

**Final Project Report
NRPP Intermountain Region
Natural Resource Management Fund**

**Ecological Restoration of Schmutz and Cottonwood Springs,
Grand Canyon National Park, Arizona
FY2001-02**

This will serve as the final completion report for the Restoration of Schmutz and Cottonwood Springs in Grand Canyon National Park. The project was funded during fiscal years 2001 and 2002.

Project Description

Grand Canyon National Park Science Center received funds from the Intermountain Region Natural Resource Fund to restore two degraded springs on the north rim of Grand Canyon National Park, Schmutz and Cottonwood. Spring and riparian areas provide an essential source of water and habitat for many plant and animal species. The majority of the native desert riparian areas in the southwest have been significantly modified or eliminated. Altered springs located in national parks provide a good opportunity for the restoration of critical ecosystem processes and habitats. These two springs, located on the north rim, in the western part of Grand Canyon National Park have been polluted by cattle over the past 30 years. The impacts include loss of vegetation and organic matter, soil compaction and loss, water pollution, destruction of cryptobiotic soils, encroachment of non-native plant species, and loss of wildlife habitat. The majority of the feral cattle have been removed from the proposed project area; however, without active restoration, these important desert environments would remain in a severely degraded state and may not recover to an acceptable condition.

Project Progress

In August 2001, a 2-day interdisciplinary site visit was conducted to survey both natural and cultural resources at Schmutz and Cottonwood springs and to determine the scope of work necessary for restoration. Two revegetation staff, an archaeologist and a wilderness ranger, all Grand Canyon National Park employees, participated in this visit.

As stated in the project description, the ground and vegetation have very obviously been degraded by cattle at both Schmutz and Cottonwood springs. However, soil compaction is most prevalent directly around Schmutz spring. The disturbance has allowed several non-native plant species to move into these areas, including cheatgrass and mullein. Plant lists of both native and non-native species at each spring were compiled as baseline information. Unknown plant species were collected, pressed and later identified. General site photos were also taken at each site to document the disturbance (these photos were submitted with the FY2001 progress report).

Several historic artifacts and rock walls are located in the immediate vicinity of Schmutz Spring, none of which will be disturbed in the restoration efforts. The archaeologist on site sketched and

documented the findings. No archaeological artifacts or sites have been found at Cottonwood Spring.

Park wildlife staff visited these sites in June 2001 and installed a camera at Schmutz spring. A complete wildlife inventory has been started for both springs (submitted with FY2001 project report).

A safety report was completed for this project in May 2001 and the compliance document was started. It was determined that the scope of the project would fall under a Categorical Exclusion (CE). The CE was completed in September 2001.

The first volunteer work trip happened in September 2001. The Grand Canyon Field Institute provided 7 volunteers for a 5-day work trip, September 25-29, 2001. Transects and photopoints were installed at each spring with this group. The data from these transects will be analyzed to determine baseline native plant densities and will quantify disturbance. At Schmutz Spring, the volunteers clipped and bagged 27 mullein seed heads to limit future populations.

In June 2002 three revegetation staff revisited both Schmutz and Cottonwood spring. The crew mapped exotic plant species at each spring, clipped and bagged 32 mullein seedheads at Schmutz Spring and completed transect and photopoint installation at Cottonwood spring. Due to the remote location of Cottonwood, time has been limited and a spike camp is recommended for future work trips.

Finally, in September 2002 revegetation staff backpacked into Cottonwood Spring and removed 695 tamarisk of varying sizes. Depending of the size and root system, the tamarisk plants were either manually removed or cut and treated with Garlon 4 herbicide. The herbicide when used was applied with small sprayer and the stream was aimed directly onto the cambium of the plant to prevent spilling. The crew reread transects, retook photopoints after removal and also completed a tamarisk survey downstream of Cottonwood's riparian plant community. The following day, the crew worked at Schmutz Spring removing 45 large mullein plants and 85 immature mullein rosettes. The area was seeded using native seed that had been collected in June 2002. Again, the crew reread transects and retook photopoints. To ensure project success, the site will need to be visited and monitored on an annual basis at minimum. The soil holds many of these mullein seeds at Schmutz that will most definitely germinate next spring.

Whereas Cottonwood's tamarisk seed source down canyon will be disbursing seed again into the lush riparian area.

Mapping

The areas of disturbance have been measured and will be plotted on a topographic map. However, due to the topography at both springs, it is difficult to receive accurate GPS readings. Mapping with the GPS unit will be attempted again during the next visit. UTM (Universal Transmercator) coordinates were taken with the GPS for transects and photopoints when possible.

All non-native plant species were mapped at both springs using a GPS unit to determine densities of each species. The data collected will be sent to the Southwest Exotic Mapping Project (SWEMP) for compilation into a regional database.

Schmutz Spring

<i>Common Name</i>	<i>Species Name</i>	<i>Area</i>	<i>Percent cover</i>	<i>Density (per m²)</i>
Cheatgrass	<i>Bromus tectorum</i>	.1-1 acres	5-25%	75/m ²
Mullein	<i>Verbascum thapsus</i>	.1-1 acres	5-25%	3/ m ²
Red Brome	<i>Bromus rubens</i>	.1-1 acres	1-5%	55/ m ²

Cottonwood Spring

<i>Common Name</i>	<i>Species Name</i>	<i>Area</i>	<i>Percent cover</i>	<i>Density (per m²)</i>
Cheatgrass	<i>Bromus tectorum</i>	1-5 acres	5-25%	30/ m ²
Red Brome	<i>Bromus rubens</i>	.1-1 acres	<1%	3/ m ²
Bermuda Grass	<i>Cynodon dactylon</i>	.1-1 acres	<1%	20/m ²
Tamarisk	<i>Tamarix ramosissimi</i>	.1-1 acres	<1%	6/m ²

Vegetation Sampling

One band transect was installed above Schmutz Spring to determine native plant densities. Two line transects were also installed at Schmutz in disturbed areas near the spring. At Cottonwood Spring, only one line transect was installed due to weather and hiking time. Two to four additional line transects will be installed during the next visit.

Two additional line transects were installed at Cottonwood Spring in June 2002. Each of the three transects have very different vegetation types based on location to the spring. Transect #3 hit the highest number of various non-native plants including tamarisk, cheat grass and red brome.

In addition to transect installation, plant lists for each spring were compiled and are located in the Data Collection section of this document (p. 5). The entire drainage at Schmutz Spring was surveyed and the list denotes where each species is located in relation to the spring. Due to the magnitude of Cottonwood drainage, the plant survey started 25 meters above the spring and ended at the terminal of the riparian area. However, since the tamarisk likely started downstream of the spring and spread up to the spring, the drainage was surveyed for tamarisk populations approximately 1 mile down the canyon where there is a steep drop-off and no safe way to continue. To ensure eradication of tamarisk at Cottonwood Spring, the downstream plants will also need to be mapped and removed in the future.

of tamarisk plants found below Cottonwood Spring:

seedlings	110
saplings	135
mature	37

Wildlife Inventory

The wildlife staff has started an inventory, please refer to the wildlife trip report/update enclosed.

Another small mammal and bat survey is scheduled for October 2002.

Seed Collection

Native plant seed will be collected in the spring and summer of 2002. All needed seeds had dropped prior to the initial site visit in August.

In June 2002 native seed was collected at Schmutz Spring to seed after non-native plant removal completion. Based on the native plant densities at Cottonwood Spring, it was determined that seeding of native plants would not be necessary for this project.

Plant Propagation

Based on the current native plant densities, it was determined that no propagation would be necessary. In the two years working on the project, significant native plant growth has been observed at Schmutz Spring in particular.

Site Planning

Using the transects and plant inventory, replanting densities will be determined for each spring. The non-native plants, when feasible, will be removed and native seed will be broadcast again in native densities.

After visiting the springs, a site plan was developed for each:

Schmutz Spring is a compact riparian area. The majority of the spring water remains in a pool set back in the side of the drainage. Some of the water trickles out and supports a riparian plant community of sedges, brickellbush and sacred datura. The non-native mullein, cheatgrass and red brome have also thrived here at the spring. To aid in the spring's restoration, a plan to remove mullein and seed the ground disturbance with native seed was developed. Unfortunately, the cheat grass, red brome and pepper grass are wide spread throughout this area and removal of these plants was not included in the site plan.

Cottonwood Spring is a much larger riparian area that's length is approximately 400 meters. The disturbance here is mainly the encroachment of tamarisk, with some cheat grass, red brome and bermuda grass interspersed. Again, due to the prolific nature of these grasses, their removal was not included in the scope of work for this project.

Partnerships

The Grand Canyon Field Institute (GCFI) was our first, very successful partner in this project. All participants expressed their appreciation for the project and the opportunity to help to restore these remote and precious resources.

Volunteer hours donated: 182 hours

To ensure project success, the GCFI has committed to another visit to these springs in October 2003. At that time, we will follow-up on tamarisk and mullein removal and continue to monitor these sites.

Deliverables

All information gathered to date on this project is available. The final report will be disseminated to interested parties.

Summary

This funding opportunity has allowed the park to initiate this important riparian restoration project. The data collected through this funding source is displayed in the pages to follow. A significant amount of tamarisk and mullein has been eradicated at the two springs and a long-term monitoring program has been installed. Volunteer groups have been integral to completing this work and will continue to be utilized in the future. As two very unique springs and extremely fragile plant communities, the park is committed to continuing this project. Park staff will need to seek additional funding to continue this project and make it even more of a success.

Data Collection

As stated in the vegetation sampling section, long-term monitoring will be used to determine the project success. Five permanent line transects were installed to measure vegetation cover and change over time. Using the point-intercept method, a point was read every 0.25 meters for the 25-meter transect length. A total of 100 hits were recorded for each transect. A 2-meter long, 1-centimeter in diameter pole was used as the point; vegetation or ground cover of any kind was recorded up to the 2-meter height of the pole. With this technique it is important to understand that it is possible to have greater than 100% cover when all the species are added together since there are often more than one hit at any one point along the transect line. The following general categories and their attributes were used in data collection:

- Litter - Dead vegetation smaller than 2cm in diameter - primarily leaf litter or dead annual grasses and forbs.
- Rock - Larger than a football, boulders or bedrock.
- Bare Ground - No vegetation on the ground or up to 2 m.
- Brush - Dead vegetation larger than 2cm in diameter.
- Soil Crust - Microbiotic soil layers.

GPS readings were taken at the start and end point of each transect when possible. When GPS could not be used because of steep canyon walls or weather, photos were taken to triangulate back to the start and end points and in some cases, a metal spike was placed into the ground and labeled. Photographs were taken from the start and end points of each transect, as well as reference photos to return to the exact location. Transect locations were selectively chosen at random to incorporate the type of disturbance necessary to track the success of the project. Especially, in such a small riparian area as Schmutz Spring, it was important to hit some of the non-native plants. The eradication of these species will determine the project's success and must be monitored. In addition to the transect photos, 22 permanent photopoints were installed (7 at Schmutz and 15 at Cottonwood).

Tables 1 and 2 below (*Plant Species List for Schmutz Spring* and *Plant Species List for Cottonwood Spring*) lists all of the plant species in the area. This table provides baseline data for each spring and its surrounding area, and is a reference for the transect tables. Common names are used in the transect data in the appendices, whereas the following tables provide common, scientific and family names for each species. There were 7 unknown grasses, 1 unknown forb and 1 unknown mustard encountered.

Table 1 - Plant Species List for Schmutz Spring

Common Name	Species	Family Name	Location
Apache Plume	<i>Fallugia paradoxa</i>	Rosaceae	below spring
Banana Yucca	<i>Yucca baccata</i>	Agavaceae	above and below spring
Beargrass	<i>Nolina microcarpa</i>	Agavaceae	above spring
Blazing Star	<i>Mentzelia</i> sp.	Loasaceae	above spring
Broom Snakeweed	<i>Gutierrezia sarothrae</i>	Asteraceae	at, above and below
Buffalo Berry	<i>Shepherdia rotundifolia</i>	Elaeagnaceae	below spring
Catclaw Acacia	<i>Acacia greggii</i>	Leguminosae	at, above and below
Cheatgrass	<i>Bromus tectorum</i>	Poaceae	non-native; at and below

Desert Saltgrass	<i>Distichlis spicata</i>	Poeceae	at and below spring
Desert Trumpet	<i>Eriogonum inflatum</i>	Polygonaceae	below spring
Flat Top Buckwheat	<i>Eriogonum plumatella</i>	Polygonaceae	above spring
Globemallow	<i>Sphaeralcea</i> sp.	Malvaceae	above and below spring
Indian Rice Grass	<i>Oryzopsis hymenoides</i>	Poeceae	above and below spring
Lemonade Berry	<i>Rhus aromatica</i>	Anacardiaceae	below spring
Long-leaf Brickellbush	<i>Brickellia longifolia</i>	Asteraceae	at and above spring
Maidenhair Fern	<i>Adiantum capillus-veneris</i>	Adiantaceae	at spring only
Mormon Tea	<i>Ephedra viridis</i>	Ephedraceae	below spring
Mullein	<i>Verbascum thapsus</i>	Scrophulariaceae	non-native; at and below
Needlegrass	<i>Stipa</i> sp.	Poeceae	above and below spring
Peppergrass	<i>Lepidium virginicum</i>	Cruciferae	non-native; at, above and below
Prickly Pear	<i>Opuntia</i> sp.	Cactaceae	above and below spring
Purple Aster	<i>Machaeranthera</i> sp.	Asteraceae	at and below spring
Rabbitbrush	<i>Chrysothamnus nauseosus</i>	Asteraceae	above and below spring
Red Brome	<i>Bromus rubens</i>	Poeceae	non-native; at, above and below
Sacred Datura	<i>Datura meteloides</i>	Solanaceae	at and below spring
Sand Dropseed	<i>Sporobolus cryptandrus</i>	Poeceae	above and below spring
Sedge	<i>Carex</i> sp.	Cyperaceae	at and below spring
Shrub Live Oak	<i>Quercus turbinella</i>	Fagaceae	below spring
Sideoats Grama	<i>Bouteloua curtipendula</i>	Poeceae	above and below spring
Tumble Mustard	<i>Sisymbrium altissimum</i>	Cruciferae	non-native; at and below
Unknown legume		Leguminosae	at and below spring

Compiled by Rachel Stanton, Lori Makarick 8/26/01

Table 2 - Plant Species List for Cottonwood Spring

Common Name	Species Name	Family Name	Location/comments
Bushy Beardgrass	<i>Andropogon glomeratus</i>	Poeceae	*
Arizona Three Awn	<i>Aristida arizonica</i>	Poeceae	
Sagebrush	<i>Artemisia</i> sp.	Asteraceae	
Seep Willow	<i>Baccharis salicifolia</i>	Asteraceae	
Red Brome	<i>Bromus rubens</i>	Poeceae	non-native
Cheatgrass	<i>Bromus tectorum</i>	Poeceae	non-native
Long-leaved Paintbrush	<i>Castilleja linariaefolia</i>	Scrophulariaceae	
Bermuda Grass	<i>Cynodon dactylon</i>	Poeceae	
Desert Saltgrass	<i>Distichlis spicata</i>	Poeceae	
Broom Snakeweed	<i>Gutierrezia sarothrae</i>	Asteraceae	in side drainage to spring
Prickly Pear	<i>Opuntia</i> sp.	Cactaceae	in side drainage to spring
Utah Beardtongue	<i>Penstemon utahensis</i>	Scrophulariaceae	in side drainage to spring
Fremont Cottonwood	<i>Populus fremontii</i>	Salicaceae	
Skunkbush	<i>Rhus trilobata</i>	Anacardiaceae	
Goodings Willow	<i>Salix gooddingii</i>	Salicaceae	
Sedge	<i>Scirpus americanus</i> or <i>Eleocharis</i> sp.	Cyperaceae	no positive ID
Tamarisk	<i>Tamarix ramosissima</i>	Tamaricaceae	non-native
Turpentine Broom	<i>Thamnosmos montana</i>	Rutaceae	
Cattail	<i>Typha</i> sp.	Typhaceae	

Compiled by Beth Eisenberg, Rachel Stanton, Kate Watters 6/20/02

* unless otherwise noted, all species are found in the riparian area of Cottonwood Spring

Appendices are as follows:

Appendix A – *Transect Data for Schmutz and Cottonwood Spring Restoration* - the complete data set. In Appendix A, the total percentage for each of the categories and for each individual plant species is recorded. Additional information including the end point GPS readings and general descriptions of the location are included for each transect.

Appendix B – *Transect Data Summary – First and second transect readings* in two separate tables, respectively. The tables compare the transect data for all locations and readings.

Appendix C – *Transect Data Summary – Comparison of average % of intercepts* to compare the first and second readings and project success.

Appendix A -- Transect Data for Schmutz and Cottonwood Spring Restoration

Location: Schmutz Spring

Date Transect Installed:

Transect Name: Schmutz 1

Start Point:

Northing no satellites available

Easting

Bearing: 276°

End Point:

Northing

Easting

	1 st reading 9/26/01	2 nd reading 9/20/02
Organic Litter	20	42
Rock	12	8
Bare Ground	4	6
Cow pie	2	0
Seep Willow	4	0
Long-leaf Brickellbush	0	6
Cheatgrass	5	8
grass, unknown 6	3	4
grass, unknown 8	3	6
legume, unknown	9	8
Mullein	2	0
Rabbitbrush	4	4
Sacred Datura	3	3
Desert Saltgrass	13	20
Snakeweed	10	6

General Description: Transect start point is marked with a metal spike and tag. It is located directly across from the source of the spring, up against the rock cove. This is below and just up-canyon from the man-made rock wall across from the spring. ** Note that this transect is only 15 m long and ends at the spring.

Location: Schmutz Spring

Date Transect Installed:

Transect Name: Schmutz 2

Start Point:

Northing no satellites available

Easting

Bearing: 200°

End Point:

Northing

Easting

	1 st reading 9/26/01	2 nd reading 9/20/02
Organic Litter	16	22
Rock	19	12
Bare Ground	15	20
Brush	5	3
Cow pie	2	0
Seep Willow	0	0
grass, unknown 5	1	0
legume, unknown	0	0
Mullein	4	0
Rabbitbrush	2	2

Sacred Datura	0	0
Desert Saltgrass	17	20
Snakeweed	2	4

General Description: Transect start point is the same stake as Schmutz Transect #1, but #2 runs almost perpendicular to #1. The end point is also staked.

Location: Cottonwood Spring

Date Transect Installed:

Transect Name: Cottonwood 1

Start Point:

Northing 327793.5

Easting 4022297.6

Bearing: 60°

End Point:

Northing

Easting

	1 st reading 9/28/01	2 nd reading 9/19/02
Organic Litter	92	84
Rock	10	12
Bermuda grass	9	12
Cattail	2	1
Cottonwood	24	26
forb, unknown	1	0
Paintbrush	9	6
Desert Saltgrass	37	40
Sedge	66	75

General Description: Transect start point is just up the drainage from the spring source. Starting from last large Cottonwood up drainage before leaving the riparian area.

Location: Cottonwood Spring

Date Transect Installed:

Transect Name: Cottonwood 2

Start Point:

Northing 3276120.0

Easting 4021465.0

Bearing: 192°

End Point:

Northing 327855.0

Easting 4022254.0

	1 st reading 6/20/02	2 nd reading 9/19/02
Organic Litter	42	36
Rock	21	18
Bare Ground	9	12
Soil Crust	2	0
Brush	2	5
Water	15	20
Cow Pie	1	0
aster shrub, unk	1	0
Seep Willow	1	3
Cottonwood	2	2
Dropseed	1	0
grass, unknown 3	2	1

Red Brome	1	2
Desert Saltgrass	20	18
Sedge	28	25
Snakeweed	3	5
Three Awn	1	0

General Description: Transect start point is where spring canyon meets the main drainage. The start point is on the downstream side of the drainage and cuts perpendicular to Cottonwood Canyon. The transect spans across the canyon through a patch of penstemmon.

Location: Cottonwood Spring

Date Transect Installed:

Transect Name: Cottonwood 3

Start Point:

Northing 328104.0

Easting 4022268.0

Bearing: 244°

End Point:

Northing 328079.0

Easting 4022267.0

	1 st reading 6/20/02	2 nd reading 9/19/02
Organic Litter	65	72
Bare Ground	14	10
Brush	1	6
Cow Pie	1	0
Seep Willow	7	6
Cheatgrass	3	7
Cottonwood	13	10
Dragonsage	2	2
grass, unknown 5	1	2
mustard, unknown	1	0
Red Brome	20	16
Desert Saltgrass	18	21
Snakeweed	2	5
Tamarisk	4	0

General Description: Transect start point is at the lowest end of riparian vegetation (excluding tamarisk) approximately 20 meters below last Cottonwood. Transect starts from pointy end of large grey rock on north side of drainage.

Appendix B

**Transect Data Summary - First transect reading
Schmutz Spring Transect #**

	S-1	S-2	Schmutz Average %
Organic Litter	20	16	18.00
Rock	12	19	15.50
Bare Ground	4	15	9.50
Brush		5	5.00
Cow pie	2	2	2.00
Baccharis	4		4.00
Brickellia		23	23.00
Cheatgrass	5		5.00
grass, unknown 5		1	1.00
grass, unknown 6	3		3.00
grass, unknown 8	3		3.00
legume, unknown	9		9.00
Mullein	2	4	3.00
Rabbitbrush	4	2	3.00
Red brome		13	13.00
Sacred datura	3		3.00
Salt grass	13	17	15.00
Snakeweed	10	2	6.00
Total Hits	94	119	

**Transect Data Summary - Second transect reading
Schmutz Spring Transect #**

	S-1	S-2	Schmutz Average %
Organic Litter	42	22	32.00
Rock	8	12	10.00
Bare Ground	6	20	13.00
Brush		3	3.00
Cow pie	0	0	0.00
Baccharis	0		0.00
Brickellia		30	30.00
Cheatgrass	8		8.00
grass, unknown 5		0	0.00
grass, unknown 6	4		4.00
grass, unknown 8	6		6.00
legume, unknown	8		8.00
Mullein	0	0	0.00
Rabbitbrush	4	2	3.00
Red brome		11	11.00
Sacred datura	3		3.00
Salt grass	20	20	20.00
Snakeweed	6	4	5.00
Total Hits	115	124	

**Transect Data Summary - First transect reading
Cottonwood Spring Transect #**

	C-1	C-2	C-3	Average %
Organic Litter	92	42	65	66.33
Rock	10	21		15.50
Bare Ground		9	14	11.50
Soil crust		2		2.00
Brush		2	1	1.50
Water		15		15.00
Cow pie		1	1	1.00
aster shrub, unk		1		1.00
Seep Willow		1	7	4.00
Bermuda grass	9			9.00
Cattail	2			2.00
Cheatgrass			3	3.00
Cottonwood	24	2	13	13.00
Dragonsage			2	2.00
Dropseed		1		1.00
forb, unknown	1			1.00
grass, unknown 3		2		2.00
grass, unknown 5			1	1.00
mustard, unknown			1	1.00
Paintbrush	9			9.00
Red brome		1	20	10.50
Salt grass	37	20	18	25.00
Sedge	66	28		47.00
Snakeweed		3	2	2.50
Tamarisk			4	4.00
Three awn		1		1.00
Total Hits	250	151	152	

**Transect Data Summary - Second transect reading
Cottonwood Spring Transect #**

	C-1	C-2	C-3	Average %
Organic Litter	84	36	72	64.00
Rock	12	18		15.00
Bare Ground		12	10	11.00
Soil crust		0		0.00
Brush		5	6	5.50
Water		20		20.00
Cow pie		0	0	0.00
aster shrub, unk		0		0.00
Seep Willow		3	6	4.50
Bermuda grass	12			12.00
Cattail	1			1.00
Cheatgrass			7	7.00
Cottonwood	26	2	10	12.67
Dragonsage			2	2.00
Dropseed		0		0.00
forb, unknown	0			0.00
grass, unknown 3		1		1.00
grass, unknown 5			2	2.00
mustard, unknown			0	0.00
Paintbrush	6			6.00
Red brome		2	16	9.00
Salt grass	40	18	21	26.33
Sedge	67	25		46.00
Snakeweed		5	5	5.00
Tamarisk			0	0.00
Three awn		0		0.00
Total Hits	248	147	157	

Appendix C

Table 2 - Transect Data Summary – 1st transect reading

	Schmutz 1	Schmutz 2	Average	Cottonwood 1	Cottonwood 2	Cottonwood 3	Average
Total Vegetation	56	62	59	148	59	71	65
Rock & Bare Ground	16	34	25	10	45	14	29.5
Brush	0	5	2.5	0	2	1	1.5
Litter	22	18	20	92	45	66	55.5
Non-native species and cow pies	7	17	12	9	1	28	14.5
Mullein only	2	4	3	0	0	0	0
Tamarisk only	0	0	0	0	0	4	4
Total Hits	94	119	106.5	250	151	152	151.5
Percent Composition of Non-natives of Total Vegetation and broken out separately as Mullein or Tamarisk	12.50% Mullein 3.57%	27.42% Mullein 6.45%	19.96% Mullein 5.08%	6.08% Tamarisk 0	1.69% Tamarisk 0	39.44% Tamarisk 5.63%	20.57% Tamarisk 1.88%
Percent Composition of Non-natives of Total Transect Hits and broken out separately as Mullein or Tamarisk	7.45% Mullein 2.13%	14.29% Mullein 1.68%	10.87% Mullein 2.82%	3.60% Tamarisk 0	.66% Tamarisk 0	18.42% Tamarisk 2.63%	9.54% Tamarisk .88%

At Schmutz Spring it is difficult to capture the area of disturbance in point intercept transects because of the small riparian area. In such a fragile system any non-native plant competition can severely disturb the community, plants, animals and even water availability. In the first reading at Schmutz the percentage of non-native plants in this community is 19.96 of the total vegetation.

Cottonwood Spring has various vegetation types throughout its riparian area. The percent of non-natives varies from 1.69% to 39.44%. In general, the disturbance at this spring is minimal compared to that of Schmutz. It is interesting to note that the transects show Cottonwood to have a higher average of non-native plants when compared to the total vegetation and lower average when compared to the total transect hits.

Table 3 - Transect Data Summary – 2nd transect reading

	Schmutz 1	Schmutz 2	Average %	Cottonwood 1	Cottonwood 2	Cottonwood 3	Average %
Total Vegetation	59	67	63	152	56	69	62.5
Rock & Bare Ground	14	32	23	12	50	10	30
Brush	0	3	1.5	0	5	6	5.5
Litter	42	22	32	84	36	72	54
Non-native species	8	11	9.5	12	2	23	12.5
Mullein	0	0	0	0	0	0	0
Tamarisk	0	0	0	0	0	0	0
Total Hits	115	124	119.5	248	147	157	152
Percent Composition of Non-natives of Total Vegetation and broken out separately as Mullein or Tamarisk	13.56% Mullein 0%	16.42% Mullein 0%	14.99% Mullein 0%	7.89% Tamarisk 0%	3.57% Tamarisk 0%	33.33% Tamarisk 0%	18.45% Tamarisk 0%
Percent Composition of Non-natives of Total Transect Hits and broken out separately as Mullein or Tamarisk	6.96% Mullein 0%	8.87% Mullein 0%	7.91% Mullein 0%	4.84% Tamarisk 0%	1.36% Tamarisk 0%	14.65% Tamarisk 0%	8.01% Tamarisk 0%

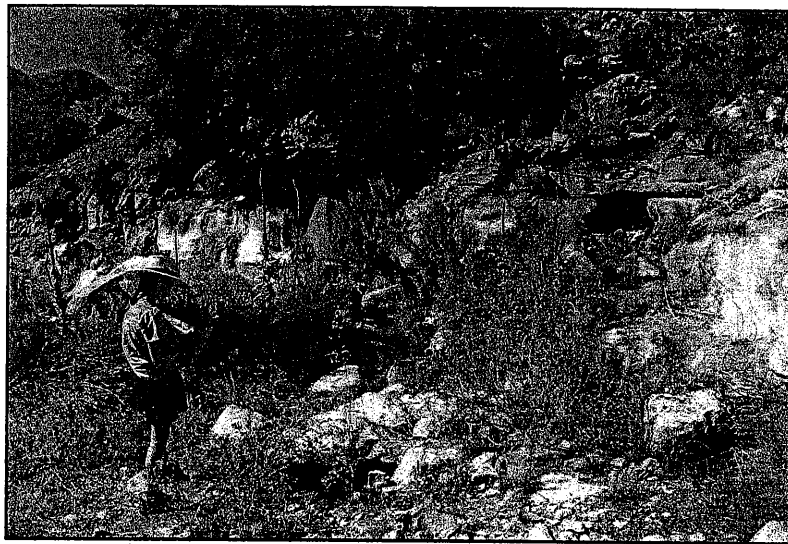
The second reading of these transects shows a decrease in the percent composition of non-native plants at both Schmutz and Cottonwood springs. For overall non-native species, we see a 25% decrease at Schmutz spring and an 11% decrease at Cottonwood. If cheatgrass, red brome and peppergrass were not included, the success would be 100% at this time. Since the project was recently completed and the transects reread, there seems to be no tamarisk or mullein remaining at either spring. The project plan was completed successfully and the area will continue being monitored for regrowth of priority non-native plant species.

Appendix C

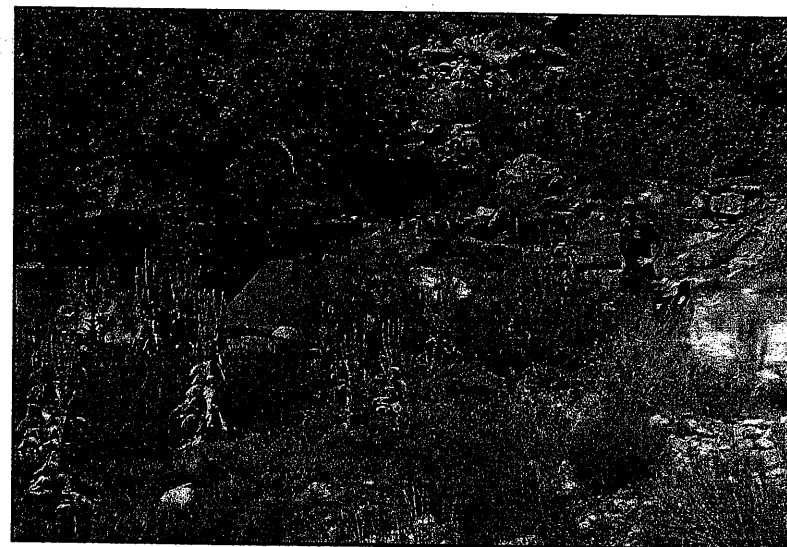
Transect Data Summary – Comparison of average % of item hit

Schmutz transects	AVERAGE %	
	1st transect reading	2nd transect reading
Organic Litter	18.00	32.00
Rock	15.50	10.00
Bare Ground	9.50	13.00
Brush	5.00	3.00
Cow Pie	2.00	0
Seep Willow	4.00	0
Long-leaf Brickellbush	23.00	30.00
Cheat Grass	5.00	8.00
grass, unk 5	1.00	0
grass, unk 6	3.00	4.00
grass, unk 8	3.00	4.00
legume, unk	9.00	8.00
Mullein	3.00	0
Rabbitbrush	3.00	3.00
Red Brome	13.00	11.00
Sacred Datura	3.00	3.00
Desert Saltgrass	15.00	20.00
Snakeweed	6.00	5.00

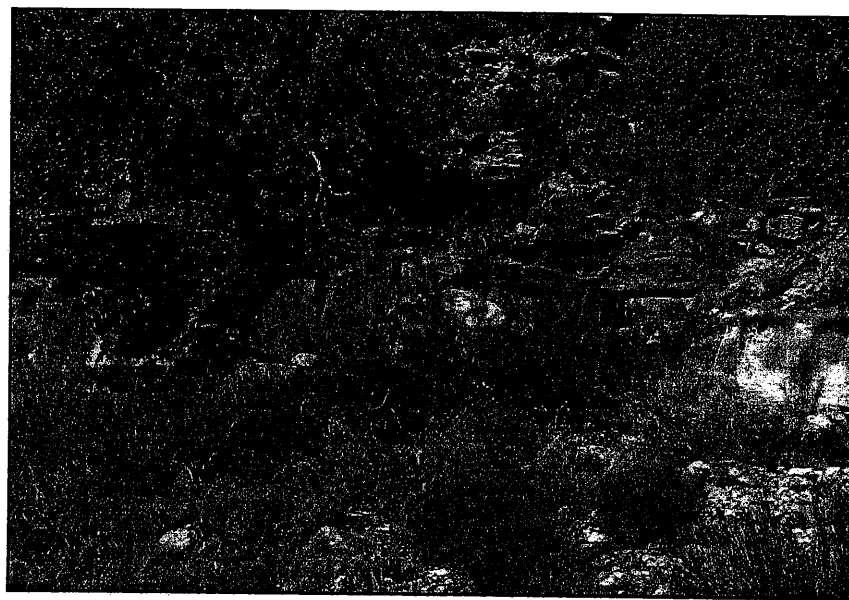
Cottonwood transects	AVERAGE %	
	1st transect reading	2nd transect reading
Organic Litter	66.33	64.00
Rock	15.50	15.00
Bare Ground	11.50	11.00
Soil Crust	2.00	0
Brush	1.50	5.50
Cow Pie	0	0.14
aster shrub, unk	1.00	0
Seep Willow	4.00	4.50
Bermuda Grass	9.00	12.00
Cattail	2.00	1.00
Cheat Grass	3.00	7.00
Cottonwood	13.00	12.67
Dragonsage	2.00	2.00
Dropseed	1.00	0
forb, unk	1.00	0
grass, unk 3	2.00	1.00
grass, unk 5	1.00	2.00
mustard, unk	1.00	0
Paintbrush	9.00	6.00
Red Brome	10.50	9.00
Desert Saltgrass	25.00	26.33
Sedge	47.00	46.00
Snakeweed	2.50	5.00
Tamarisk	4.00	0
Three Awn	1.00	0



View of Schmutz Spring – September 2001



View of Schmutz Spring – September 2002 before mullein removal



View of Schmutz Spring – September 2002 after mullein removal



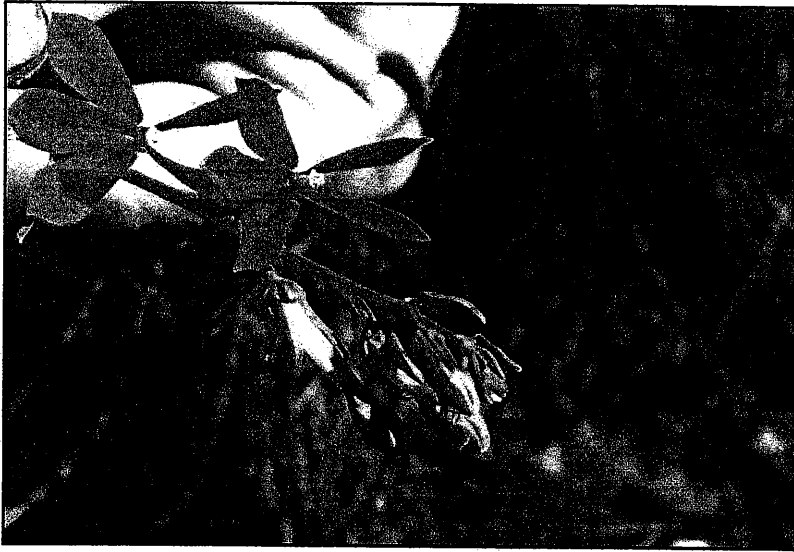
Volunteer takes a bearing with her compass to install a photopoint at Schmutz Spring



View downstream of Schmutz Spring – more mullein!



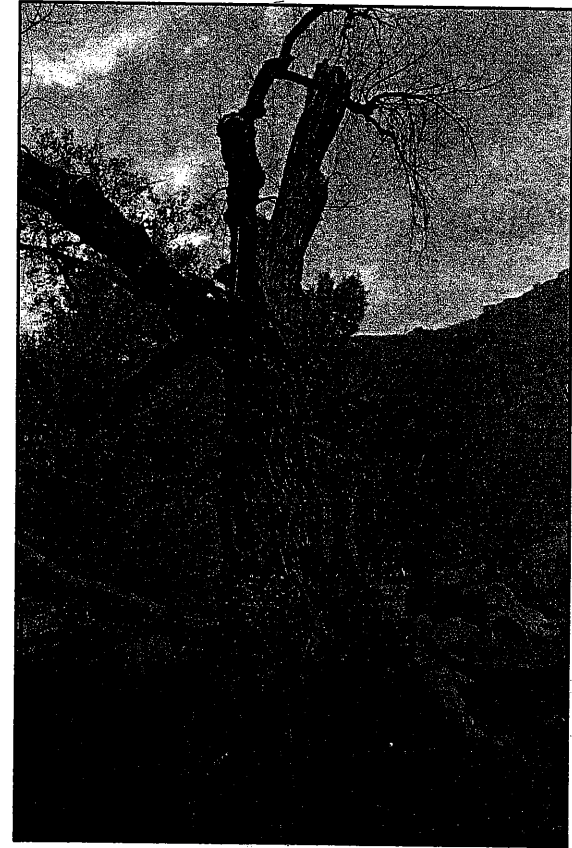
Revegetation crew member manually removes mullein at Schmutz Spring



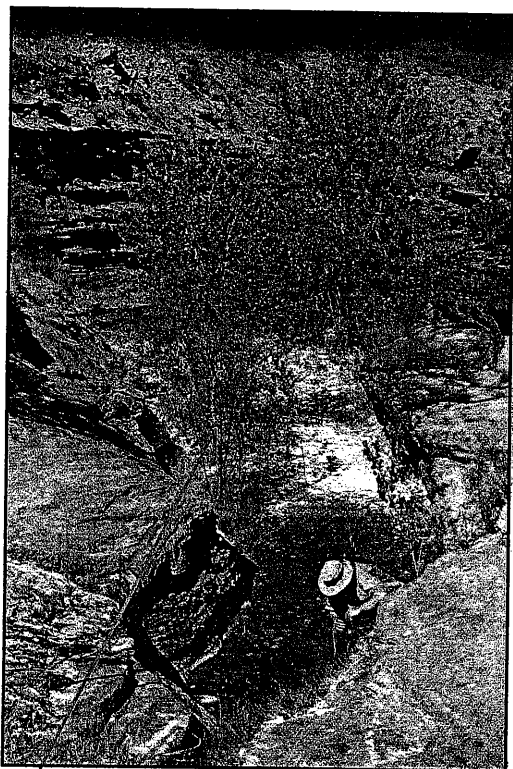
Lobelia cardinalis – found downstream of Cottonwood Spring



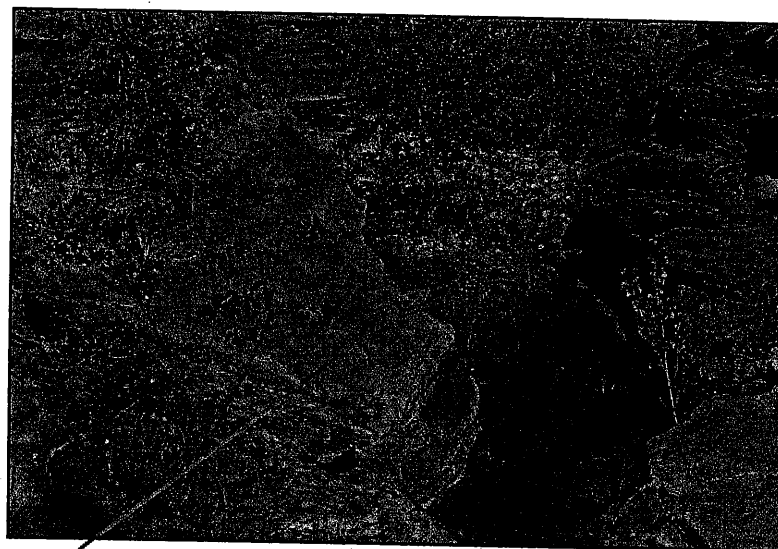
Grand Canyon Field Institute Volunteers shading up after hiking 5 miles into Cottonwood Spring – it was a balmy 100° September day



Large cottonwood tree at Cottonwood Spring



Cottonwood Spring, mature tamarisk and
hundreds of small ones nearby



Cottonwood Spring after tamarisk removal



Revegetation crew member preparing
to cut and apply herbicide to a
tamarisk at Cottonwood Spring

