoak Mushroom

Of the wild mushrooms harvested in the Pacific Northwest, the white or North American matsutake (*Tricholoma magnivelare*), known locally as

the tanoak or pine mushroom, is the most commercially valuable (Schlosser and Blatner 1995). This mushroom is sold to Japan as an acceptable substitute for the Japanese native species, *Tricholoma matsutake*. A traditional food, the Japanese species is a noncultivated native of red pine (*Pinus densiflora*) forests (Hosford et al. unpublished) and is highly prized during its limited season of a few weeks in October, when it commands exorbitant prices (Martin and Martin 1970). As the productivity of Japanese *Tricholoma matsutake* has steadily declined in recent years, demand for the American species has rapidly increased: harvest of American *Tricholoma magnivelare* in Washington jumped from 2,600 pounds in 1989 to 106,327 pounds in 1990 (USDA-FS 1993).

Few ecological studies have been conducted on the North American species (Hosford and Ohara 1994; Hosford et al. unpubl.). Although tanoak mushrooms form mycorrhizae with a wide range of hosts, commercial harvesting has been concentrated in the lodgepole pine (*Pinus contorta*) and red fir (*Abies magnifica*) forest community types in the higher elevations (4,000 to 5,000 feet) of the Cascade Range of Washington and Oregon and the Siskiyou and Klamath Mountains of southern Oregon and northern California. The latter area includes the ancestral land of the Karuk people. Much Karuk ancestral land became part of the Klamath National Forest in 1905 (Davies and Frank 1992). The earliest documentation of Karuk use of tanoak mushrooms dates from the 1939 ethnobotanical field studies of Schenck and Gifford (1952), who reported, "A certain mushroom, found in November, is cooked on coals and eaten."

Among the Karuk, Yurok, and Hupa peoples, *Tricholoma magnivelare* is known as the tanoak mushroom because it is associated with tanoak (*Lithocarpus densiflorus*) hosts. The

Karuk consider the tanoak mushroom—*haiwish* in the Karuk language—an important traditional food. It is undoubtedly the mushroom to which Schenck and Gifford (1952) referred.

Until about 1991 there was little commercial harvesting on Karuk ancestral lands. As commercial pickers arrived in greater numbers, local tribal



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**Commercial demand for edible wild fungi that have symbiotic associations with trees may affect forest health if harvesting depletes the resource. Native Americans' knowledge of the dynamics of the tanoak mushroom (*Tricholoma magnivehre*), a Pacific Northwest fungus, may prove useful to forest managers.**

members complained that their traditional gathering sites, many on Forest Service land, were being overharvested. In early 1993, the Karuk appealed the Klamath National Forest's decision to allow a commercial mushroom season, and forest managers issued no commercial permits for autumn 1993. As part of a study to identify the different resource values assigned to *Tricholoma magnivelare* and the basis for the resource conflict on the Klamath National Forest (Richards and Creasy 1996), I conducted interviews to document Karuk tribal knowledge and use of the mushroom.

### Research Design

Quantitative methodology can obtain responses representative of the population through a random sample

and control for variables through a standard questionnaire, but to obtain and verify detailed explanations for a particular social group, a *qualitative* methodology is needed. Personal interviews were chosen for this study because tribal members had to be selected for their knowledge of tanoak mushrooms. A qualitative design was also appropriate given the lack of information on tribal mushroom harvesting and the consequent lack of hypotheses to test. Qualitative research methodology allows evidence to be collected and other possible explanations to be eliminated during the investigation rather than before (Maxwell 1996).

During November 9-22, 1993, I interviewed Karuk tribal members who were considered knowledgeable about tribal traditions and tanoak mushroom gathering. The tribe numbers fewer than 3,000. Because those who still live on ancestral lands along the Klamath and Salmon Rivers are widely dispersed, the number of people who could be interviewed in the time of the study was limited. Scheduled, semistandardized interviews (e.g., Berg 1995; Marshall and Rossman 1995) were held with 10 Karuk men and women who had grown up on the Karuk ancestral village lands near Happy Camp, Ti Bar, Somesbar, Orleans, and Forks of the Salmon. The five men and five women ranged in age from early 30s to late 80s, and most of them were considered elders.

Interviewees were selected through both purposeful and snowball sampling (Miles and Huberman 1994). Those purposefully selected were tribal elders and younger but culturally knowledgeable tribal members identified by the Karuk Department of Natural Resources. They in turn suggested others, and in many cases, these snowball sample suggestions overlapped with the purposefully selected individuals.

Because of controversy over the Klamath

math National Forest's decision not to issue commercial permits, most tribal members were reticent about being interviewed. I therefore explained the general nature of the questions I would be asking. The interview included questions about host trees, soils, and other environmental conditions supporting tanoak mushrooms. In English, I asked how tanoak mushrooms were gathered, how many mushrooms were commonly harvested, and how mushrooms were used and distributed among tribal members. To enhance validity, I used "member checks": at the end of the interview I asked the person to verify or confirm the descriptions offered by others. These member checks were compared until a regular pattern of harvesting practices and mushroom knowledge was established (Maxwell 1996).

To put people at ease, I did not tape interviews but took notes that I later transcribed, following the semistandardized protocol. I then analyzed these transcripts for the general patterns in commonalities and differences following standard guidelines for qualitative data analysis (Miles and Huberman 1994). I have bracketed species

nomenclature following Arora (1986) for fungi and Hickman (1993) for higher plants.

### Research Findings

The Karuks I interviewed confirmed that they had picked tanoak mushrooms either continually or at regular intervals since childhood. Several of those interviewed were in their 80s and said they had picked tanoak mushrooms every year since childhood.

All 10 tribal members had learned to identify the tanoak mushroom from its distinctive cinnamon-like odor. One woman recalled, "Once I came home with a whole sack of mushrooms and Mom picked through them and threw them all out except one. She could always tell by the smell. She was real good at finding mushrooms." The odor made identification easy, but there were other clues: "It doesn't break like a stick. It is stringy."

The tribal members interviewed were consistent about where tanoak mushrooms fruited. Mushroom habitat was described as ridges, usually facing north, with moist but well-drained soils. One elder summarized this pro-

file: "You look for places where they are buried in red dirt or shale. Someplace where it is not real damp but where it doesn't dry out. They come in after it rains where the soil holds the moisture."

Most said that tanoak mushrooms generally fruited after a warm rain and then a period of clear weather: "They're not in snow, but they need initial rain and then clear weather. With a lot of rain they rot. The season lasts about a month." One woman noted that tanoak mushrooms fruited "in the fall, after a couple of weeks of warm rain. If you have warm rain and warm weather until they start coming up, then you can [harvest in] the same area approximately every five to 10 days." She thought tanoak mushrooms needed a "resting time," and when they weren't fruiting upriver, she often went downriver, "where it is warmer." Several tribal people said they often found tanoak mushrooms after a light snow.

Interviewees noted that specific fungus successional patterns were associated with tanoak mushrooms. One said, "When the grandmas [*Ramaria* sp.] came in, the tanoak mushrooms would fruit a week later. Mom looked

**Table 1. Documented use of wild mushrooms by Native American tribes of western North America.**

Tribe	Scientific name	Common or native name	Use	Reference
Taos Pueblo	<i>Tricholoma populinum</i>	Poplar tricholoma	Food	Arora 1991
Eastern Rockies Blackfeet	<i>Marasmius oreades</i> and <i>Lycoperdon</i> sp.	Fairy ring mushroom and puffballs	Food and medicine	Johnston 1970
Alaska and British Columbia Coast Salish	<i>Agaricus</i> sp. and <i>Tremellodon</i> sp.	Common mushrooms and white jelly fungus	Food	Turner and Bell 1971
Yukon Athabascans	<i>Lactarius deliciosus</i> and <i>Lycoperdon perlatum</i>	Delicious milk caps and puffballs	Food	Holloway and Alexander 1990
Sierra Nevada Miwoks, Yokuts, and Paiutes	<i>Morchella</i> sp. and unknown taxa	Morels and a cup fungus	Food	K. Anderson, pers. commun. 1993
Sierra Nevada Mono	Unknown taxon	Nomi or conk	Food	N. McDougald, pers. commun. 1993
Southern California Coast Chumash	Unknown taxon	Shelf fungus	Food	Timbrook 1990
Central California Costanoan	Unknown taxa	Hongo	Food	Bocek 1984
Northern California Yuki	<i>Pleurotus</i> sp.	Oyster mushroom	Food	Yuki tribal member, pers. commun. 1993
Northern California Hupa and Karuk	<i>Tricholoma magnivelare</i> and <i>Ramaria</i> sp.	Tanoak (matsutake) mushrooms and granny (coral) mushrooms	Food	Hupa and Karuk tribal members, pers. commun. 1993

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Native American plant gatherers  
is a cultural resource for forest  
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biodiversity and forest health.**

for the granny mushrooms first. That would be a sign that the tanoaks would be up.” One tribal member believed *Ramaria* mushrooms were called grandmas or grannies because they were the generation before the tanoak mushrooms.

All noted a wide range of host trees but agreed that tanoak (*Lithocarpus densiflorus*), madrone (*Arbutus menziesii*), and to a lesser extent, chinquapin (*Crysolepis* sp.) were the most common. One elder commented, “We call them tanoak mushrooms since they are always under tanoak, but I’ve found them under firs, black oak, and white oak, but not in abundance.” (Presumably the firs are *Abies* sp. and *Pseudotsuga menziesii*, black oak refers to *Quercus kelloggii*, and white oak refers to *Quercus garryana*.) Two women also found them in rhododendrons (*Rhododendron* sp.). One said she never found them under sugar pines (*Pinus lambertiana*).

Two people had heard the belief that the Karuks ate tanoak mushrooms because deer ate them. One man said, “By the time the deer find them, there aren’t any left to pick.” One woman noted that the mushrooms fruited when “it is too cold for bears. I have never seen signs of bears eating them.” Another woman said, “Bears go further up from where the mushroom grows.” According to several, it was not uncommon for squirrels and other rodents as well as insects to eat the mushrooms.

Several people thought the tanoak mushroom was fruiting less abundantly than in the past, and no one suggested that the mushroom was fruiting more. They said they had not found as many mushrooms as in the past and generally attributed the scarcity to increased harvesting. “I’ve picked since I was a little girl,” said one. “I didn’t have to go far from home up the hill. Now I go to the same places and the same areas and can hardly find any.” Another commented, “We’ve been out and seen areas with signs of raking. We saw commercial

pickers before 1987 but no buyers. I saw people picking the last few years since 1989 by big carloads. We used to pick by the roads because the elders couldn’t walk far. . . . now we have to go further into the woods.” She added, “They aren’t as plentiful as they were before but then the weather is different, too. We’ve had milder winters.” Some people said the tanoak mushroom did not fruit as heavily after severe fires, such as those of 1989.

Several people used to pick tanoak mushrooms while gathering acorns—the main food in the Karuk traditional diet. Others picked tanoak mushrooms after they had gathered acorns because “acorns came before tanoaks.” Some located tanoak mushrooms in this way: “You lie on your side and look up toward the hill. Yes, you get wet but you get wet anyway because you are bending down picking up acorns!” After looking up the slope, they looked for “humps of leaves” or “white spots under the leaves.” Then, “You move the leaves with your hands. If you see a hump, you move the leaves.” Whether a mushroom was there or not, “you put the leaves back.” Several people said tanoak mushrooms grew in a line downslope from a host tree; once they found one mushroom, they would look down the line for more.

Methods of picking tanoak mushrooms varied. Some people broke the mushroom “with a twist.” Others pulled the mushroom out: “You pick it by pulling up from the stem,” and “Most of the time it pulls right out.” One Karuk used a knife and cut the mushroom from its stem.

All the interviewees left the small buttons and often old mushrooms as well. One person said, “We didn’t dig for the ones underground. We left the

older ones and picked the younger ones above the ground, about three to four inches before the cap opens.” Another always left the old mushrooms “to spore out,” and a third picked some of the old mushrooms and “threw them down the hill” to distribute spores.

One person did pick large mushrooms. “My son picked one the size of a plate a few years ago,” she reported. “It was so big we ate the stem for several days!” All interviewees noted the importance of leaving some mushrooms, and all believed, as one put it, “They should come back every year if you pick them right. They always came back where we were picking.”

Most of the Karuks I interviewed made several gathering trips during the tanoak mushroom season. Elders who had lived near their family gathering sites would go out nearly every day, often for recreation, during mushroom season. The amounts that older people had once gathered were considerable. One elder said, “We probably ate 100 pounds in a season. We used to bring gunnysacks half-full home. We’d eat them morning, noon, and night. We canned them once in a while, but with six or seven in the family, we would cook a mess and eat them all. Then we’d go get some more.” One of the oldest people I interviewed said, “We picked in Indian baskets, about two feet in diameter and about one foot deep. That was about one half of a five-gallon bucket. We would pick one basket at a time.” In recent years, they had picked “two onion sacks full when I can [am able]” or “two to three five-gallon buckets in a season, usually a bucket at a time.”

### Lessons from Ethnoecology

The knowledge of Native American mushroom gatherers may help answer critical questions about the role of edible fungi in forest health. Tanoak mushrooms are associated with numerous tree species in a wide range of habitats, and these local ecological adaptations and specific habitat requirements

need to be better understood (Hosford et al. unpubl.).

Long-term documentation of ecological conditions for these mushrooms has been confined to midelevation grand fir (*Abies grandis*) and western hemlock (*Tsuga heterophylla*) sites in the Cascades of central Washington (Hosford and Ohara 1994). Here, the mushrooms are found on gentle slopes or benches, often with a southwest aspect, after relatively warm rain from early September to mid-November. Understory vegetation, generally sparse, includes vine maple (*Acer circinnatum*) and five ericaceous species. Soils at these sites are sandy and well drained with less than 25 percent organic matter (Hosford and Ohara 1994; Hosford et al. unpubl.). Differences in seasonal production are directly related to rainfall and temperature. Fruiting occurs when annual accumulated rainfall reaches 14 centimeters or more and temperatures average above 5° C (Hosford et al. unpubl.).

In the Klamath bioregion, ridges with northern aspects and well-drained "red" or granite soils were the most common habitat reported, and warm, wet late summers followed by early autumns with cold temperatures near freezing and often a light snowfall were the favorable meteorological conditions. Aspect may account for the difference: in the Cascades, summers tend to be cooler and wetter than in the lower-elevation Klamath bioregion, with its hot, dry summers. Since the mushroom requires both warm and wet summer conditions, northern aspects in the Klamath bioregion may be more productive than the southern aspects of the Cascade slopes.

Similarly, a light autumn snow may both insulate the soil and prevent soil desiccation, thereby ensuring more warmth and moisture just before fruiting. Such seasonal requirements may be important environmental indicators for forest managers who need to prepare commercial harvest plans and monitor and enforce mushroom-harvesting requirements without knowing in advance whether a season will be a boom or a bust.

The host trees consistently mentioned by the Karuks were tanoak and madrone, which mycologists generally consider the most common hosts in coastal California (Arora 1986). That some Karuks reported finding tanoak mushrooms under rhododendron is consistent with observations from the Cascades that the fungi also favor ericaceous shrubs, like rhododendron, huckleberry, and manzanita (Arora 1986; Hosford et al. unpubl.).

### Harvesting Patterns

The Karuk people traditionally ate tanoak mushrooms in the late autumn and early winter, when other foods were limited. Their observations of deer eating tanoak mushrooms indicate that they recognized the nutritional value of the mushrooms to wildlife; as some interviewees believed, the observation may have inspired human consumption. Similarly, the fruiting habits of the mushroom were probably carefully observed, and these observations may have shaped Karuk mushroom management practices.

Spores were cast downhill to enhance the fruiting line that many mushroom pickers said occurred naturally (Richards 1995). Spore removal has generally been considered detrimental to sustaining productivity, and in Japan, older matsutake are replanted in the same site to ensure regeneration (Hosford et al. 1994). In the Klamath, replacing the leaf litter may provide the necessary insulation for fruiting of immature "buttons."

All the Karuks I interviewed had gathered the tanoak mushroom since they were children and had been taught common gathering practices. They believed these practices—especially twisting the mushroom so as not to disturb the mycelium and leaving small mushrooms to continue to fruit—sustained the mushroom. Their practices are consistent with those of other Native American tribes in the Sierra Nevada, where other species of wild mushrooms were harvested by Miwoks, Yokuts, and Paiutes: "We used to gather mushrooms under the pines. The dirt would puff up under

pine needles. We'd use a knife to slice it so the root would stay in the ground. Mother said it was important to leave starters for other mushrooms" (Anderson 1993).

Tribal gathering practices may show modern pickers a way to harvest sustainably. Many commercial pickers debate cutting versus twisting, saying that certain species, like chanterelles (*Cantharellus* sp.), benefit from cutting, but others, such as matsutake, produce more from twisting. Since heavy raking and overharvesting by some commercial pickers allegedly destroy the mycelium, prevent regeneration, and curtail future production (Richards 1995; Hosford et al. 1994), forest researchers need to study the effects of cutting versus twisting, leaving old mushrooms and young buttons, and replacing the leaf litter.

### Implications for Management

Although the Karuks whom I interviewed indicated that mushrooms did not fruit abundantly after severe fires, the effects of light fires, timber harvesting, and other disturbances were not reported. Several people recalled the exceptional size of mushrooms they had collected in the past. Their memories are confirmed by an old newspaper article given to me by a tribal member: "Lottie [a Karuk woman] has just completed her mushroom gathering for the year. Each year, she and her sister... pick and can at least 40 quarts of mushrooms. This has been a good year, probably due to the warm August rain which caused rapid growth. These large, flat mushrooms which grow near tanoak, measure up to nine inches in diameter and a large specimen can weigh as much as two pounds" (Chamberlain, date unknown). A recent decline in the abundance or size of the mushrooms might indicate landscape-level changes in disturbance patterns, such as forest management practices and fire regimes, or even global changes, such as climate or atmospheric shifts.

In fact, disturbance regimes have changed considerably in the Klamath bioregion since the arrival of miners in

the 1850s brought an end to traditional Karuk tribal life. Fire suppression has increased in this century, and clearcutting, widely practiced in the 1950s, ended only in the 1970s. That the mushrooms do not abundantly fruit after severe fire may suggest that leaf litter, which may retain moisture at the soil surface as well as insulate it, is important to production. Clearcutting would also remove the forest litter and thus suppress mushroom growth. Both fire and logging remove tall conifers, allowing the host hardwoods to sprout quickly. When fire was suppressed and the logging ended, the hardwoods were succeeded by conifers. More recently, however, because of the lack of selective harvesting of conifers, reverse succession has allowed the hardwood species to dominate many mixed evergreen stands (USDA-FS 1995).

Because the dominant host trees in the Klamath bioregion are tanoak and madrone, forest management practices that select for conifers inhibit mushroom production. Selective timber harvesting of mixed evergreen stands to retain large overstory hardwoods, however, could promote mushroom growth. In particular, thinning practices that foster hardwood crown expansion prevent transpiration loss and ensure sufficient leaf litter to insulate the soil during the hot summers and maintain the host tree nutrient pool.

How tanoak mushrooms respond to methods of harvest, soil compaction, fire regimes, and timber management practices needs additional study. Qualitative research with the Karuks is urgent: since 1993, when my interviews were conducted, one of the oldest Karuk elders has died, and with her has passed not only cultural knowledge but invaluable ecological information as well. The traditional knowledge of Native American plant gatherers is a resource for forest researchers and managers concerned with sustaining biodiversity and forest health through ecosystem management. Increasing public participation opportunities so that Native Americans can contribute their tribes' knowledge of forest species will ensure better adaptive management and more sustainable forests. **UCF**

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