Propagating Plant Materials for the Hopi Reservation, Arizona

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Abstract: The USDA Forest Service, USDA Natural Resources Conservation Service (NRCS), and the Hopi Tribe Office of Range Management are collaborating on a plant materials project for Hopi wetland and riparian areas. The objective of the project is to generate seedlings rather than rooted cuttings of native willows, cottonwoods, and aspen to restore and maintain the genetic diversity of the isolated wetland and riparian populations. In addition to their value in ecological restoration, these plants also hold cultural significance to the Hopi Tribe. Plant materials were collected on the Hopi Reservation for propagation and generation of seeds and seedlings at the NRCS Plant Materials Center in Los Lunas, New Mexico. Major species collected include cottonwood (*Populus fremontii* and *P. acuminata*), aspen (*Populus tremuloides*), and willows (*Salix gooddingii, S. exigua,* and *S. lutea*).

Keywords: restoration, culturally significant plants, invasive species, Intertribal Nursery Council, *Salix* spp., *Populus* spp.

Introduction

The Hopi Reservation is 1.6 million ac (650,000 ha) in size, and is located in northeast Arizona (Figure 1). This plant materials project was conceived at the first meeting of the Intertribal Nursery Council in Durango, Colorado in August 2001. Max Taylor and Priscilla Pavatea of the Hopi tribe asked for help in propagating plant materials for riparian and restoration projects on the Reservation. The tribe has been working to eradicate the exotic plants tamarisk (*Tamarix ramosissima* Deneb.) and Russian-olive (*Elaeagnus angustifolia* L.), which have taken over many of the streams and springs on the Reservation. Although these areas only comprise about 2% of the Reservation, they are ecologically and culturally valuable for livestock grazing, wildlife habitat, traditional gathering, and ceremonial use (Lomadafkie 2003).

Because "nature abhors a vacuum," we proposed growing native willows, cottonwoods, and aspen to outplant in the project areas once the exotics have been removed. One of the unique aspects of this restoration project is that, because these species are dioecious, our target plant material will be seedlings, not cuttings, to restore and maintain genetic diversity (Landis and others 2003). Another challenge is that some of the wetland and riparian areas are so isolated on the Hopi Reservation that the some of the existing plant stands are comprised of plants of only one sex (Figure 2A), and sometimes only one individual (Figure 2B). Therefore, our project objective was to produce seedling plant materials that will survive and grow into sustainable plant communities.

The Propagation Plan

The first step in our propagation plan (Table 1) involved identifying and collecting mature male and female hardwood cuttings from riparian and wetlands project areas on the Hopi Reservation (Figure 1). The sex of the cottonwoods was confirmed by dissecting and examining the sexual buds. Because the willow buds were smaller, we made tentative identifications by looking for dried-up flowers or capsules. The cuttings were taken back to the NRCS Los Lunas Plant Materials Center in Los Lunas, New Mexico, where they were rooted. Once established, the rooted cuttings will be forced to flower, cross-pollinate with

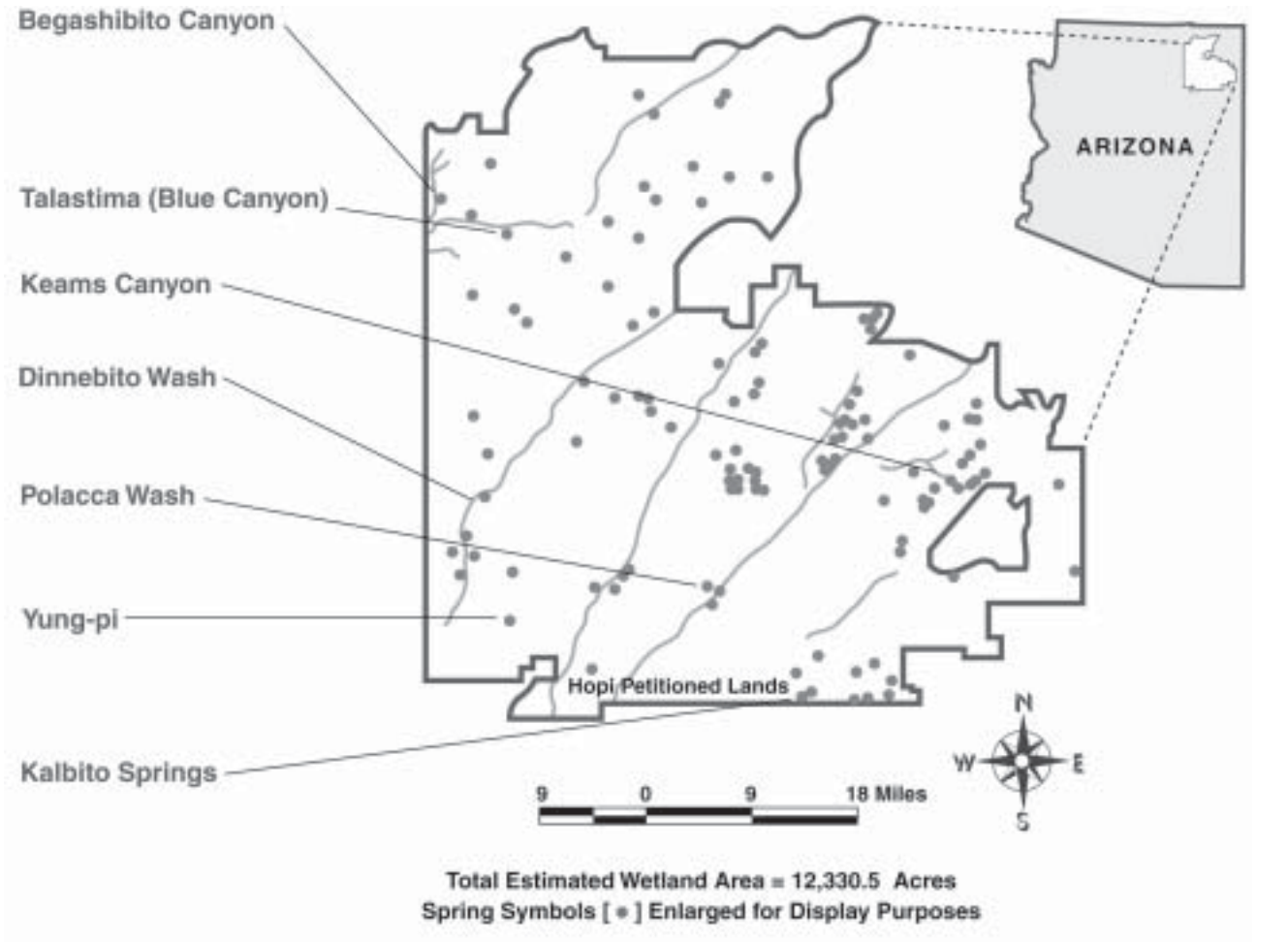

Figure 1—Map of riparian and wetland restoration projects on the Hopi Reservation, Arizona.

plants from different project areas, and produce seeds. These genetically diverse seeds will be collected, processed, and sown to produce seedlings. This entire process of propagating genetically diverse seedlings will take up to 4 years (Table 1). In addition, some of the rooted cuttings of cottonwoods and the tree-type willows will be grown into poles for outplanting on the project site.

Because of their rarity on the Reservation and the fact that stem cuttings will not root, the propagation of quaking aspen (*Populus tremuloides*) presented a special challenge. Therefore, sections of root suckers were collected and taken to Los Lunas where propagation was attempted (Dreesen and others 2002).

During field collections, it was noticed that some stands appeared to all be of the same sex. Therefore, leaves were collected for genetic testing at the USDA Forest Service National Forest Genetic Electrophoresis Laboratory (NFGEL) in Placerville, California.

Collecting Plant Materials

We collected plant materials during 3 separate periods in 2003.

Mid-January 2003

We collected dormant hardwood cuttings of *Populus fremontii* (Fremont cottonwood), *Salix exigua* (coyote willow), *S. gooddingii* (Goodding's willow), and *S. lutea* (yellow willow) in Keams Canyon, Blue Canyon, and Blue Bird Springs (Figure 1). Cuttings were taken from the upper branches with a pole pruner to ensure collection of mature cuttings with floral buds. We identified *Populus* sex by cutting the floral buds with a razor blade and examining them with a hand lens. With magnification, round pistils could be identified in the cross section of the female floral buds. After several plants were sampled, it was determined that there was a trend in floral bud shape to the sex of Fremont cottonwood. The female buds were determined to be smaller and rounder, while the male floral buds were larger and pointed. It was not as easy to decipher the sex in the *Salix* spp.; the buds were too small to make a field determination. Instead, *Salix* sex was determined by the presence of dried leftover flowers from the previous spring. When there was absolutely no indication of sex, random samples were taken from multiple plants in an attempt to capture as many male and female source plants as possible. For both species, individuals were labeled with location,

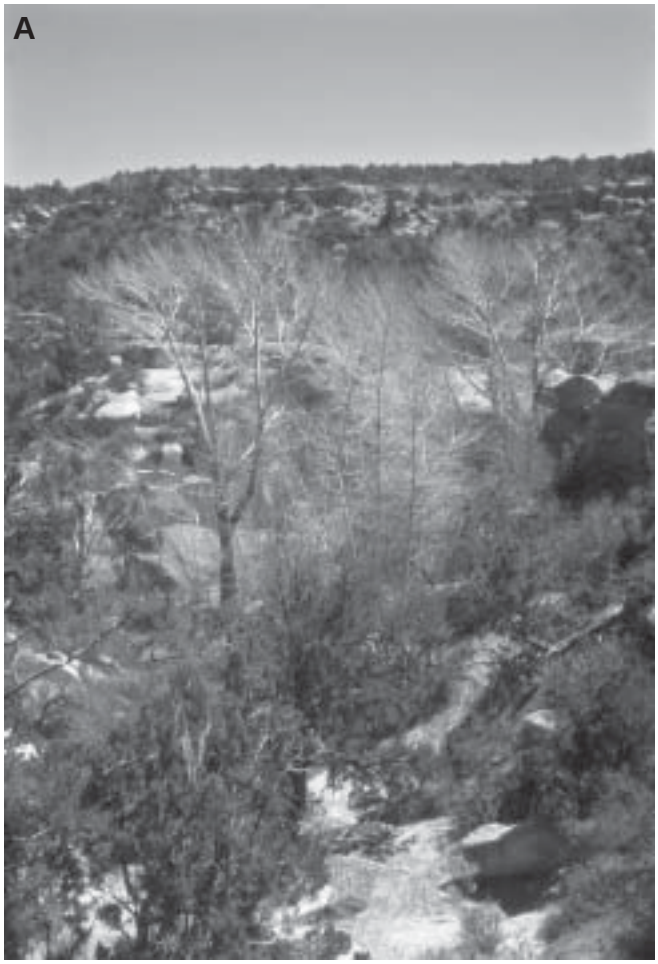

Figure 2—On the Hopi Reservation, many willow, cottonwood and quaking aspen stands are extremely isolated and therefore genetically and sexually limited. A) A stand of lanceleaf cottonwood was found to consist of single clones, all male. B) Max's aspen appears to be a single individual that is severely browsed.

including latitude and longitude, bagged in plastic bags separately, and marked male or female when possible. All plant materials were then taken to the NRCS PMC in Los Lunas for rooting and nursery culture.

Mid-April 2003

We made a second collection of hardwood cuttings in Keams Canyon, Deer Springs, White Ruin Canyon, Lamb Well, Aspen Canyon, and Max's Aspen seep. During this time, we collected *Salix goodingii*, *Populus acuminata* (lanceleaf cottonwood), and *P. tremuloides*. Our procedure was the same as that used in the first collection, except for collection of the aspen. For aspen, shovels, pulaskis, and clippers were used to gather root suckers approximately 2 cm (0.75 in) to 3 cm (1.25 in) in diameter, and 30 to 60 cm (1 to 2 ft) in length. Plant materials were handled, labeled, and transported in the same manner as the first collection.

Table 1—Propagation strategy for collecting and propagating willows, cottonwoods, and aspen on the Hopi Reservation, Arizona.

Propagation plan	Where	When	What
Step 1	Project sites (Figure 1)	Years 1 and 2	1. Identify sex of donor plants 2. Collect mature hardwood cuttings 3. Collect seeds whenever possible
Step 2	Nursery	Years 1 and 2	1. Root cuttings 2. Force flowering and promote pollination 3. Collect and clean seeds
Step 3	Nursery	Years 1 and 2	1. Sow seeds into miniplug containers 2. Grow seedlings large enough to transplant
Step 4	Nursery	Years 1 and 2	1. Transplant miniplug seedlings into large containers 2. Grow to shippable size
Step 5	Project sites	Year 2 and on	Outplant willow, cottonwood, and aspen seedlings of diverse genetic origins and both sexes
Step 6	Project sites	Ongoing	Outplanted stock flowers and pollinates with existing plants to produce genetically diverse seed

Mid-May 2003

A third collection of plant materials was done on the Hopi Reservation at Keams Canyon, Blue Canyon, Blue Bird Springs, Deer Springs, and Aspen Canyon. To increase the genetic diversity in our samples, an additional collection of aspen root sections was made at Washington Pass on the Navajo Reservation with the permission of the Navajo Department of Forestry.

In addition to the branch and root cuttings, we also collected leaf samples for genetic testing of cottonwood and willows because we suspected that some stands could be comprised of a single clone. Leaf sample collection was done according to the NFGEL *General Collection Guide for Vegetative Materials*. Ten random samples of *Populus acuminata* were taken from Deer Springs, 9 random samples of *Salix goodingii* were taken from Blue Canyon, and 10 random samples of *Salix lutea* were taken from Blue Bird Springs. Samples were processed at NFGEL.

Results and Discussion

Willows and Cottonwoods

The cuttings from all collections have been cultured at the Los Lunas Plant Material Center to produce seedlings for Hopi lands restoration plant materials. Seedlings are to be outplanted in the fall and spring after 3 years of culturing (Table 1). Protocols have been developed by NRCS Horticulturist Dave Dreesen for producing seedlings from rooted cuttings and/or seeds (Dreesen 2003). The process involves the collection of dormant cuttings with floral buds from male and female *Salix* species. These cuttings are rooted and forced to flower in the nursery. Flowers are pollinated, and seeds are collected for production of restoration project seedlings. The seedlings are grown and transplanted until the target plant material is reached.

At the end of the first growing season, 5 species of willows and 2 species of cottonwood had been propagated as rooted cuttings (Table 2). Some of these can be outplanted this fall but most will be kept in the nursery so that they can flower and cross-pollinate next spring. The resultant seeds will be collected, processed, and sown immediately to produce genetically and sexually diverse seedlings. Note that 2 new species of willows were identified after the cuttings had rooted and produced leaves. We will have to wait until next spring to identify the sex of these collections.

In the field, all of our collected yellow willow cuttings were female, and all the lanceleaf cottonwood cuttings were male. Not only were they the same sex, but the preliminary results of the genetic testing done at NFGEL confirm our field observations that the lanceleaf cottonwood (Figure 2A) and the yellow willow samples are each from one clone (Hipkins 2003). These tests confirm our initial assumption that the extreme isolation of some of the project sites has resulted in clones that are genetically and sexually identical. We hope to be able to locate other individuals of the opposite sex so that we can cross-pollinate and produce seeds of greater diversity.

Table 2—Rooted cuttings produced in first year at Los Lunas Plant Materials Center, New Mexico.

			Inventory	
Plant species	**Project site**	**Sex of plant**	**Original cuttings (stuck spring 2003)**	**Rooted cuttings available for outplanting (fall 2003)**
Goodding's Willow	Keams Canyon	Male	80	20
Goodding's Willow	Blue Canyon	Male?	214	110
Goodding's Willow	Blue Canyon	Male	266	200
Goodding's X Peachleaf Willow [a]	Keams Canyon	Female	98	70
Coyote Willow	Blue Canyon	Male	61	0
Coyote Willow	Blue Canyon	Male	187	160
Coyote Willow	Blue Canyon	Female	154	135
Coyote Willow	Keams Canyon	Unknown	98	70
Yellow Willow [b]	Bluebird Springs	Female	235	140
Pacific Willow [a]	Keams Canyon	Female	161	110
Fremont Cottonwood	Keams Canyon	Female	38	10
Fremont Cottonwood	Keams Canyon	Male	45	15
Fremont Cottonwood	Keams Canyon	Male	43	10
Fremont Cottonwood	Keams Canyon	Female	67	0
Fremont Cottonwood	Keams Canyon	Female	56	10
Fremont Cottonwood	Blue Canyon	Female	119	30
Fremont Cottonwood	Blue Canyon	Male	52	0
Lanceleaf Cottonwood [b]	Deer Springs	Male	231	120

[a] New species identified after rooting cuttings.
[b] Single sex clones.

Quaking Aspen

Our initial propagation trials with root cuttings of quaking aspen were not successful. This may be due to the timing of the collections. Therefore, we will try to collect root sections earlier in the winter. Aspen catkins were collected in Aspen Canyon on the Hopi Reservation but yielded no viable seeds. This may have been due to the extreme drought. Next spring we will try to collect branches with female catkins before they are open and store them in water in the greenhouse to enhance seed development.

Some viable seeds were collected on the surrounding Navajo Reservation in May 2003 and seedlings were produced at the Navajo Forestry Nursery. These seedlings will be transplanted into 1-gal (4-l) containers and kept in the nursery until their sex can be determined. Hopefully, we will eventually be able to cross-pollinate the Navajo aspen with plants from the Hopi Reservation.

Summary

The goal for restoring riparian sites on the Hopi Reservation is ultimately to create a sustainable plant community. By providing seedlings to these areas, and thereby increasing the genetic diversity, we hope to create a willow and cottonwood ecosystem that will survive and reproduce. The success of this goal is hinged upon planting materials that are suited to riparian conditions, and using locally adapted plant species for the production of future seed sources. With the cooperation of the USDA Natural Resources Conservation Service, the USDA Forest Service, the Navajo Department of Forestry, and the Hopi Tribe, the first steps will be taken to restore genetically diverse communities to critical riparian sites.

Acknowledgments

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