Diversity of Ethnobotanicals and Other Herbaceous Plants in Ecological Restoration Areas and Riparian Gradients

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Abstract

Ethnobotanicals are important considerations to restoration because they help indicate the general health and diversity of a specific region. The locations that were used to test this idea for this study were Cibola Arizona on the Cibola National Wildlife Refuge, West Fork Oak Creek Arizona, and Kanab Creek Utah. At these locations, a general plant census was taken to sample the species richness and composition. We found a trend that shows a decrease of introduced species as the age of restored stand increased.

Keywords: ethnobotany, cottonwood, *Populus fremontii*, restoration, succession, canopy cover

Introduction

In the field of restoration ecology one aspect that is not commonly taken into consideration is the species abundance and richness of ethnobotanicals. Villeux and King (2003) describe ethnobotany as "... the study of how people of a particular culture and region make of use of indigenous plants. Ethnobotanists explore how plants are used for such things as food, shelter, medicine, clothing, hunting, and religious ceremonies." Ethnobotanicals are important characteristics to local culture and history. According to Altiere et al (1987) "Preservation of these traditional agriecosystems (i.e. ethno botanicals) can not be achieved when isolated from maintenance of the culture of the local people.

Therefore, projects should also emphasize maintenance of culture diversity." Ethnobotanicals can potentially provide sustainable financial support to the local economy by the development of cottage industries. Sustainable harvesting of ethnobotanicals for commercial use is far less destructive than agribusiness on ecosystems. (Altiere et al, 1987) Plant diversity provided by native habitat (vs. monocultures generally used in agribusiness) allows for a wide range of niches in a habitat throughout trophic levels. Preserving or restoring native habitat also fosters a greater genetic diversity of plants which helps to protect the population against pests and disease. Theses are two of the reasons why plant diversity is an important determining factor of habitat health. (Margalef, 1968, Odum 1969)

The areas in this study were Cibola Arizona; West Fork Oak Creek, Coconino County, Arizona; and Kanab Creek, Utah. In Cibola, we looked at an age gradient in *P. fremontii* restored stands; each stand being three years apart starting at age 1. In these restored stands *Populus fremontii (cottonwood) was* the dominant species and provided many different levels of canopy cover and habitat for various species. In Oak Creek and the Utah location, the forest sites were riparian areas with an unknown age. Our common factor was the riparian zone which allowed us a greater diversity of plants along an ecotonal gradient.

Methods

The sites chosen spanned two southwestern states, Arizona and Utah. The first four sites were in the Cibola National Wildlife Refuge, Arizona, which is located in the flood plains of the Colorado River. Three of those sites were across an age gradient ranging from 1-6 year old cottonwoods. In each of these areas, thirteen random plots were established by measuring along the edge of the stand to find the center. Once the center was found the group entered the stand following a random number generator. One person was designated to pace through the stand. After that person reached the end of the number they would throw a 1-meter square of pvc piping, over their shoulder to establish a plot. Each plot was then divided into a subplot by placing a 1/8-meter square of pvc piping in the center. The subplot was used to determine the characteristics of the overall plot.

The fourth site consisted only of tamarix (*Tamarix pentandra*). This area was chosen because it represents an unrestored riparian area dominated by an invasive species. Thirty random plots were established along a 720 meter transect at the edge of the tamarix stand.

The other two sites were established in natural riparian zones. The first site was in a canyon in West Fork of Oak Creek, Arizona. Since the canyon walls were too narrow, a parallel transect traveled along the river's edge. Thirteen random plots were created along this transect using a random numbers table. The second site was at Kanab Creek, Utah. Due to time constraints, only eight plots were established along a 61.6meter transect; starting at the creek and going perpendicular from the edge.

Many variables were measured within the plots. First we counted all the species, and then the plants were identified using several different dichotomous keys and field guides. If identification was not possible, a specimen was preserved using a plant press for later identification in the lab. For each of the species present in the plot and the sub plot, the percentage of ground cover was estimated. The litter depth, measured in centimeters, was performed in the center of the sub plot. Using a densiometer, a calculation of percent canopy cover was recorded for each plot. Some plants were absent inside our plots, meaning the plant was in the area but never occurred in the random plots. To remedy this, a sample of these were pressed and taken back to be identified in the lab for a census of the area. The same sampling protocol was performed at each study site, except for the positioning of the transect at West Fork.

After returning to the lab, all of the plants were identified and compiled into a species list for plant species inside and outside of the plots at each site. The identified plant species were researched through the University of Michigan's database of Native American Ethnobotany to find out their ethnobotonical uses. The USDA's Plant Database was used to find out if the plants were native to the United States.

Statistical analysis was conducted with three different stats programs. PC-Ord v. 4.3 was used for community analysis of the different species from this we graphed species area curves, along with a MRPP (Multi-response Permutation Procedure). SPSS v. 13. was used for liner regressions. And Microsoft Excel v. 11.2.3 was used to create graphs that displayed the number of ethnobotanicals at each site.

Results

An ordination sorted by location expresses that the first, second, and sixth locations share similar canopy cover, which may mean they share similar understory composition. Other than these three sites, the canopy structure is closely related to the location (Figure 1). Also shown by the ordination is that percent canopy cover is relative to location: this means that the ethnobotanicals that appear to be site specific (baccharis, reed grass, etc…) may be correlated to canopy cover, occurring in these locations due to their respective forest structure. This is essential as it supports the need for conservation of a variety of forest types in order to preserve a diversity of ethnobotanicals.

Although canopy cover may be linked to the restoration of ethnobotanicals, increased canopy cover resulted in a decrease of species richness both in the Cibola sites ($P = 0.000$) as well as across all sites ($P = 0.000$). Refer to Figure 2 and 3. The highest number of ethnobotanicals occurs in the first-year cottonwoods, which reinforces this observation, and is represented in Figure 4.

Related to this result is the finding that introduced species within the Cibola sites decrease along the age gradient, and in turn decrease with increased canopy cover ($P > 0.05$). See Figure 5.

Discussion

Among all of the sites surveyed there was a correlation between canopy cover and diversity in the understory plant communities, specifically, more open areas supported a greater diversity of plants. Our most compelling results, however, came from the Cibola, AZ sites. There we found marked differences in understory plant communities according to the particular stage of restoration in individual sites.

Nearly all of the plant species encountered within the censused plots were of some ethnobotanical significance, the only exception being *Medicago lupulina* (L) in the 3-year-old stand. Ethnobotanicals were categorized into by usage type to analyze how type varied by stand age and understory community. The ethnobotanical plants fell out in a clear pattern with number of species at each site from greatest to fewest being utilitarian, medicinal, and food, respectively. While this finding may not have any direct implications for riparian restoration, it may provide some insight into the resources available to Native American tribes.

As may be expected in an early seral-stage forest, the most recently disturbed site (1-year-old cottonwood stand) supported the most abundant and diverse community of plants. The species in this community were affected by agricultural remnants however, which may have been a somewhat confounding factor. Nevertheless, a disturbed site would still be expected to show higher diversity as a result of pioneer plants and invasive species moving in. This is supported by our results showing that non-native species richness was greatest in the 1-year-old cottonwood stand. Interestingly, the number of non-native species decreased as stand age increased until disappearing altogether in the six-year-old stand.

The successively older stands of cottonwood also supported proportionally fewer total species of understory plants. The tamarisk site, representing an unrestored riparian area dominated by an invasive species, supported no other plant species – though tamarisk species have been used by some Native American tribes and thus were considered ethnobotanicals for the purposes of this study. It is interesting to note that, unlike some other invasive species that simply crowd out and overshadow native plants, tamarisk actually alters the environment to make it unsuitable to less hardy species. Tamarisk transpires large quantities of water and thus can dry out the surrounding soil; it is also salt-tolerant as it can excrete salt from its leaves, when leaves fall the ground soil salinity is increased thus killing off less tolerant plants. This study was only able to address canopy cover as a factor of physical crowding. This has implications for restoration efforts since canopy cover may not be the only limiting factor for native species. Depending on the length of time that an area has been dominated by tamarisk, even when an area has been cleared and replanted with native species soil conditions may remain unsuitable for growth to occur.

Although diversity decreased as stand age increased, the species composition of plant communities found were different in all three stands. This suggests that a patchwork of mixed-aged stands would be the most beneficial from the standpoint of having access to the greatest variety of ethnobotanicals. However, if the goal of restoration was to limit the number of invasive species present, then managing for mature stands would be the more appropriate course of action.

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Figures

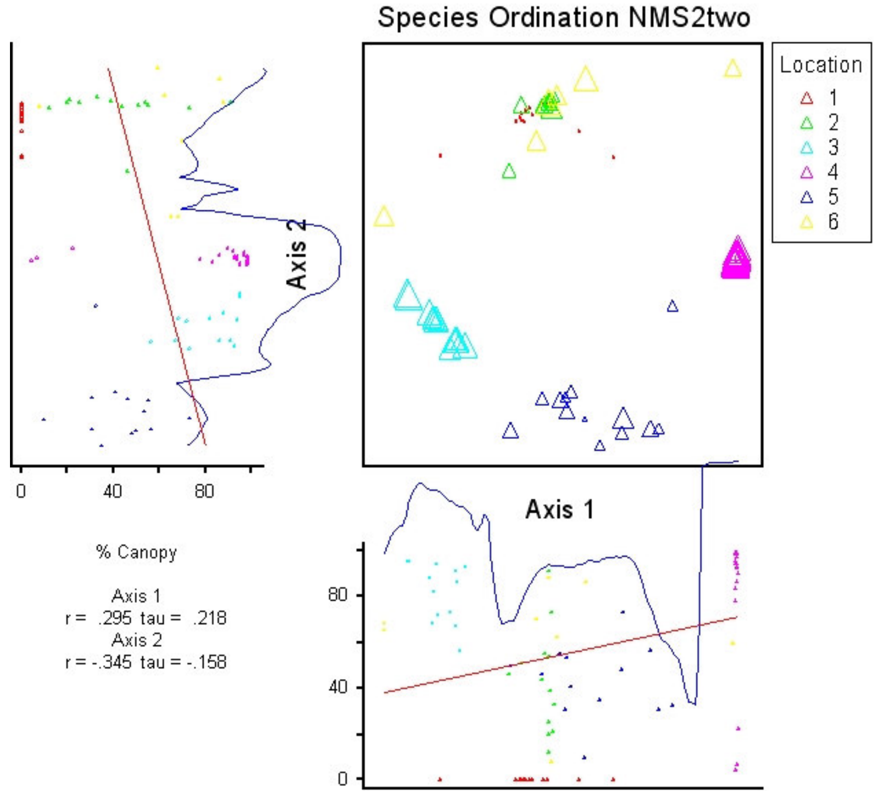

Figure 1. Ordination of understory community composition sorted by location, and corresponding correlations of community composition (axis 1 and 2 separately) with percent canopy cover. Sites 1 (1 year Cibola), 2 (3-year Cibola), and 6 (Virgin R., UT) share similar communities and canopy cover despite a >300 mile distance between them, while other sites have very different communities. Note that even though canopy cover can be similar between site 4 (Cibola tamarisk) and site 3 (Cibola 6-year old stand), the community composition is very different between stands.

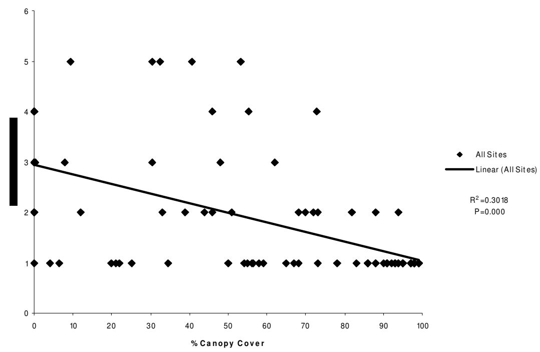

Figure 2. Effects of canopy cover on understory diversity across all sites. As canopy cover increased species richness decreased.

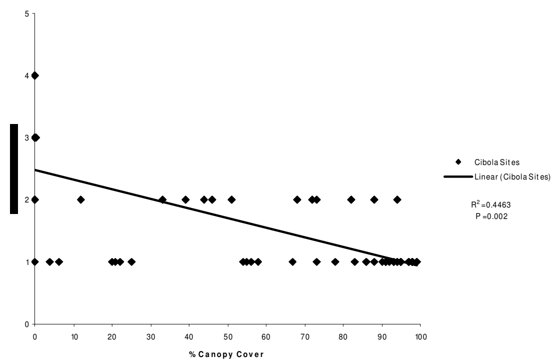

Figure 3. Effects of canopy cover on understory diversity in Cibola sites. Again, an increase in canopy cover results in decreased species richness.

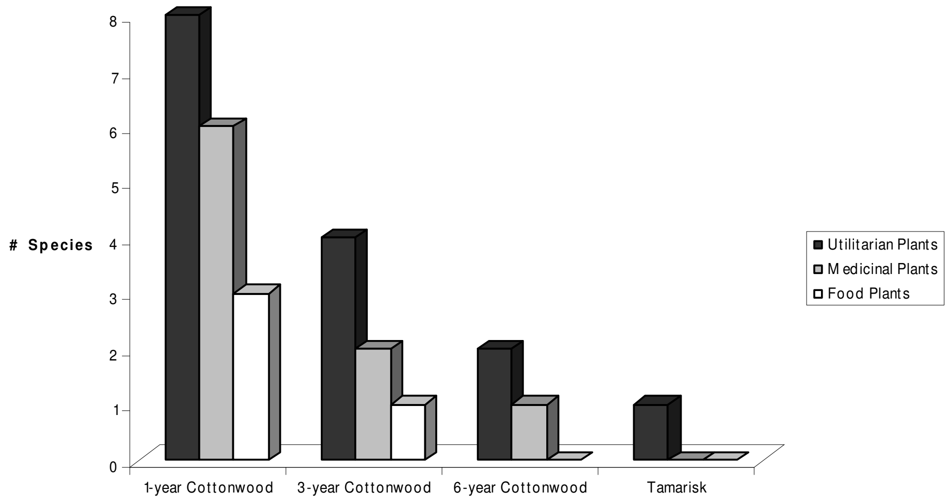

Figure 4. Species richness of ethnobotanicals by usage type. Utilitarian plants have the highest species diversity, food plants have the lowest. Number of species for all usage types decrease along the age gradient.

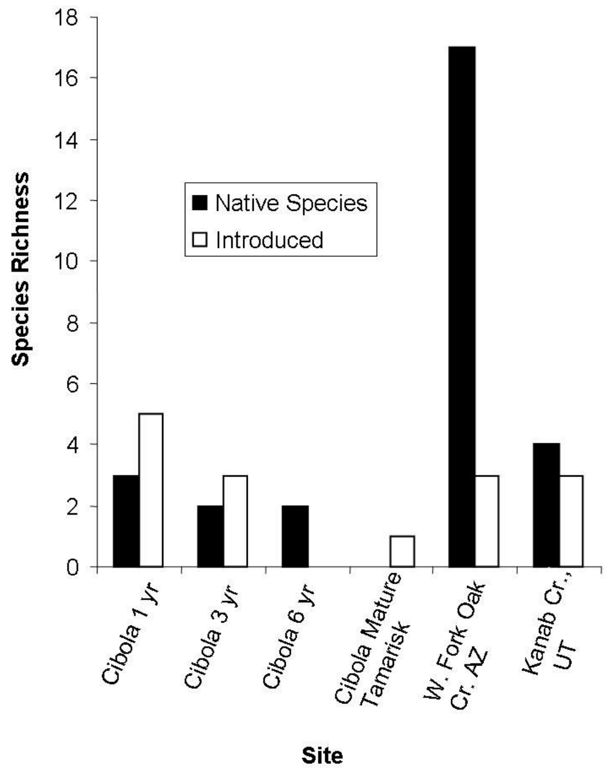

Figure 5. Total number of the native and introduced species by site. Introduced species decrease over the age gradient but have no correlation to the other sites.