Medicinal Flora of the San Francisco Peaks in Northern Arizona: A Historical Compilation

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The American Southwest has been a hub for ethnobotany and anthropological study for almost one hundred years (Parsons 1924; Robbins 1916; Russell 1908; Stevenson 1915). The combination of unique biological and cultural diversity has made the Southwest a treasure trove for scientific study. This land covers eight distinctive life zones, more than 3,500 species of vascular plants, and is home to 21 Native American tribes (Hogan et al. 2005).

To many of these tribes the San Francisco Peaks, located 16.09 km north of Flagstaff, AZ, are the sacred mountains of the west and hold deep cultural and spiritual significance. Southwest tribes still using the Peaks in a cultural, historical, and religious context include the Hopi, Navajo, Acoma, Apache, Hualapai, Havasupai, Tewa, Yavapai, Zuni, and San Juan Southern Paiute. A central underlying concept to all tribes for which the Peaks are especially important is the recognition that the San Francisco Peaks are a source of water in the form of rain, springs, and snow. They also believe that the Peaks were put there for their people to protect for the benefit of the world (Reid 2001).

Sites such as the San Francisco Peaks contain sacred knowledge and are the source of life. This relationship between the native people and the land is indispensable to their religion, culture, and way of life (Reid 2001). Thus, both brief ethnographic examination (Table 1) and descriptions of unique tribal relationships to the Peaks (Table 2) are essential for a holistic understanding of this continued dependence upon the land.

Study Area

The San Francisco Peaks (hereafter Peaks or SF Peaks) are the remains of a composite volcanic cone of the Plio-Pleistocene to early Pleistocene Age (Péwé and Updike 1972). Situated on the southeastern edge of the Colorado Plateau, the Peaks are the most prominent feature of the San Francisco volcanic field. This field stretches 4,662 km2 and consists of lava flows, cinder cones, and volcanoes formed over the last 8 million years (Péwé and Updike 1972). It is thought that the Peaks formed near the beginning of the Ice Age, almost 2 million years ago, with a series of violent volcanic eruptions that, aided by wind, rain, and ice, built and shaped the six prominent peaks. The original cone is believed to have reached a maximum height of 4,724 m until its collapse between 200,000 and 400,000 years ago (Duncklee 1976). Today the highest remaining peak reaches up to 3850 m.

The United States Department of Agriculture (USDA) Forest Service manages the Peaks and the surrounding Coconino National Forest. Under its supervision, use of this land has included livestock grazing, logging, and mining of cinders and pumice. Today, recreation and tourism are the most prominent land-uses of the Peaks (Grahame and Sisk 2002).

Also included in this study is Mount Elden, discussed separately due to its unique geology and vegetation. Mount Elden (2,834 m) is located just northeast of the city of Flagstaff and about 8.05 km southeast of the San Francisco Peaks.

Life Zones

A variety of life zones are present on the Peaks. The Alpine Tundra vegetation zone is an area approximately 6.5 km2 and is above timberline at elevations exceeding 3,353 m. The Spruce-Fir vegetation zone of the San Francisco Peaks generally lies between 2,750 m to 3,500 m. Mixed Conifer forest (2,440 m to 2,900 m) and the Ponderosa Pine life zone is found at elevations from 1,830 m to 2,440 m, but

may be as low as 1675 m on north-facing slopes or as high as 2,750 m on south-facing slopes (Haney 1985).

The largely south-facing aspect of Mount Elden creates a heat sink that increases diversity of lower elevation plants such as Pinyon-Juniper woodland, while the northern side has vegetation comparable to the San Francisco Peaks at similar elevations.

Threatened and Endangered Plants

There are several threatened, endangered, and sensitive plants found on the San Francisco Peaks. The first is a federally-listed, threatened plant species, the San Francisco Peaks groundsel *(Senecio franciscanus* Greene*) (*Asteraceae*)* (Endangered Species Act 2006). An additional endemic species, the Graceful Buttercup (*Ranunculus inamoenus* Greene *var. subaffinis* (Gray) L. Benson) is considered critically imperiled by the Nature Conservancy. Three Forest Service Sensitive plant species found on the Peaks are Bearded Gentian (*Gentiana barbellata* (Engelman.) Iltis), Rusby's Milkvetch (*Astragalus rusbyi* Greene), and Crenulate Moonwort (*Botrychium crenulatum* W.H. Wagner).

Objectives

This ethnobotanical study was undertaken in order to understand the biological and cultural value of the San Francisco Peaks and to assess the need for conservation of the Peaks as a natural resource. The primary objective was to identify the historically medicinal and ceremonial plants of the Peaks and document their usage by the Native American tribes who find these mountains sacred. The list of medicinal and ceremonial plants were then used in comparative studies to address three questions: 1) whether the proportion of medicinal and ceremonial species mirrors the species richness of the total flora within each life zone present on the San Francisco Peaks; 2) whether the distribution of medicinal plants is significantly different from the distribution of ceremonial plants, and, 3) whether there is more similarity in the uses of plants within historically related tribal clusters or between unrelated but geographically adjacent tribes.

Methods

This study utilized the plant checklist compiled for the *Vascular Flora of the San Francisco Peaks* (Moir 2005). A literature and database search was performed for each species to compile records referencing medicinal or cultural value with respect to the tribes previously discussed. All records from databases were crosschecked with the original literature for accuracy.

Medicinal species within each life zone were compared to the species richness of the total flora within life zones. Distributions of ceremonial and medicinal plants by life zone were calculated with reference to the *Vascular Flora of the San Francisco Peaks* (Deaver Herbarium Staff 2006). Total occurrence values were then calculated, and this sum was then divided by the number of occurrences to provide the mean life zone distribution for each species. These were then used to perform a two-tailed *t*-test to determine if a significant difference was present in the distribution of medicinal and ceremonial plants.

To address the third question, a hierarchical cluster analysis was performed. The first step in this process was to create a similarity index. Cell entries were a measure of similarity (i.e., 0=not shared, 1=shared), with 125 total characters. This index was then run through JMP Version 4.0.4 (SAS Institute 2001), adding linguistic tribal cluster and distributional tribal cluster labels. The Ward method was then utilized, which uses the sum of squared Euclidean distances to calculate the mean of all variables.

Results

Of the over 800 total vascular species documented for the San Francisco Peaks area, 237 species (29.3%) were found to have medicinal or ceremonial significance to the surrounding tribes. These species represent 167 genera across 56 families. Two-thirds of the *vascular plant families of the Peaks flora* were found to have medicinal or ceremonial usages. Three families are found within the ferns, two are found within the conifers, with the remaining 51 families found within the flowering plants. This composition follows the total floristic composition closely (Figure 1).

One critically imperiled plant endemic to the Peaks was found to be used medicinally. In Arizona, the Graceful Buttercup (*Ranunculus inamoenus* Greene *var. subaffinis* (Gray) L. Benson) is found only on the Peaks, requiring an alpine or subalpine environment. Other threatened plants within the medicinal flora include mainly Arizona salvage restricted plants (AZ (SR) such as the Mariposa Lily (*Calochortus gunnisonii* S. Wats.), Torrey's Craglily (*Echeandia flavescens* (J.A. & J.H. Schultes) Cruden),

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Starry False Lily of the Valley (*Maianthemum stellatum* (L.) Link), and Banana Yucca (*Yucca baccata* Nutt.).

Distributional Correlations

An inverse correlation exists between medicinal/ceremonial plants and altitude. The Ponderosa Pine life zone had the largest number of medicinal species (204), followed by Mixed Conifer with 123 medicinal species, Spruce-Fir with 76 medicinal species, and Alpine Tundra with only 13 species.

Of the total vascular flora of the Peaks, the Ponderosa Pine life zone and Mount Elden held the most medicinal plants with 35% and 36% respectively. The Mixed Conifer zone held 29% of the medicinal taxa, while the Spruce-Fir zone contained 27%. The Alpine Tundra zone held only 14% of medicinal species for the entire vascular flora. See Figure 2 for a comparison between the medicinal, total, and unique flora of the San Francisco Peaks distributed by life zone.

Average life zone occurrences were calculated to determine if there was a significant difference between medicinal and ceremonial species distributions. No significant difference was found (p= 0.396635), indicating widespread distributions of both medicinal and ceremonial species throughout all the life zones present on the Peaks.

Seventy-three general medicinal uses were found within this flora. Of these, 1367 applications were identified. These are distributed over the 13 tribes included within this study. The five most utilized medicinal species found in the Ponderosa Pine life zone and above were also determined. These were identified as Western Yarrow (*Achillea millefolium* L. *var. occidentalis* DC.) (38 uses), Oregon Grape (*Mahonia repens* (Lindl.) G. Don) (22 uses), Rocky Mountain Iris (*Iris missouriensis* Nutt.) (13 uses), Mountain Taperleaf (*Pericome caudata* Gray) (12 uses), and Elkweed (*Frasera speciosa* Dougl. ex Griseb.) (11 uses).

Tribal Correlations

Of the 13 tribes considered, the Ramah Navajo were found to not only have the most medicinal plant species, but the most medicinal uses for these species as well. One hundred and seventy two medicinal plant species are documented for this tribe, with 546 different applications. This averages out to approximately 3 different uses for each medicinal plant. This holds true for all other tribes with the exception of the Paiute, who average about 6 different uses for each of their 31 medicinal plants. See Figure 3 for medicinal species and use distributions per tribe.

Ethnobotanical Analysis

The five medicinal species with the most documented uses were cross-culturally examined to compare common uses as well as application methods. See Table 3 for comparative analysis of the five most commonly used medicinal plants in this area.

Hierarchical Cluster Analysis suggests that there may be more similarity among linguistic and distributionally related tribal clusters (Figure 4). Two main clusters are shown in this analysis, a subset of the Athabaskan cluster (NE distribution), and the remaining groups comprised mainly of the Yuman cluster (NW distribution) and a small subset of Uto-Aztecan cluster (NE distribution). The Hopi and Tewa (Uto-Aztecan) subset were found to share 16 medicinal plants and uses, while the Navajo and Ramah Navajo (Athabaskan) subset were found to share 32 plants and uses.

Discussion

The large composition of medicinal and ceremonial plants found on the San Francisco Peaks highlights the importance of this area as a natural and cultural resource. This is especially true when species endemic to the Peaks are considered such as *Ranunculus inamoenus var. subaffinis.* Ceremonially used species such as this cannot be substituted for, and this particular subspecies is considered critically imperiled.

A large number of introduced species with medicinal value correlates with the high number present within the total vascular flora of the San Francisco Peaks (13%). This may be due to increased recreation, as well as mining and thinning on the Peaks, increasing the exposure to exotic species in these disturbed areas. The integration of these exotic species into present-day tribal pharmacopeias demonstrates the continued importance of the Peaks as a medicinal plant gathering ground.

Analysis of medicinal plant distributions according to life zone revealed that the medicinal flora decreased proportionately to the total flora as elevation increased up to the Spruce-Fir life zone (about 30%). As the Alpine

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Tundra life zone was reached, however, that proportion dropped substantially (14%). Mount Elden exhibited the highest medicinal species composition. This is largely due to the unique conditions previously discussed and a higher overall species richness.

Geographic area must also be considered when taking medicinal plant distributions into account. The Ponderosa Pine life zone measures 262 km2, by far the largest area of all the life zones. Mixed conifer is substantially less (85 km2), followed closely by Spruce Fir (51 km2). The Alpine tundra has by far the smallest area with 3 km2. Mount Elden, in its entirety measures closely to that of the Spruce Fir life zone (45 km2). The high level of plant diversity present on the slopes of this small geographic area again highlights its ethnobotanical importance.

The myriad of medicinal uses and applications described in this study indicate extensive tribal knowledge of the San Francisco Peaks flora. Twelve out of the 13 tribes studied had documentation of medicinal plant use from the Peaks, with many tribes using the same plants for the same medicinal purpose. The relatively high number of plant species and their applications by the Ramah Navajo may largely be a function of frequent contact with many different cultures and a transfer of knowledge, as speculated by Vestal (1952), or perhaps as a result of sampling bias in historic research. The exception of the Acoma having no documented medicinal or ceremonial uses is due largely to the lack of available literature on this topic.

The hierarchical cluster analysis appears to support the hypothesis that there is more similarity among some of these linguistically and distributionally related tribal clusters than between unrelated groups. However, the data utilized for this analysis is only a small subset of the total plant use for each tribe and therefore datasets cannot be considered strong.

Cultural interrelations may contribute to similar uses and applications of medicinal species. A long history of trade and interaction exists between these tribes. The Navajo and Apache are part of the Southern Athabaskan group who migrated into the Southwest from the North. Hopi, Tewa, and Paiute are all classified as Uto-Aztecan. The Hualapai, Havasupai, and Yavapai, are also known to share common Yuman ancestry. While the Acoma and Zuni are known as linguistic isolates, they are historically grouped with the Hopi and Tewa as Ancestral Pueblo people.

Present day tribal distribution also plays a major factor in cultural interrelations today. The Yavapai and Apache for example, have had very close contact, living on the same land for generations. The Havasupai and Hualapai once shared the same land and culture as well, and were known as the Walapai. The Tewa live on the first mesa of the Hopi Reservation and have done so for many generations, while Hopi land is surrounded by the Navajo Reservation. These examples indicate interrelationships that have led to a merging and sharing of knowledge over time, and with that the ability to optimally utilize the surrounding flora.

Conclusion

Comparative studies determined that the proportion of species richness of the medicinal flora did, in fact, mirror the species richness of the total flora within each major life zone present on the San Francisco Peaks. This proportion only dropped significantly in the Alpine Tundra. Data suggested that there was more similarity in the uses of plants within some tribal clusters which are linguistically and distributionally related, rather than between unrelated tribes. The compilation of this data should serve as a valuable reference, with respect to the cross-cultural perspective of Native American ethnobotany on the San Francisco Peaks.

With two-thirds of the plant families and close to 30% of the total flora for the San Francisco Peaks having ceremonial or medicinal significance to native tribes, this area is clearly a vital natural resource. The Peaks host exquisitely diverse geology and biology, which are habitat for many threatened, endangered, or sensitive species. With the current management of rare species shifting towards protection of habitats, not individual species, the Peaks should be a top priority for land managers.

The San Francisco Peaks cannot be substituted for in their role as an important traditional cultural property in the Southwest. This land provides an identity for native people by defining a way of life, and its continued development may lead to an erosion of indigenous way of life and culture. The San Francisco Peaks' ethnobotanical, biological, cultural, and religious significance is unparalleled in the Southwest, and as such, deserves the same reverence today that native peoples have shown for thousands of years.

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