

Grand Canyon National Park and Grand Canyon Wildlands Council

**FALL 2002 REPORT
FOR
TAMARISK ERADICATION AND RESTORATION OF 63 TRIBUTARIES
IN
GRAND CANYON NATIONAL PARK**

Arizona Water Protection Fund Contract Number 99-075WPF

Prepared by:

Lori J. Makarick
Restoration Biologist
Grand Canyon National Park
823 North San Fransisco, Suite B
Flagstaff, AZ 86001-3265

Phone: (928) 635-0139
Email: Lori_Makarick@nps.gov

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Please Note: This report, including Appendices A-E, is included on the compact disc that accompanied the report. The disc also contains all of the project photographs, organized into folders of the project area. Each photograph is dated to make review easier.

I. Abstract

Tributaries and side canyons of the Colorado River, and seeps and springs in Grand Canyon National Park (GCNP), are among the most pristine watersheds and riparian habitat remaining in the coterminous United States. These riparian systems deserve a high level of protection from non-native plant invasion. The encroachment of tamarisk into these tributaries poses a significant threat to the integrity of the natural ecosystems. GCNP is committed to the preservation of native plant communities and native ecosystems. National Park Service (NPS) Management Policies require park managers "to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems" (NPS 2001b). Park managers are directed to give high priority to the control and management of exotic species that can be easily managed and have substantial impacts on the Park's resources (NPS 1985, NPS 2001b).

The primary objectives of this portion of the overall project are to remove tamarisk from 63 tributaries of the Colorado River in Grand Canyon National Park, and to monitor the success of the tamarisk removal through pre- and post-removal plant monitoring. This project will significantly reduce tamarisk distribution within the treated areas, and allow native vegetation to reestablish without exotic plant competition. Prior to initiation of the project, extensive public scoping was completed and an Environmental Assessment / Assessment of Effect (EA/AEF) was prepared. Under the new Director's Orders on Compliance (NPS 2001a), cumulative effects of multiple projects were considered, and tamarisk removal in all of the park's tributaries was included in the document and analyzed. After review of the public comments, GCNP issued a Finding of No Significant Impact (FONSI) for the project in June 2002. Upon completion of the FONSI, GCNP restoration biologist Lori Makarick worked with the Grand Canyon Wildlands Council (GCWC) to revise the Tamarisk Eradication Plan, budget and contract for this project, and then began to plan the logistics for the fall 2002 river trips.

Two eradication trips were conducted in the fall of 2002. On these trips, tamarisk eradication was initiated, and work was completed in 45 of the 63 project areas. Over 15,000 tamarisk trees were removed from the project areas. The fall trips were extremely successful, and the project is now well underway. This report will detail all of the work completed this fall, and will lay out the remaining work that will be completed in the fall of 2003, and the spring of 2004.

II. Introduction

a. Overview of project status.

The tamarisk eradication portion of this project is finally underway. The National Park Service worked for two years to complete the first task listed in the above contract. The task was to "obtain all permits and environmental clearances necessary to conduct the proposed work." The

compliance process was longer than anticipated, due to new compliance guidelines that were issued in 2001. The new guidelines, Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision Making, required that additional public scoping and documentation be completed prior to the initiation of this project (NPS 2001a). The documentation aims to ensure the use of interdisciplinary approaches and principles to decision-making, and that all decisions are based on technical and scientific information (NPS 2001a).

Public scoping and interdisciplinary team discussions about tamarisk management had been ongoing since 1998. The final Environmental Assessment / Assessment of Effect for the project was issued to the public in February 2002. Public comments were received and analyzed, and a Finding of No Significant Impact Statement (FONSI) was prepared and signed by the regional office on June 18, 2002. The park received a written response to the Informal Consultation with the U.S. Fish and Wildlife Service (USFWS) on January 25, 2001 and that letter, along with the incorporation of their recommended changes, completed the Section 7 consultation that was necessary for this project. On April 8, 2002, the State Historic Preservation Officer (SHPO) provided the park with written concurrence on the project moving forward.

By mid-June 2002, all of the necessary permits and clearances for this phase of the overall project were in hand. The Tamarisk Eradication Plan was revised to incorporate the new project timeline which is as follows:

- October 2000 – 18-day river trip, transect installation and monitoring
- October 2002 – 18-day river trip, eradication trip #1
- November 2002 – 18-day river trip, eradication trip #2
- October 2003 – 18-day river trip, eradication trip #3
- November 2003 – 18-day river trip, eradication trip #4, and post-project monitoring and follow-up maintenance
- Spring 2004 – 18-day river trip, post-project monitoring and follow-up maintenance

The river trip application, which is required by the park, was revised and approved by the park superintendent. A permit for the take-out at Diamond Creek was issued by the Hualapai Tribe. GCNP and the GCWC reviewed and revised the project budget and the contract for this project, which was submitted to the Arizona Water Protection Fund (AWPF) for approval. The dates and deliverables in the contract were altered to reflect the new schedule for the project. The other significant change in the contract was the fact that due to new NPS regulations, GCNP is no longer able to have reimbursable agreements for projects. This signified that the GCWC would have to maintain the budget for the project, which put a greater burden on them, but in the end, the change actually simplified the overall project logistics.

After all revisions were made, GCNP restoration biologist Lori Makarick and GCWC director Kelly Burke began to work on the logistics for the two fall river trips. Due to the new change in liability, the GCWC was responsible for contacting and hiring the boatmen for the trip, with input from park staff. Larry Stevens worked on securing the boats, equipment, and boatmen. Lori Makarick lined up the crew leaders, developed the itinerary, and ensured that all of the tools and safety equipment were purchased and could actually fit on the boats. The trips launched on October 11 and November 8, and both were considered extremely successful. The number of project areas visited

was well beyond what was actually anticipated as possible, and the number of trees controlled far exceeded expectations. With the first two trips completed, GCNP and the GCWC eagerly await the fall of 2003 and the completion of the control portion of this project.

b. Justification for recent work

Tamarisk (*Tamarix sp.*), commonly known as salt cedar, is an exotic (nonnative) shrub or tree that grows in dense stands along rivers and streams in the West. Tamarisk, introduced to the U.S. in the 19th century as an erosion control agent, spread through the West and caused major changes to natural environments. Tamarisk reached the greater Grand Canyon area during the late 1920s and early 1930s, and became a dominant riparian zone species along the Colorado River following completion of Glen Canyon Dam in 1963. The impacts caused by tamarisk in the Southwest are well documented (Refer to Reference Section of the EA/AEF and Stevens 2001). These prolific nonnative shrubs displace native vegetation and animals, create conditions that are inhospitable for the germination of native plant seeds, and increase fire frequency. Salt cedar is an aggressive competitor, often developing monoculture stands and lowering water tables which can negatively affect wildlife and native vegetative communities (Duncan 1996). In many areas, tamarisk occupies previously open spaces and is adapted to a wide range of environmental conditions. Once established in an area, it typically spreads and persists.

Distinctive soil types, vegetation, and hydrologic conditions characterize riparian areas that provide biologically diverse and productive ecosystems. In the Southwest, riparian areas account for less than 2% of the land, yet over 65% of Southwestern wildlife depend on riparian habitats. Riparian habitats are the most productive, most valuable and most threatened habitats in the American Southwest (Johnson et al. 1985). Tributaries and side canyons of the Colorado River, and seeps and springs in GCNP, are among the most pristine watersheds and desert riparian habitat remaining in the coterminous United States. These riparian systems deserve a high level of protection from non-native plant invasion. The recent encroachment of tamarisk into these tributaries poses a significant threat to the integrity of the natural ecosystems. GCNP is committed to the preservation of native plant communities and native ecosystems (NPS 1995). NPS management policies require park managers "to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems" (NPS 2001b). Park managers are directed to give high priority to the control and management of exotic species that can be easily managed and have substantial impacts on the Park's resources (NPS 1985, NPS 2001b). The removal of tamarisk from these tributaries will provide this protection, and allow native plant communities to recover. An increase of native plant species in these areas is expected once the tamarisk trees are removed.

III. Methods

a. Area of interest in recent analysis

Tamarisk eradication, under this contract, will be completed in 63 areas within Grand Canyon National Park. These areas were selected based on the numbers of tamarisk trees found during the preliminary surveys (i.e. feasibility of control at this time) and also the extent of the seeps, springs, and riparian habitat found within the project areas.

High species diversity, high species density, and high productivity generally characterize riparian areas. Continuous interactions occur among riparian, aquatic, and upland terrestrial ecosystems through exchanges of energy, nutrients, and species. Warren et. al. (1982) provided the following description:

"Riparian woodlands (or forests) characterized by cottonwood-willow associations are primarily restricted to the larger perennial streams and drainages of the Colorado Plateau region of northern Arizona. The great biological importance and floristic diversity of these cottonwood-willow riparian forests is disproportionate to their limited total area.... Riparian scrub usually occurs along ephemeral or intermittent watercourses (such as desert arroyos), or in narrow canyons which are periodically scoured by floods. Riparian scrub communities are characterized by a broad continuum of vegetative associations that range from mesic vegetation types to xeric growth along desert arroyos (Brown et al., 1980). These arroyos often contain water only one day or less each year and the resulting vegetation is commonly composed of a mixture of facultative riparian species and upland species. This is in contrast to mesic species, which are generally absent from the surrounding uplands.... Side canyons throughout the park with perennial water support riparian vegetation characterized by cottonwood (*Populus fremontii*) and willow (*Salix* spp.) which is generally very similar to that found in similar situations throughout northern Arizona (Phillips and Phillips, 1979)...."

Each dry wash, spring, seep, or stream has a different association of species, depending on environmental features including elevation, permanence of water, substrate, frequency of flooding, and colonization (Warren et al., 1982). Riparian vegetation typically occurs in small, discrete stands or patches. The floristic diversity in wetland and riparian composition is highly variable, but is extremely high when compared to the upland vegetation. Typical stands may consist of broad-leaved deciduous trees in the overstory, with a mixture of shrubs and grasses in the understory. Species typical of drainages with perennial water sources are:

- | | |
|---|---|
| ♣ Fremont cottonwood (<i>Populus fremontii</i>) | ♣ Willow (<i>Salix exigua</i> , <i>Salix goodingii</i>) |
| ♣ Brickellia (<i>Brickellia longifolia</i>) | ♣ Monkey flower (<i>Mimulus cardinalis</i>) |
| ♣ Catclaw acacia (<i>Acacia gregii</i>) | ♣ Mesquite (<i>Prosopis glandulosa</i>) |
| ♣ Apache plume (<i>Fallugia paradoxa</i>) | ♣ Emory baccharis (<i>Baccharis emoryi</i>) |

Species typical of drainages with dry washes or intermittent water are:

- ♣ Catclaw acacia (*Acacia greggii*)
- ♣ Baccharis (*Baccharis* spp.)
- ♣ Snakeweed (*Gutierrezia sarothrae*)
- ♣ Apache plume (*Fallugia paradoxa*)
- ♣ Utah agave (*Agave utahensis*)
- ♣ Mormon tea (*Ephedra* spp.)
- ♣ Four-wing saltbush (*Atriplex canescens*)
- ♣ Fremont cottonwood (*Populus fremontii*)
- ♣ Skunkbush (*Rhus trilobata*)
- ❖ Red-bud (*Cercis occidentalis*)

Upland species, described below, are also present in these dry or intermittent washes. Trees and shrubs tend to be scattered, but may also form dense thickets. Species composition varies depending on moisture availability, elevation, and geographic location in the canyon. Within the park, tamarisk occurs in the many of the side canyon and tributaries; however, the distribution and density is highly variable.

The vegetation surrounding the tributaries is generally from desertscrub communities, which are composed of plant species from three of the four North American desert floras. The Sonoran desertscrub has the highest diversity of species. A two-season rainfall regime and lack of freezing temperatures characterizes the Sonoran desert (Warren, et al. 1982). The Mojave desertscrub has higher local species diversity, but is primarily dominated by shrubs; it is characterized by winter rains and the absence of freezing temperatures (Warren, et al. 1982). The Great Basin desert receives more winter rain than the Mojave, and frequently has severe winter freezes and the lowest diversity of the three (Warren, et al. 1982).

The Great Basin desertscrub is dominated by big sagebrush (*Artemisia tridentata*) rabbitbrush (*Chrysothamnus* spp.), Mormon tea (*Ephedra* spp.) and a variety of perennial grasses. These associations are typically found in the lower portion of the canyon and comprise the vegetation surrounding some of the middle and lower tributaries. Typical Mojave desert species include blackbrush (*Coleogyne ramosissima*), turpentine broom (*Thamnosma montana*), bladder sage (*Salazaria mexicana*), and other species. The Sonoran desert species include brittle bush (*Encelia farinosa*), catclaw acacia (*Acacia greggii*), ocotillo (*Fouquieria splendens*) and desert willow (*Chilopsis linearis*). Sonoran associations occur in the lower portion of the canyons, and many of these species can grow directly in drainages that are not frequently scoured.

Please refer to the next sections for the complete list of areas in which work was completed during the fall 2002 river trips.

b. Dates, times and conditions under which work was completed

The tamarisk eradication work was completed in October and November 2002. These months were selected because the trees are still actively transporting nutrients and water through the phloem and xylem, and the insertion of herbicide into the tree yields effective control results.

The days were long, with coffee served by 6:15 a.m., and dinner was often not ready until long after dark. The work was very physically demanding, yet the crew participants kept up good spirits by composing songs about the project and trading off tasks during the day. Due to the remoteness of the terrain, it is necessary to access the project areas from the river. Each of the fall trips launched

from Lees Ferry and took out at Diamond Creek. On each trip, there were 16 participants and five rafts. There was an exchange at Phantom Ranch, and new, invigorated volunteers would arrive to assist with the project while the upper half volunteers would tell horror stories about the long days and blisters. The dedication and perseverance of all of the crew members was amazing and really contributed to the overall success of the project. The volunteers were really crucial to the project accomplishments. In October, 1005 volunteer hours were donated and in November 1248 volunteer hours were donated. The total hours spent on the two fall trips was 5499; therefore, about 40% of the total hours were supplied by volunteers. Please refer to Appendix D and Appendix E for complete project hour data.

It should be noted that during the November 2002 trip, a working river trip with NPS representatives and employees of Arizona River Runners (ARR) assisted with this project. A total of 292 hours were donated by the participants of that trip and these hours are not included in the appendices listed above. The hours were divided into 36 hours of surveying, 161 hours of manual seedling removal, and 116 hours of joint sapling / mature control with this project at Lava Chuar and Boucher. This assistance was invaluable at the large project sites and was very beneficial to the project.

The project participants on the October 11-28, 2002 trip were:

	<u>Upper Half</u>	<u>Lower Half</u>
1.	Trip Leader	Bob Dye
2.	Boatman	Kim Crumbo
3.	Boatman	RJ Johnson
4.	Boatman	Alison Steen
5.	Volunteer Boatman	Chris Louderback
6.	Cook	Simone Sellin
7.	Crew Leader 1	Kim Fawcett
8.	Crew Leader 2	Kate Watters
9.	Crew Leader 3	Anne Hadley
10.	Project Coordinator	Lori Makarick
11.	Archeologist	Lisa Leap
12.	Volunteer	Kelly Burke
13.	Volunteer	Herman Griego
14.	Volunteer	Emily King
15.	Volunteer	Donna Koster
16.	Volunteer	Steve Till
		Matt Gontram

The project participants on the November 8-25, 2002 trip were:

	<u>Upper Half</u>	<u>Lower Half</u>
1.	Trip Leader Bob Dye	Bob Dye
2.	Boatman Dan Hall	Dan Hall
3.	Boatman Alison Steen	Alison Steen
4.	Boatman Chris Louderback	Chris Louderback
5.	Volunteer Boatman Matt Gontram	Matt Gontram
6.	Cook Simone Sellin	Simone Sellin
7.	Crew Leader 1 Kim Fawcett	Kim Fawcett
8.	Crew Leader 2 Kate Watters	Kate Watters
9.	Volunteer Rona Levine	Shawn Edwards
10.	Project Coordinator Lori Makarick	Lori Makarick
11.	Volunteer/Tribal Monty Tillinghass	Steve Lomadafkie
12.	Volunteer Beth Eisenberg	Beth Eisenberg
13.	Volunteer Donna Koster	Donna Koster
14.	Volunteer Sheila Yokers	Sheila Yokers
15.	Volunteer Anne Minard (out Tanner)	Tom Schiavone
16.	Volunteer Margie Erhart (out Tanner)	empty

*Note: Johanna Divine and Mike Whalen on trip from Tanner (Lava Chuar) to Phantom

Solid itineraries were prepared prior to each trip. The itineraries were altered by the project and/or trip leader to account for poor weather conditions or additional time needed at specific sites. During both trips, there were a few days of rain (and some snow). Many of the project areas are in narrow side canyons which are subject to flash flooding. On rainy days, work was completed only in wide open canyons that would be safe during a flood event. On those days, the cut stump method was not used since the rain would wash the herbicide off of the tree's surface. Only the injection or girdling methods were used on those days.

The final itineraries for each of the trips are included on the next 2 pages.

Table 1. October 2002 Itinerary**Grand Canyon National Park / Grand Canyon Wildlands Council****Tamarisk Eradication Trip #1**

October 11-28, 2002

DATE	CAMP	RM	PROJECTS
10/8-9			Food Pack - Simone, Larry, Kim F. & Lori
10/10	Lees Ferry		Meet at 8:45am at Larry's house in Flagstaff for departure. Once we are at Lees Ferry – rig the boats, have lunch, and spend time working on tamarisk treatment techniques.
10/11	North Canyon	RM 20.5 R	All people going downstream need to be at Lees Ferry by 7:30am for an 8:30am departure!!! We'll get to camp late – 20 mile river day! Get all tools and supplies ready for early departure up North.
10/12	Buckfarm Canyon	RM 41 R	North Canyon
			First Redbud alcove
			Second Redbud alcove
			Tatahatso Wash
10/13	Kwagunt	RM 56.2 R	Buckfarm
			Bert's Canyon
10/14	Kwagunt	RM 56.2 R	Kwagunt
10/15	Carbon	RM 64.7 R	Carbon Canyon
10/16	Basalt	RM 69.8 R	Palisades
			Basalt
10/17	Nevills	RM 75.6 L	74 mile wash
			Escalante
			75 mile Creek
10/18	Grapevine	RM 81.3 L	Vishnu Creek
10/19	Cremation	RM 87.2 L	85 mile spring
			Lonetree Canyon
			Clear Creek
10/20	Schist	RM 96 L	EXCHANGE DAY!!! Let's pick up the new folks and be heading downstream by noon. Orientation to the project for new folks, clean up coolers, organize tools, etc.
10/21	Slash/Parkins Camp	RM 108 L	Boucher Creek
10/22	Bighorn Wash	RM 117 L	Bighorn Wash
10/23	Stone Creek	RM 132 R	122 Mile
			Lower Blacktail
10/24	First Chance	RM 157.7 R	142 Mile Spring
10/25	No name	RM 185.5 R	Transit Day
10/26	Granite	RM 209 L	Transit Day
10/27	222 Mile	RM 222 R	Bessie's Camp Creek 212 R
10/28	Sus casitas		TAKE OUT!!!

Table 2. November 2002 Itinerary

**Grand Canyon National Park / Grand Canyon Wildlands Council
Tamarisk Eradication Trip #2**

November 8-25, 2002

Date	Camp	RM	Projects
11/6			Food Pack - Simone, Kate and Kim
11/7	Lees Ferry – We'll do dinner at VC		Meet at 9am at Larry's house in Flagstaff for departure (1705 N. San Francisco). Once we are at Lees Ferry – rig the boats, project orientation, etc.
11/8	Above Tiger Wash	26.3 L	LAUNCH!!!!!! All people going downstream need to be at Lees Ferry by 7:30am for an 8:30am departure!!!
11/9	Malgosa	57.5 R	Malgosa
11/10	Malgosa	57.5 R	Continue work on Malgosa
11/11	Lava Canyon	65.5 R	Lava Canyon *CRF trip works with us
11/12	Lava Canyon	65.5 R	Finish Lava!
11/13	Phantom Ranch	87.2 L	Clear Creek *CRF folks will do the seedlings Lonetree
11/14	Trinity	91.6 R	EXCHANGE DAY!!! Head downstream EARLY!!!! Really. Trinity
11/15	Boucher	96.7 L	Finish Trinity in the morning Salt Creek (1 boat) Boucher
11/16	Waltenberg	112 R	Boucher – continue with this canyon *CRF folks work with us! Waltenberg Canyon
11/17	Upper Blacktail	120 R	Garnet Elves (may cancel this one depending on time) Upper Blacktail
11/18	Stone Creek	132 R	Forster Stone *CRF folks will do the seedlings
11/19	Across from Deer	136.2 L	Fishtail 148 Springs (L)
11/20	Ledges	151.5 R	Matkatamiba (may cancel this on depending on time) 150 Mile
11/21	Fern Glen	168 R	Spring above 152 at Ledges Fern Glen
11/22	Cove	174.3 R	Stairway Cove Canyon – Lower Cove Canyon - Upper
11/23	Parashant	198.5 R	TRANSIT Day
11/24	222 Mile	222 R	TRANSIT and clean up day!
11/25	Sus casitas		TAKE OUT!

c. Tamarisk control methods and conditions

Each river trip consisted of 16 people (including boatmen) and was 18-days long. The trip length allowed for sufficient time to access and work in canyons on the itinerary. The goal of the control work was to target 15 tributaries per trip, totally the 63 canyons over the 4 control trips during the project period. The October 2002 trip focused on canyons along the upper half of the river (Lees Ferry to Phantom Ranch) and the November trip focused on canyons along the lower half of the river. Some project areas will require several visits to complete the initial control of the entire tamarisk populations, and some of these areas may also require several days of work on an upcoming trip. For example, Kwagunt Canyon has several dense thickets of tamarisk several miles up the canyon. The work was initiated over a two day period, and the area is noted in the summary tables as an area that needs to be revisited.

The number of people necessary to complete eradication efforts in each area were based on the data collected in the initial surveys. It was originally anticipated that the minimum number of people that will be needed for tamarisk removal in each tributary is six, and that has proved accurate for the smaller project sites. However, in the project areas with large thickets, it is actually most efficient to have all of the crew leaders and project participants. The project participants were carefully selected, and were all very supportive of the project and very excited about the work.

The eradication methodology was finalized after all public comments were incorporated into the Environmental Assessment / Assessment of Effect (EA/AEF) document, which is required under the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA). The EA/AEF was an in-depth study of the impacts of and alternative to proposed actions, and serves as a method to involve the interested and affected public before any decisions affecting the environment is made. A copy of the EA/AEF has already been provided to the AWPF. For this project, a combination of methods was used including mechanical, chemical, and cultural (i.e. seeding). The methods selected for each project location were site specific and were determined by the restoration biologist / project leader; a brief description of each method follows:

Manual Removal

Seedlings in washes, streambeds, and non-sensitive areas will be manually removed. In addition to hand pulling, leverage devices (weed wrenches™) may be used for slightly larger seedlings and saplings to ensure that the entire root system is removed. Hand tools (i.e. picks, pulaskis, and shovels) will be used to loosen the soil surrounding the larger plants and then the entire root system, or at least below the root crown, will be removed.

Garlon Lance Injection

The lance injector is a three- to four-foot long tool with four chambers. Small herbicide capsules (approximately ¾" long by ¼" in diameter) are placed inside the chambers, the lance is placed against the trunk of the tree, and as the top of the lance is pushed, the chamber opens and a capsule is inserted into the tree. The number of capsules inserted into the tree is based on the trunk's diameter. The overall effectiveness of this method on tamarisk has not been determined, but it has been used with great success on woody tree species in Hawaii. It is a method the park would use if

proven effective. Direct herbicide injection into the tree would eliminate the possibility of chemical spillage. It would also be safer for the applicators since there is less likelihood of herbicide contact. This method would be used on large saplings and mature trees. Since the lance must be held at 45 degrees to the trunk, it would be difficult to use as the sole method in dense stands.

Girdle Method (a.k.a. Hack and Squirt)

With this method, a hatchet, tree girdler, or hand saw will be used to cut downward into the water-conducting tissue (phloem) of standing trees. The herbicide mixture is then directly applied into the cut with a hand-pressurized sprayer (and coarse spray nozzle) or 12cc syringe. On larger trees, two or more cuts would be necessary. The cuts would be made at about one to two meters above the ground. This method would be used in areas with scattered individual mature trees; it would be difficult to use as the sole method in dense stands.

Cut Stump Method

Tree trunks are cut near ground level with handsaws and then stumps are sprayed with Garlon4 mixed with a penetrating oil (JLB oil) at a rate of 25% herbicide to 75% oil. The mixture is absorbed by the plant's phloem and transported to the root; if the herbicide mixture is applied quickly (2-10 minutes), 90-95% control is possible. Pressurized hand or backpack sprayers allow precision herbicide application with minimum overspray or drift risk. This method would be used on a limited number of larger trees in dense stands and for smaller trees where manual removal would cause extensive soil disturbance.

Basal Bark Application

With this method, the entire stem is treated with Garlon4 (again in the same mixture as above) from near ground level up for about 30-38 centimeters. The chemical is applied with a backpack sprayer or hand held pressurized sprayer, both of which have small nozzles with coarse spray settings that allow for direct spraying with minimal drift or overspray. A paintbrush may also be used for small sapling application. This method is much less labor intensive, but is less effective on mature trees and would be used for smaller saplings and some seedlings. It is effective on trees up to one year and three meters tall.

Mitigation Measures

The following specific measures apply to all methods used for the project:

- Every attempt would be made to dispose of debris to minimize visual impact (i.e. off trail, out of the drainage).
- Empty herbicide capsules would be removed from trees in the year following treatment.
- Cut stumps would be hidden from view to the extent possible.
- Soil would be tamped where manual removal is used to help minimize establishment of other invasive exotic species and to minimize visual impact.
- When the hack and squirt method is used, tree cuts would be made on tree sides least visible to backcountry users.
- If pruning is necessary, a minimal number of branches would be cut to minimize visual impact.

The debris was left on site to decompose and provide habitat for wildlife. The visual impacts of the project were minimized through carefully placed cuts and girdles, and also through the combination of control methods employed at each project site.

Herbicide Use

The herbicide used for control was Garlon, which is a general use herbicide. A mixture of 25% Garlon4 and 75% JLB oil was used. Stainless steel sprayers that were pressurized with bicycle pumps were used. Backpack sprayers were not used due to space limitations on the boats. The capsules used with the lance injection system contained Garlon3.

Pesticide certification is not required for Garlon application; however, the park has adopted the policy of having trained and certified application on site during application. During these trips, the project leader, all field crew leaders, and two of the volunteers had Arizona State pesticide certification. All project participants received herbicide orientation and training from the project leader. Project participants understood and abided by the established Personal Protective Equipment (PPE) requirements and rules outlined in the safety plan for the project. Rubber gloves, long sleeve shirts, long pants, and eye protection were part of the PPE necessary for this project. Job hazard analyses (JHA) for exotic plant removal and herbicide application were prepared and reviewed with all project participants.

All information and instructions on the herbicide label was strictly followed. All herbicide containers were leak- and spill resistant. All application equipment and chemicals were stored in sealed ammunition cans or large silver boxes during transport on rafts, and all storage containers had the product's specimen label and the Material Safety Data Sheet (MSDS) clearly displayed underneath a waterproof plastic sheet. The MSDS contains fire and explosive hazard data, environmental and disposal information, health hazard data, handling precautions, and first aid information. All trip participants reviewed the MSDS with the project leader and understood the first aid instructions described on the MSDS. All herbicide and application equipment was stored on one boat, and was isolated from food and personal items. Additional ammunition cans for disposal of used PPE (such as gloves, goggles, etc.) and herbicide containers were stored on the tool boat.

Although control methods for tamarisk are well documented in the literature, some refinement to the methods occurred during the work in Grand Canyon. The changes are discussed in the next section. Please refer to Appendix A for examples of methods and sample photographs.

d. Analysis of methods and tests

Since the control was initiated in the fall of 2002, there is little analysis that can be done at this time. Project monitoring will be completed during the spring of 2004, at which time project success can be analyzed. At this point, the control methods can be discussed since there was some refinement during the first two control trips.

In some areas with loose soil, sapling sized trees could be manually removed, which was predicted but was actually surprising when it actually worked. Whenever possible, this method was used since it minimized the need for herbicide. At first, project participants tried to remove the entire

root system when manually pulling seedlings. Upon discussion with Larry Stevens after the October trip, this method was refined. His work showed that it is only necessary to remove the root to below the root crown, which can be buried in the soil but is typically relatively near the soil surface. The other change with the seedling pulling is that initially the debris was scattered outside of the drainages to avoid resprouting of the pulled plants. Again, Larry's research revealed that even if those seedlings were to re-root, the survivorship was very low and the growth of a plant without the root crown material was permanently retarded (Stevens 2001). The pulled seedlings were then scattered in drainages where moving them to outside of the drainage would cause additional impacts to resources such as soils and plants.

Project leaders also noticed that the data sheets needed slight revisions. At first it was assumed that for the majority of saplings and mature trees, either cut stump or girdling would be used on an individual tree. However, project leaders realized that a combination of those methods was most useful for the really large trees. Sawing through huge branches was incredibly time consuming, and since girdling was easier in many cases, this was used on some of the branches. The project coordinator is confident that this combination of methods will provide excellent results.

The hack and squirt method was also perfected and was renamed the Girdle Method. With this method, either a hatchet or a handsaw was used to cut into the tree bark. Using the saw was perfected on a rainy day, when this seemed like the best alternative to use to actually get the herbicide down into the trunk without the possibility of run-off. The use of the saw was also less visually intrusive and was opted for in highly visited areas. The cut was barely visible and very little herbicide was needed with this method.

The injection method was used at two project sites during rain events. Once the lance injectors got up and running, they worked fairly well. The lances are designed to allow only one capsule out of the opening as you apply pressure against the tree. However, both lances on the October trip were malfunctioning and several capsules would fall out with each push. The extra capsules would land on the ground, and were retrieved by the operator or assistant, but this was a time consuming process. Since the other methods were working so smoothly, the lance injection method was not utilized as much as anticipated. The other factor considered was the need to return to the project sites and retrieve all of the empty capsules, which again would be a time commitment. This method may be used in some of the project areas that participants can hike to and its effectiveness re-evaluated. For a hiking situation, the lance system would be ideal because it does not require the transport of any liquid herbicide.

IV. Results

a. Results of recent data collection

During the fall 2002 river trips, 15639 tamarisk trees (11634 seedlings, 2584 saplings, and 1421 mature) were controlled (Refer to Figure 1). The total tamarisk canopy cover removed from the project sites was 7129 sq. meters. The control methods used were site specific and were determined

by the project leader after an on site analysis of the area. Refer to Table 3 for complete control data for the project areas. The methods used are summarized as follows and are depicted in Figure 2:

<u>Method</u>	<u>Number of Tree Used On</u>
Pulled	9745
Girdled	546
Basal Bark Application	203
Cut Stump	4974
Combination (Cut/Girdle)	104
Injection	67

The amount of Garlon used was surprisingly low. A total of 20 mixed gallons were used on the two fall trips. This is equivalent to 5 gallons of Garlon4 concentrate. This overestimate of the amount of herbicide needed was a very pleasant surprise.

Work was completed at 45 sites (approximately 70% of the project areas). Due to extensive populations or lack of time in the itinerary, the following project sites will require additional visits and control implementation:

- Kwagunt
- Lava Chuar
- Vishnu
- Clear Creek
- Boucher
- Garnet
- 128 Mile (river right)
- Stone Creek
- Matkatamiba
- Stairway
- 209 Mile (river right)
- Bessie's Camp Creek

The remaining work at Vishnu, Garnet, 128 Mile, Stairway and Bessie's Camp Creek can be accomplished in 1 day per area. The other areas may require a layover on future trips. Even with these revisits, the project remains on track and all control work should be completed in the project timeline.

A large component of this project is the long-term monitoring that is included with the control work. On the first river trip (October 2000), the majority of the monitoring components were installed. The components include vegetation transects and photopoints. On the fall 2002 trips, photopoints were installed in project areas that were not visited in October 2000 and post-work photographs were taken at previously installed photopoints. Please refer to the monitoring plan for the overall design and implementation scheme. Appendix B contains representative samples of the photodocumentation and Appendix C includes the summary data for all installed photopoints for the project. A compact disk is also included with this report; the disk contains all of the photographs taken for this project to date. The disk is organized by project area and each photograph name includes the data taken.

b. Graphs, charts and tables pertaining to results

Table 3. Tamarisk Control Summary

Grand Canyon National Park
Tamarisk Eradication and Tributary Restoration
AWPF Project Control Summary 2002

Canyon Name	Total Number for Each Size				Total Number for Each Method						Area m ²	Comments
	Seedling	Sapling	Mature		Pulled	Girdled	Basal Bark	Cut Stump	Combo Cut/Girdle	Inject		
North Canyon	6	4	21		0	16	0	15	0	0	104	Done
1st Redbud Alcove	16	25	6		0	0	0	47	0	0	60	Done
2nd Redbud Alcove	1	6	4		0	1	0	10	0	0	29	Done
Tatahatso Wash	4	4	2		0	2	0	8	0	0	32	Done
Buckfarm	11	19	20		3	0	0	47	0	0	138	Done
Bert's Canyon	4	4	7		0	1	0	14	0	0	15	Done
Kwagunt	812	445	170		28	55	0	1344	0	0	1010	Done
Malgosa	2	4	33		0	27	0	12	0	0	246	Still mature below canyon entrance - but above old high water.
Carbon	5	11	25		0	8	0	33	0	0	81	Flashed in early Sept.
Lava Chuar	81	639	311		17	31	0	923	60	0	1865	Need to return Flashed in early Sept.
Basalt	16	31	62		2	13	94	0	0	0	216	Done
Palisades	3	2	15		0	0	0	20	0	0	59	Cleared out by flash flood
74 Mile Wash	0	0	0		0	0	0	0	0	0		

Canyon Name	Total Number for Each Size			Total Number for Each Method						Area m ²	Comments
	Seedling	Sapling	Mature	Pulled	Girdled	Basal Bark	Cut Stump	Combo Cut/Girdle	Inject		
Escalante	0	6	15	0	20	0	1	0	0	52	Flashed in early Sept.
75 Mile Canyon	267	19	6	261	0	0	0	0	31	71	94 capsules injected
Vishnu	67	70	59	5	44	0	147	0	0	358	Need to return
Lonetree	139	57	31	46	14	0	167	0	0	163	Done
Clear Creek	449	45	17	399	2	0	74	0	36	106	Need to return
Lonetree	7	52	13	7	0	0	65	0	0	70	Second visit
85 Mile Spring	12	30	5	7	0	0	40	0	0	19	Done
Trinity	134	156	45	41	0	0	294	0	0	259	Done
Salt Creek	23	2	3	13	0	0	15	0	0	20	Done
Boucher	6052	681	304	4498	91	109	2329	10	0	1326	Need to return
Hotaute	6	39	27	2	0	0	70	0	0	64	Done
Waltenberg	8	4	4	8	0	0	8	0	0	11	Done
Garnet	136	110	55	139	4	0	158	0	0	254	Need to return
Bighorn Wash	223	21	20	193	52	0	19	0	0	135	Done
Lower Blacktail	0	0	0	0	0	0	0	0	0		Flashed hard!
Upper Blacktail	25	184	27	76	0	0	157	3	0	176	A few TARA left at seep in Blacktail
122 Mile Creek	0	3	12	2	10	0	3	0	0	19	Done
Forster	506	83	34	522	0	0	100	1	0		Need to return
Fossil	21	2	0	23	0	0	0	0	0		Done

Canyon Name	Total Number for Each Size			Total Number for Each Method						Area m ²	Comments
	Seedling	Sapling	Mature	Pulled	Girdled	Basal Bark	Cut Stump	Combo Cut/Girdle	Inject		
128R	219	0	0	219	0	0	0	0	0		Need to return
Stone Creek	1591	1	0	1592	0	0	0	0	0		Need to return
Fishtail	0	5	4	0	2	0	5	2	0	35	No seedlings - hiked 1 hour up canyon.
142 Mile Spring	0	5	9	0	2	0	12	0	0	103	Done
Spring above Matkatamiba	0	17	10	0	1	0	21	5	0	88	Done
Matkatamiba	926	0	0	926	0	0	0	0	0		Need to return
Ledges	137	46	20	150	14	0	38	1	0	127	Done
Fern Glen	0	1	1	0	0	0	2	0	0	2	Done
Stairway	6	34	20	2	0	0	57	1	0		Got above 2nd falls, some more on ledges - revisit.
Cove - Upper	418	5	9	420	4	0	6	2	0	117	Done
Cove - Lower	107	206	208	124	192	0	186	19	0	828	Done
209 Right	47	4	0	51	0	0	0	0	0		Done with seedlings
Bessie's Camp Creek	1	9	17	0	15	0	12	0	0	123	Need to return
Totals	11634	2584	1421	9745	546	203	4974	104	67	7129	

Total Trees Controlled: 15639

Figure 1. Tamarisk Control by Size

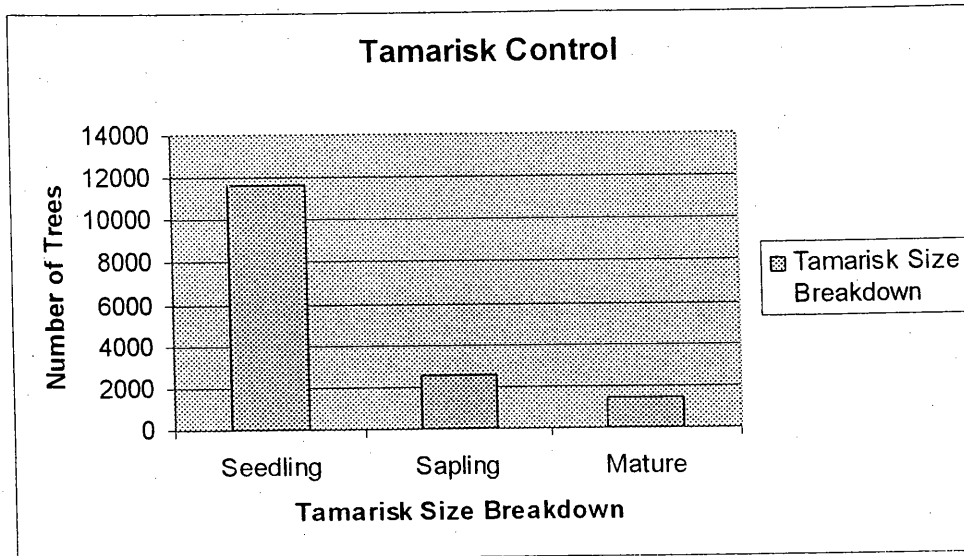
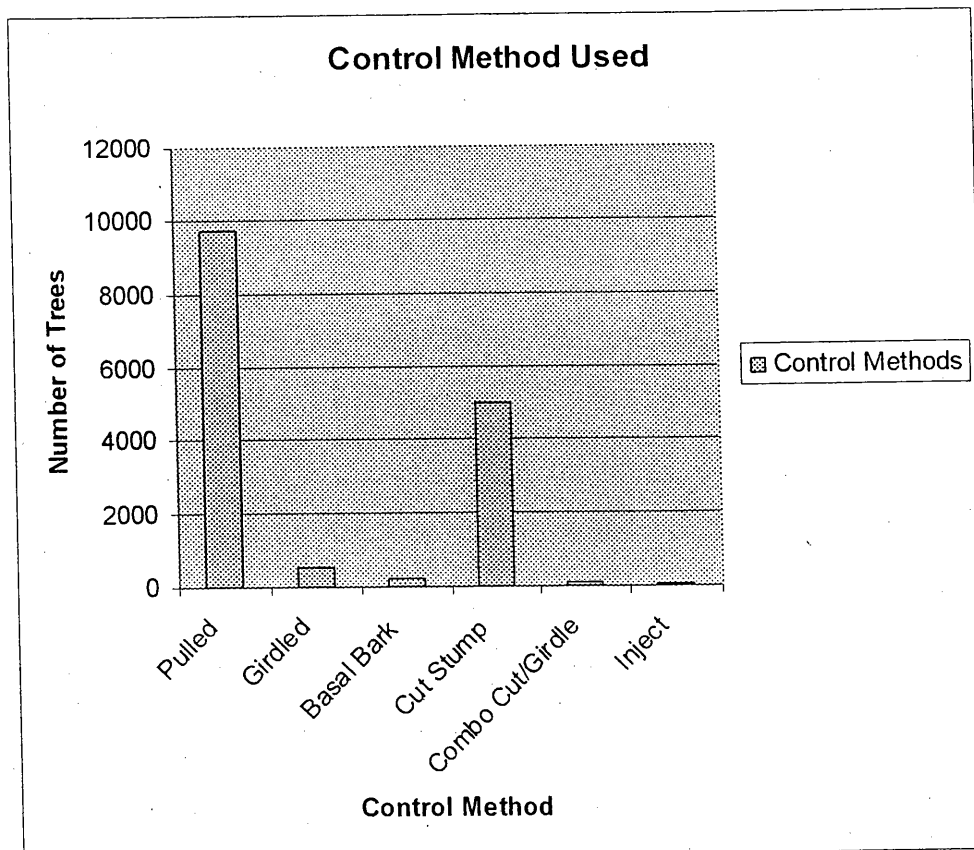


Figure 2. Tamarisk Control by Method



V. Discussion and Conclusions

a. Discussions and conclusions about results comparing current, past and control results

This report contains the control data from the first two control trips which were completed in October and November 2002. Since there is no data analysis at this point, a discussion about control results is not possible. The final report for this project will contain control conclusions and discussion.

b. Discussion and conclusions about results with relation to related literature.

This report contains the control data from the first two control trips which were completed in October and November 2002. Since there is no data analysis at this point, it is not possible to discuss the results of this project in relation to the current literature. The final report for this project will contain information under this topic.

VI. Management Recommendations

a. Overview of management options.

During the implementation of this project, tamarisk control methods have been perfected and utilized in 45 areas within GCNP. The monitoring results of this project should be utilized to further refine the control methods and management options. The National Park Service has an affirmative responsibility to protect and preserve the resources located within its units. National Park Service (NPS) Management Policies require park managers "to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems" (NPS 2001b). Park managers are directed to give high priority to the control and management of exotic species that can be easily managed and have substantial impacts on the Park's resources (NPS 1985, NPS 2001b).

This project has verified that the control of tamarisk in the park's side canyons and tributaries is indeed feasible. A vast body of literature documents the impacts that tamarisk has on southwestern ecosystems, and Stevens (2001) has summarized the impacts and ecology of the species. Since the control is feasible and tamarisk posed a substantial impact on the resources located within GCNP, the continuation of this project to include the other phases is the primary option to be considered. Park management have been very supportive of this project, and with continued documentation and successful implementation, the support should remain strong.

b. Management recommendations and justification.

The EA/AEF for this overall project included three phases of tamarisk management and tributary restoration. The work completed under this contract is considered Phase I of the overall project. The first two control trips were very successful and the overall logistics of the project and transportation to project sites have been worked out. The final two control trips for Phase I will occur in October and November 2003, and then the final monitoring trip will be in the spring of 2004. It is anticipated that the control methods will lead to successful management of tamarisk population in the project areas. Funding should be sought for Phase II and Phase III of the project, and this valuable work should be continued. The EA/AEF for this project states that the park will commit to the follow up control necessary for Phase I project sites, and this work (hand pulling seedlings) should be integrated into the overall resource management in the park.

After completion of the final monitoring trip, the results of the control work should be summarized and prepared for both internal NPS publications and also peer-reviewed journals. The funding provided by the AWPf has been essential to getting this project off the ground, and protecting and restoring the park's valuable riparian ecosystems. The AWPf was very understanding of the delays in the first task, and allowed the project timeline to be altered to incorporate the time needed to acquire all of the compliance and permits necessary to initiate the project. The partnership between GCNP and the GCWC has also been integral to the success of the project, and all parties involved are commended for their dedication. The primary recommendation at this point is to continue the work, and to expand the project to include all of the tamarisk populations in the side canyons and tributaries of the park.

VII. Literature Cited

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Appendix A

Tamarisk Control Project Representative Photographs

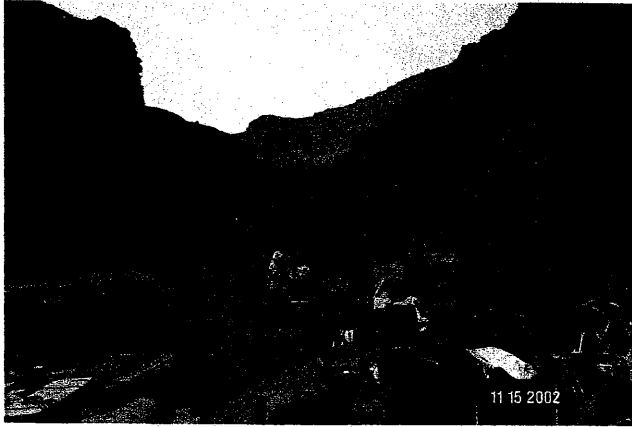


Figure 1. Example of small river camp

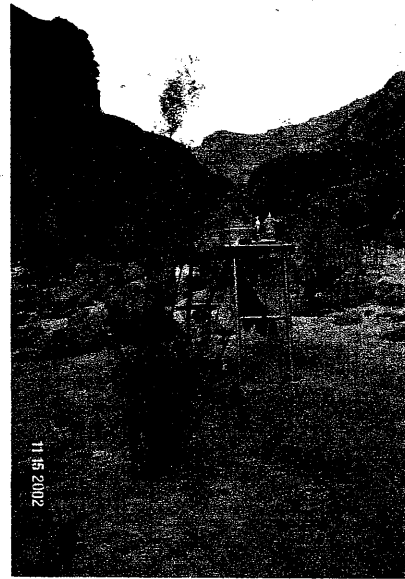


Figure 2. Tamarisk in the kitchen

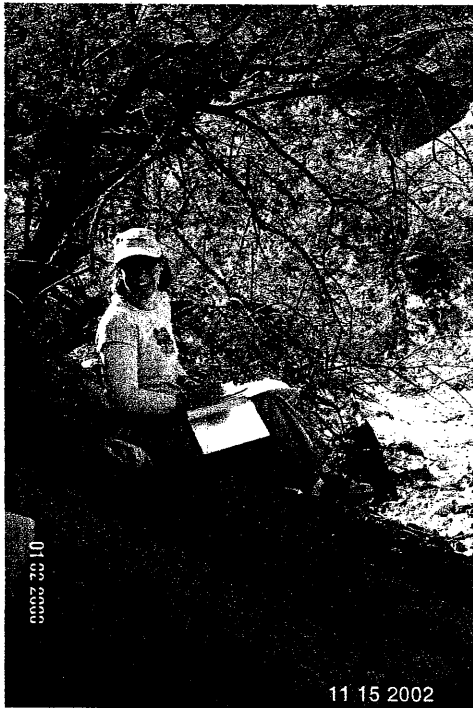


Figure 3. Kate Watters, field crew leader

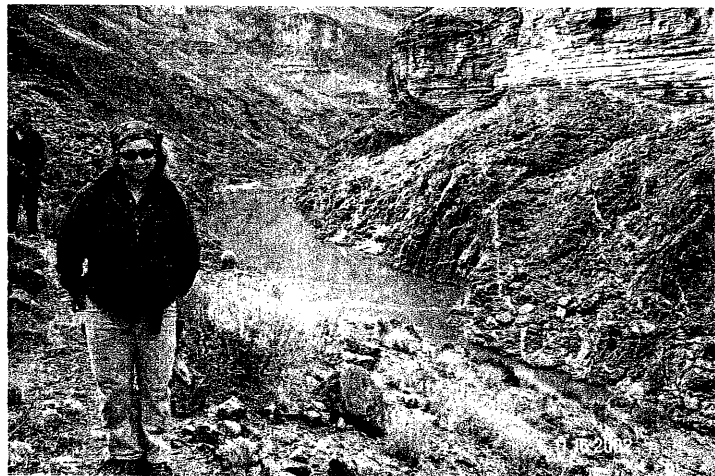


Figure 4. Lori Makarick, project coordinator and leader

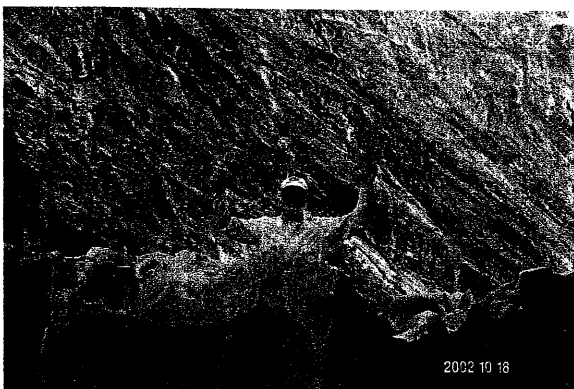


Figure 5. Bob Dye, river trip leader



Figure 6. Kim Fawcett, field crew leader



Figure 7. October 2002 crew at 75 mile (missing 5 people)



Figure 8. November 2002 crew at Cove Canyon (missing 3 people)

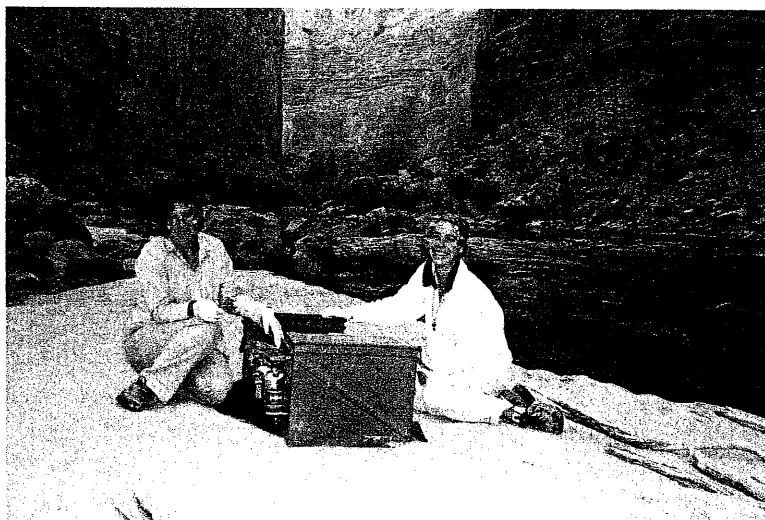


Figure 9. Kate and Kim filling herbicide sprayers at camp

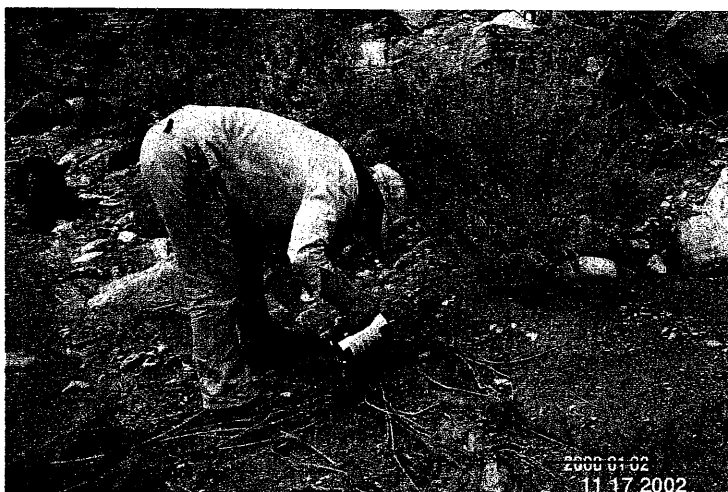


Figure 10. Kate spraying cut tamarisk stems



Figure 11. Target spraying cut tamarisk stems

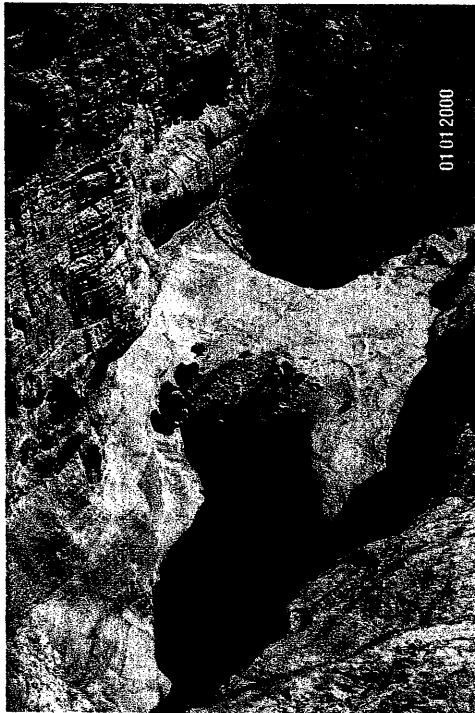


Figure 12. Pulling seedlings above pour-over at Upper Blacktail

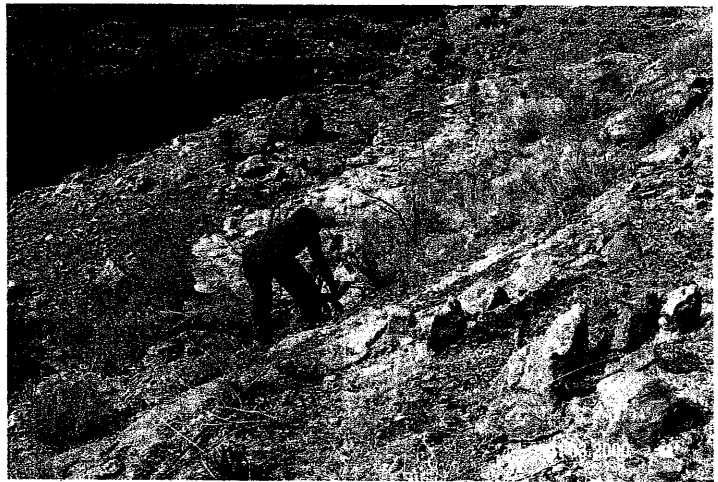


Figure 13. Pulling seedlings at small seep on desert slope, Upper Blacktail

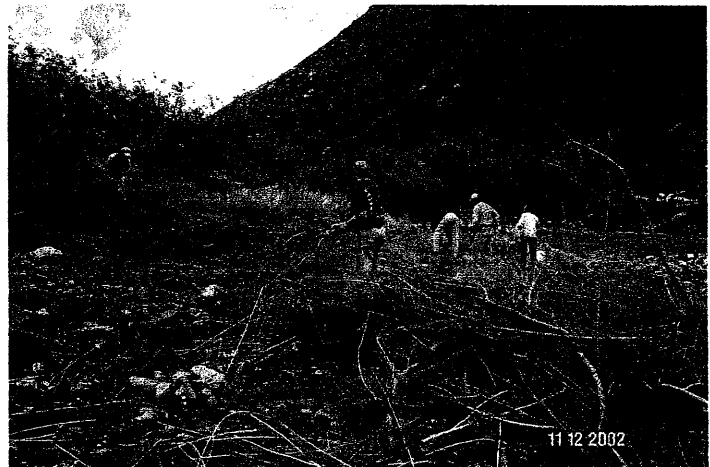


Figure 14. Crew hauling brush at Lava Chuar



Figure 15. Lopping sapling branches, Bessie's Camp Creek



Figure 16. Using small saw to cut saplings, Forster Canyon



Figure 17. Using large saw to cut mature, Buckfarm Canyon

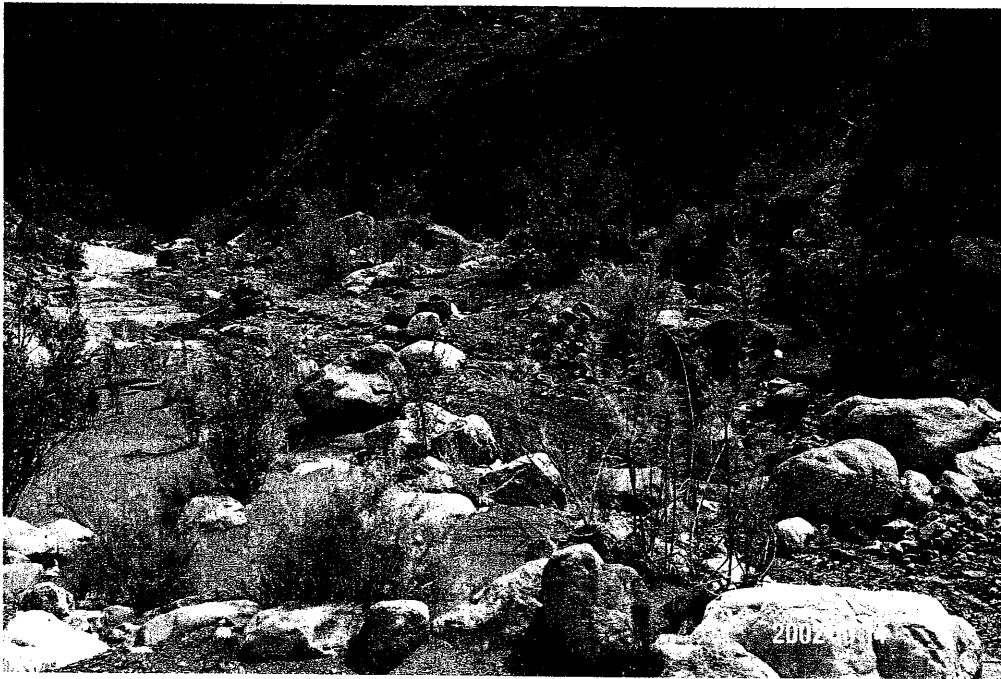


Figure 18. Using every technique on very large mature tree, Lava Chuar

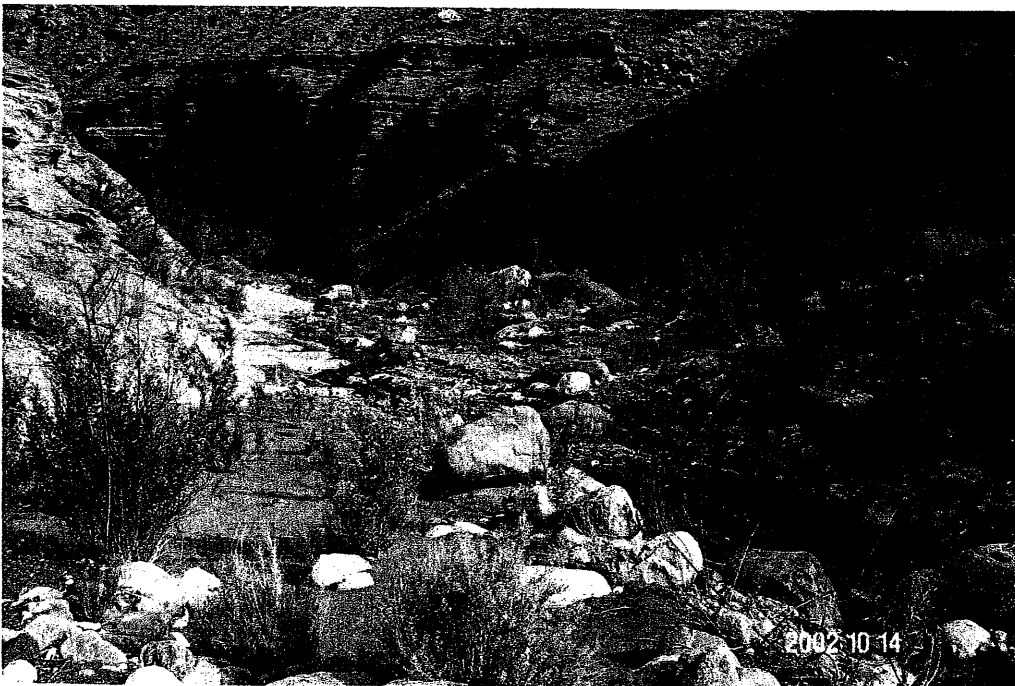


Figure 19. Large saws on a very large tree, Bessie's Camp Creek

Appendix B
Photodocumentation Representative Photographs



Kwagunt 8 view 2, pre-work, 10-14-2002



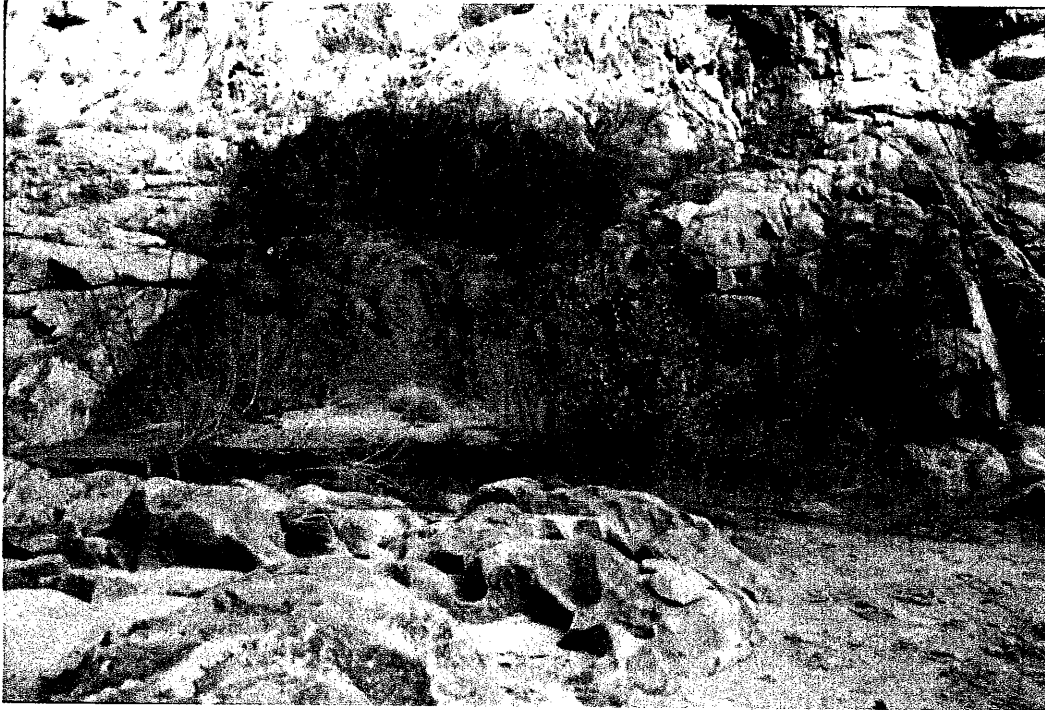
Kwagunt 8 view 2, post-work, 10-14-2002



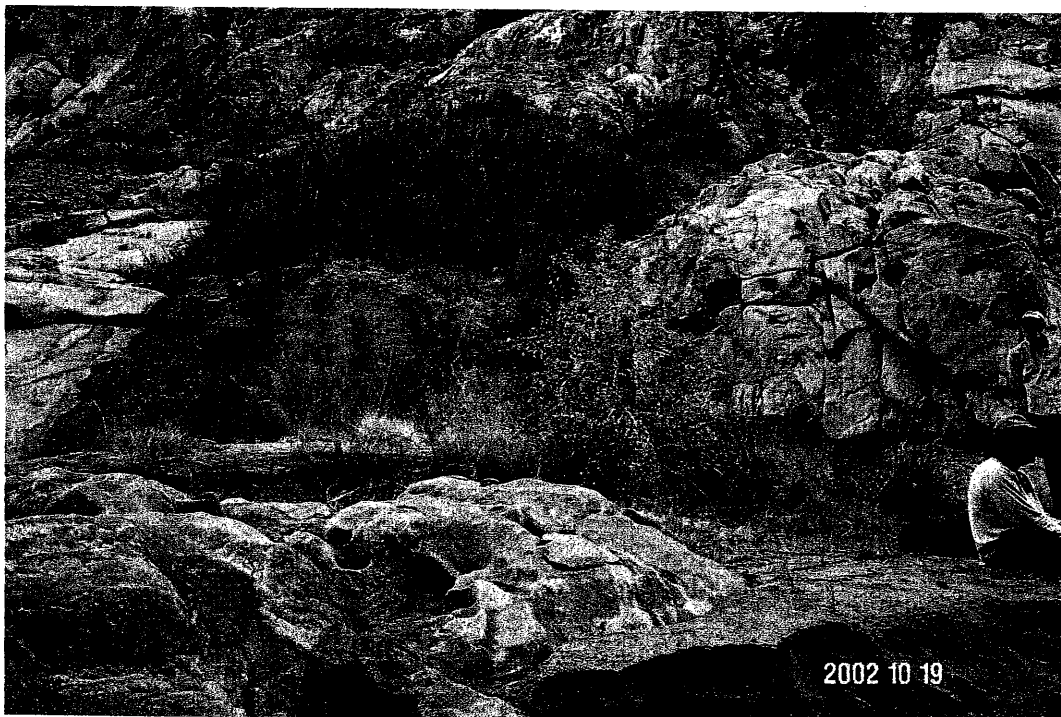
Lonetree 1, view 1, pre-work 10-2000



Lonetree 1, view 1, post-work 10-18-2002



85 Mile Spring 1 View 1, pre-work 10-2000



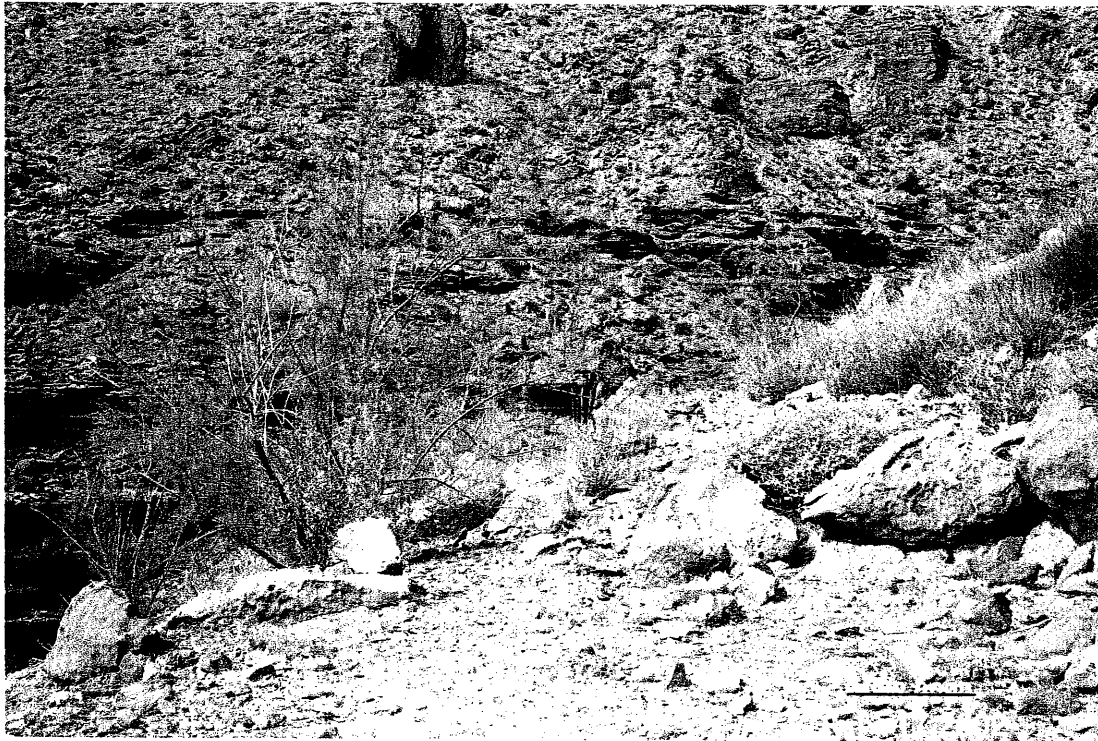
85 Mile Spring 1 View 1, post-work 10-19-02



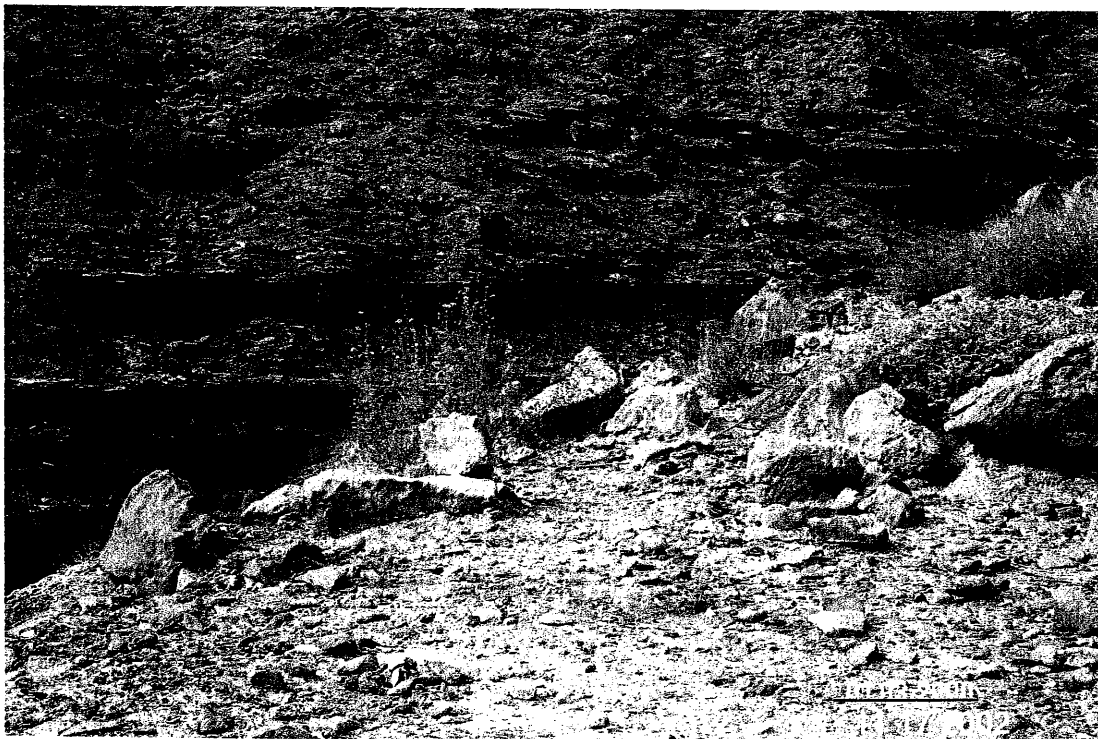
Trinity 1, pre-work, 11-13-2002



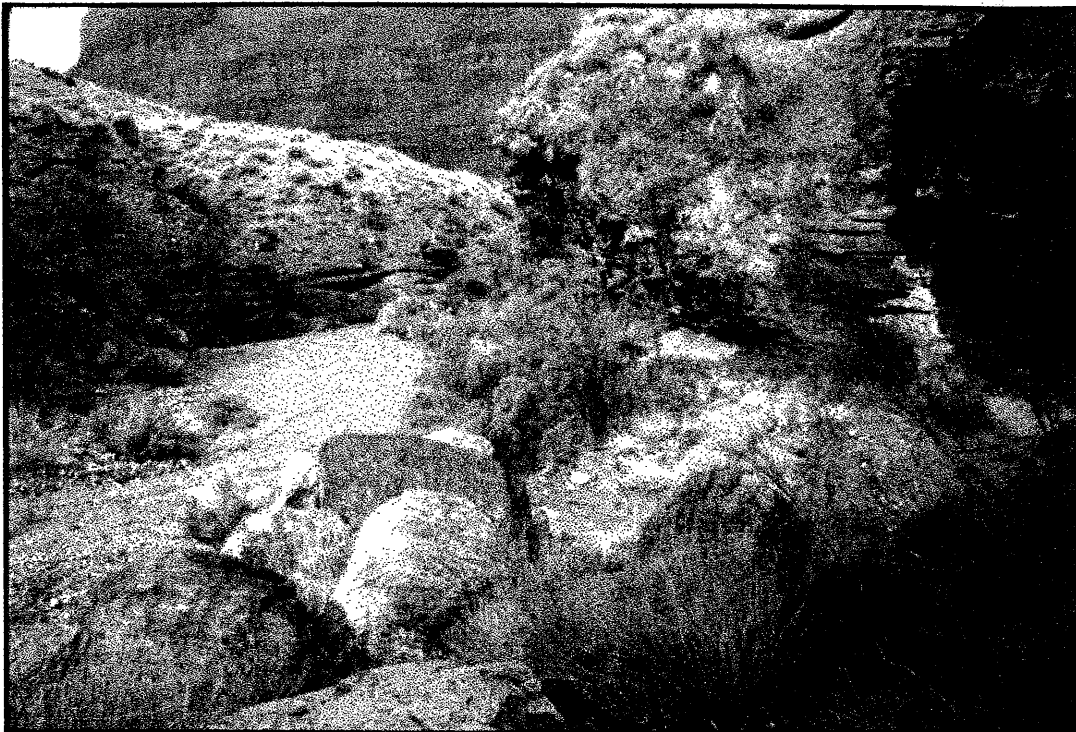
Trinity 1, post-work, 11-13-2002



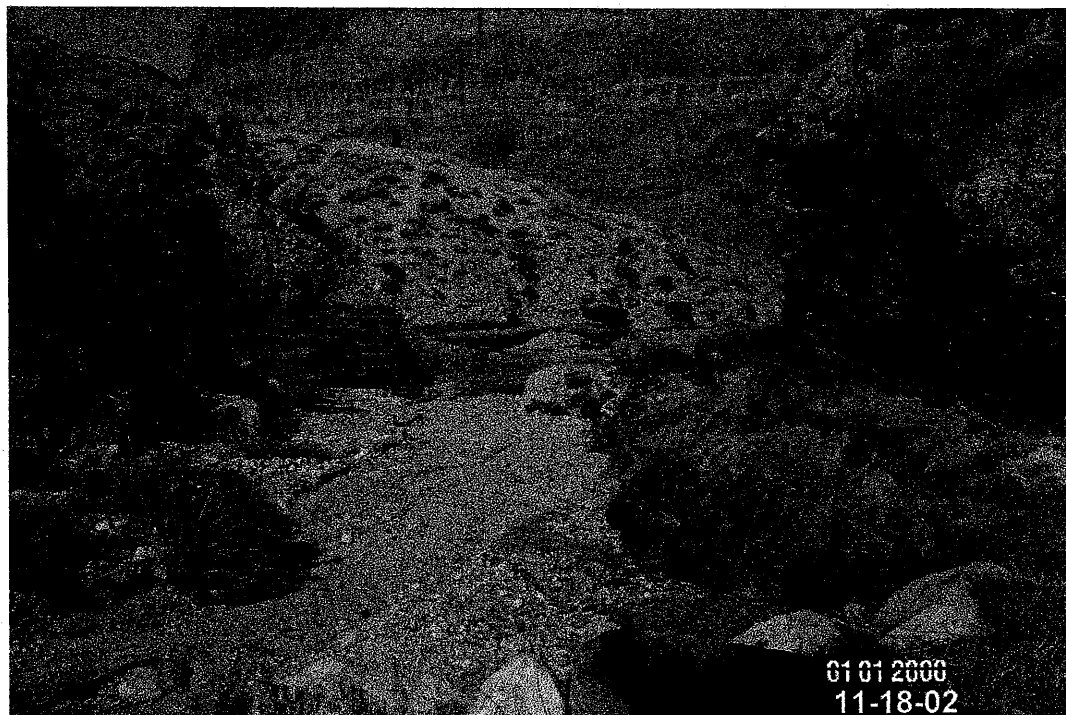
Upper Blacktail 1, pre-work, 11-17-2002



Upper Blacktail 1, post-work 11-17-2002



Forster 3 view 1, pre-work 10-2000



Forster 3 view 1, post-work 11-18-02

Appendix C

Photopoint Data for Tamarisk Eradication Project

Photopoint Name	Date	Time #	View #	Camera Height	Compass Bearing	F-stop	Lens Size	Speed	Focus Distance	Vertical / Horizontal		Photopoint Description / Comments	View From Photopoint
										Easting	Northing		
Soap 1	10/13/00	1643	1	5'2"	275	28	5.6	60	infinity	0438003	4065942	H	Start point of Soap Transect #1
Soap 1	10/13/00	1643	2	5'2"	96	28	5.5	60	infinity	"	"	H	Down canyon toward river
Soap a	10/13/00	1645	1	5'2"					infinity			H	Shows start point boulder of transect #1
Soap b	10/13/00	1650	1	5'2"					infinity			H	Overview of Soap transect #1 - shows start point
Soap c	10/13/00	1655	1	5'2"					infinity	0437964	4065967	H	Overview of Soap transect #2
North 1	10/14/00	1145	1	5'8"	70	85	4.5	125	infinity			H	20 minutes up canyon
North 1	10/14/00	1145	2	5'8"	236	28	8	125	infinity			H	
Tatahatso 1	10/15/00	1155	1	5'2"	305	30	8	60	infinity	0423755	4032133	H	3 satellites - 2840m elevation
1st Redbud Alcove 1	10/15/00	1300	1	2.5'	112	45	5.6	60	infinity			H	7.5m from and parallel to uppermost tamarisk
2nd Redbud Alcove 1	10/15/00	1400	1	5'2"	270	28	4	30	infinity			H	75m from back wall - 2 large boulders, point on alcove side of boulders
2nd Redbud Alcove 1	10/15/00	1400	2	5'2"	197	28	5.6	60	infinity			H	Focus on divot in redwall across alcove
2nd Redbud Alcove 1	10/15/00	1305	3	5'2"	122	28	5.6	125	infinity			V	Toward mouth of alcove
Buckfarm 1	10/13/02	0822	1	5'2"	295	35			infinity			V	Toward chockstone - still with tamarisk present
Buckfarm 1a	10/13/02	822		5'2"		35			infinity			H	Down canyon
Buckfarm 2	10/13/02	927	1	5'2"	245	35			infinity			H	East side of drainage after you drop back into drainage from E side climb around
Buckfarm 2a	10/13/02	0930		5'2"		35			infinity			H	Down canyon - easy spot to find

Photopoint Name

Date

Time

View #

Camera Height

Compass Bearing

F-Stop

Lens Size

Speed

Focus Distance

North

East

Vertical / Horizontal

Photopoint Description / Comments

View From Photopoint

Buckfarm 3	10/13/02	1016	1	5'2"	282	35			infinity				V	Very end of canyon at large pouroff	Looking toward large pouroff and pool	
Buckfarm 3a	10/13/02	1017		5'2"		35			infinity				V	Lori at photopoint		
Berts 1	10/13/02	0837	1	3'	59	35			infinity				H	100m up canyon to first big rock, standing on rock	Down canyon	
Berts 1a	10/13/01	0839		5'4"	240								V	Next to sawgrass, looking up	Beginning of photopoint	
Kwagunt 1	10/13/02	1500	1	5'	74	35			infinity	0425306	4012996		H	Against rock left of alluvium	Large boulder on left	
Kwagunt 1a	10/13/02	1501		5'	3	35			infinity				H		View of photopoint	
Malgosa 1	11/10/02	1005	1	5'	104	35			infinity	n/a			H	Midpoint above first cliff	Looking down canyon from large redwall rock	
Malgosa 1a	11/10/02	1007		5'	284	35			infinity				V		View of photopoint - looking up canyon at large limestone rock	
Malgosa 2	11/10/02	1245	1	5'	208	35			infinity	0424542	4010871		V		Looking up canyon	
Malgosa 2a	11/10/02	1250		5'	28	35			infinity				H		View of photopoint - looking down canyon	
Carbon 1	10/16/00	1305	1	5'2"	243	28	8	60	infinity	0425665	4001132		V	Start point of Carbon transect #1	Toward endpoint of transect #1	
Carbon 1	10/16/00	1305	2	5'2"	112	28	8	60	infinity	"	"		V			
Carbon a	10/16/00	1310	1	5'2"					infinity				H	8m down canyon from start point of Carbon transect #1	Shows start point of transect #1	
Carbon 2	10/16/00	1335	1	5'2"	56	28	5.6	60	infinity	0425617	4001103		H	Endpoint of Carbon transect #1	Startpoint of transect #1	
Carbon 3	10/16/00	1354	1	5'	77	35	11	250	infinity	0425360	4001193		H	Start point of Carbon transect #2	Endpoint of transect #2	
Carbon 3	10/16/00	1354	2	5'	300	33	11	125	infinity	"	"		H		Up drainage toward North Rim	
Carbon b	10/16/00	1354	1	5'					infinity				H		Shows start point of transect #2 (brain rock)	
Carbon 4	10/16/00	1400	1	5'2"	257	50	5.6	125	infinity	0425409	4001206		H	Endpoint of Carbon transect #2	Start point of transect #2	
Carbon 5	10/16/00	1430	1	5'	122	45	11	250	infinity	0425082	4001307		H	~200m up Carbon drainage from Carbon 3 (brain rock), on ridge of N. side of drainage	Down canyon	
Carbon 5	10/16/00	1430	2	5'	234	28	11	250	infinity	"	"		V		Up canyon	
Carbon c	10/16/00	1430	1	5'2"					infinity				H		Rachel on Carbon 5 photopoint	

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	F-stop	Speed	Focus Distance	Nothing	Easting	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint	
Carbon 6	10/16/00	1505	1	5'2"	240	28	5.6	125	infinity	0425187	4001285	H	Start point of transect #3, read 2m on NW side of tape	End point of transect #3
Carbon 6	10/16/00	1504	2	5'2"	282	28	5.6	125	infinity	"	"	V	Shows peak through TARA thicket	
Carbon 7	10/15/02	1300	1	5'	?	35			infinity	0425362	4001190	H	From new brain rock	Down narrows
Carbon 7a	10/15/02	1300		5'					infinity				Emily at photopoint	Note brainrock
Lava Chuar 1	10/16/00	1610	1	5'2"	308	85	5.6	250	infinity	0425279	3999819	H	Up Lava Chuar drainage from where trail drops in. Large boulder on left side of creekbed if looking up canyon	Overview
Lava Chuar 1	10/16/00	1610	2	5'2"	64	85	11	250	infinity	"	"	H		Shows numerous seedlings
Lava Chuar 1	10/16/00	1610	3	5'2"	107	85	8	250	infinity	"	"	H		Overview
Lava Chuar a	10/16/00	1610	1	5'2"					infinity			H		Lava Chuar 1 - with Fred and Chris
Lava Chuar 2	10/16/00	1635	1	5'	144	85	4.5	125	infinity	0425827	3999676	H	Start point of Lava Chuar transect #1	Endpoint of Lava Chuar transect #1
Lava Chuar 2	10/16/00	1635	2	5'	346	30	5.6	60	infinity	"	"	H		
Lava Chuar b	10/16/00	1645	1	5'	268				infinity			H		Lava Chuar 2 - start of transect #1 with Chris and Rachel
Lava Chuar c	10/16/00	1645	1	5'	219				infinity			H		View of ridgeline from Lava Chuar transect #1 area
Lava Chuar 3	10/16/00	1655	1	5'	320	35	4	60	infinity	0425863	3999630	H	Endpoint of Lava Chuar transect #1	Start point of Lava Chuar transect #1
Lava Chuar 4	10/17/00	0830	1	5'	138	50	11	250	infinity	0426119	3999530	H	Start point of Lava Chuar transect #2	End point of Lava Chuar transect #1
Lava Chuar 4	10/17/00	0830	2	5'	310	85	8	250	infinity	"	"	V		Shows running water and seedlings
Lava Chuar d	10/17/00	0830	1	5'	246				infinity			H		Chris at start of transect #2 - on Dox boulder in drainage
Lava Chuar 5	10/17/00	0857	1	5'4"	320	85	11	500	infinity	0426145	3999492	H	End of transect #2	Start of transect #2
Lava Chuar 6	10/17/00	0920	1	5'4"	340	85	11	250	infinity	0426133	3999545	V	From on top of Dox boulder on edge of drainage	Down into Lava Chuar
Lava Chuar 6	10/17/00	0920		5'4"	235	85	8	250	infinity	"	"	H		Chris at Lava Chuar 4 photopoint
Lava Chuar e	10/17/00	0925		5'4"	46				infinity			H		Fred standing at Lava Chuar 6 photopoint

Photopoint Name Date Time # Camera Height Compass Bearing Lens Size F-Stop Speed Focus Distance Northing Easting Vertical / Horizontal Photopoint Description / Comments View From Photopoint

Lava Chuar 7	10/17/00	0930	1	5'	110	28	11	125	infinity	0426300	3999481	H	Start point of transect #3	End point of transect #3	
Lava Chuar 7	10/17/00	0930	2	5'	234	28	11	125	infinity	"	"	H		Rachel at start point of transect #3 (Lava Chuar 7 photopoint)	
Lava Chuar f	10/17/00	0935		5'					infinity			H		Chris and Rachel dropping point 2m from transect #3 tape	
Lava Chuar g	10/17/00	0935		5'					infinity			H		Start point of transect #3	
Lava Chuar 8	10/17/00	1015	1	5'	284	50	11	250	infinity	0426344	3999466	H	End point of transect #3	Shows dense tamarisk on edge of transect tape	
Lava Chuar 8	10/17/00	1015	2	5'	240	28	8	60	infinity	"	"	H		Looking down canyon - cochise butte - bearing estimate of NE	
Palisades 1	10/16/02	1028	1	5'4"	45	35			infinity	0428163	3998476	H	Standing on tapeats/BA contact	Looking up toward redwall - bearing estimate of SW	
Palisades 1a	10/16/02	1030		5'4"	225	35			infinity			V	25m down canyon from photopoint	Looking down canyon - temple butte	
Palisades 2	10/16/02	1045		2'5"	45	35			infinity	0488124	3998548	H	Red boulder	Looking SW at red rock - bearing estimate of SW	
Palisades 2b	10/16/02	1041		5'5"	225	35			infinity	0428129	3998552	H	On large red boulder		
Lonetree 1	10/19/00	0910	1	5'8"	32	36	5.6	60	infinity			H	~300m from river at pool just below pour off and just before steep climb	Looking upstream from boulder - 2 trees up canyon	
Escalante 1	10/17/02	1400	1	5'2"	?	35			infinity			H	Right fork of canyon	Looking down canyon	
Escalante 1a	10/17/02	1400											Emily at photopoint		
75 mile 1	10/17/02	1529	1	3'5"	251	35			infinity	0420681	3988485	H	Sitting on red rock on shinamu on E side of drainage	Looking up canyon	
75 mile 1	10/17/02	1530	2	3'5"	4	35			infinity	"	"	H		Shinamu ledge - Kate sitting	
75 mile 1a	10/17/02	1532		5'4"	60	35			infinity			H	Standing on debris near edge of dryfall	Looking to east wall - Kate sitting on photopoint	
75 mile 1b	10/17/02	1536		5'4"	196	35			infinity			H	Standing on debris in middle of draining		

Photopoint Name Date Time View # Camera Height Compass Bearing Lens Size F-Stop Speed Focus Distance Easting Northing Vertical / Horizontal Photopoint Description / Comments View From Photopoint

Vishnu 1	10/18/02	1400	1	52"	17	35						0428114	3998542	H	On schist by agave	View up canyon
Vishnu 1a	10/18/02	1400			200									H	~20m upcreek of large agave - spring on creek left	View of photopoint - looking down creek
Vishnu 2	10/18/02	1440	1	2'5"	4	35						infinity	3990731	H	Standing on largest boulder	View up creek of line of TARA mixed with bcharis
Vishnu 2a	10/18/02	1423			180	35						infinity		H	Boulder with red surface down in drainage	Looking down canyon to photopoint
Vishnu 3	10/18/02	1630	1	5'	46	35						infinity	3990979	H	Standing next to large white dike on creek right	View upcreek toward rock "gate"
Vishnu 3a	10/18/02	1630			281	35						infinity			Large granite boulder midcreek -	Looking down canyon to photopoint
85 mile Spring 1	10/19/00	1020	1	5'	11	28	8	125				infinity		H	Rock in middle of sandy area below spring, ~200m below Zoroaster rapid	Toward spring
85 mile Spring 1	10/19/00	1020	2	5'	118	35	11	125				infinity		H		Up river toward Zoroaster rapid
Bright Angel 1	10/20/00	0821	1	5'	286	28	5.6	60				infinity	3995355	H	Lower bridge to water treatment plant - from 5th silver post from S side of bridge	Up Bright Angel Creek
Bright Angel 2	10/20/00	0836	1	5'	170	28	5.6	60				infinity	3995785	H	From Phantom Ranch trail crew bunkhouse, porch steps on down creek side	Down canyon
Bright Angel 3	10/20/00	0917	1	5'	198	28	8	60				infinity	3995553	H	E. side of creek - across from 2nd campsite up from stone bathroom	
Bright Angel 3	10/20/00	0917	2	5'	166	50	5.6	125				infinity	"	H	in campground - standing on rock on W. side of trail	
Bright Angel 3	10/20/00	0917	3	5'	316	48	8	125				infinity	"	H		
Salt Creek 1	10/20/00	1410	1	5'8"	326	28	5.6	30				3m	3995047	H	300m up canyon - corners from river	
Salt Creek a	10/20/00	1410	1	5'								infinity		H	Chris at Salt Creek 1	
94 mile 1	10/20/00	1540	1	5'	200	28	5.6	60				5m	3995568	H	Huge white boulder on right side of drainage as walking up canyon	
94 mile 1	10/20/00	1540	2	5'	351	50	5.6	60				infinity	"	H	250m from boat parking	
94 mile a	10/20/00	1540	1									infinity		H		94 mile 1 photopoint
94 mile 2	10/20/00	1605	1	5'8"	326	28	5.6	60				infinity	3995976	H	760m up canyon, past cave on left around next corner into gray/pink stretch, ~30m from previous corner	

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	F-Stop	Speed	Focus Distance	Northing	Easting	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
Serpentine a	10/21/00	1041	1	5'				infinity			H	Serpentine 1 photopoint with Chris and Fred on rock on SSE side of wash	
Serpentine 1	10/21/00	1041	1	5'	3	28	11	125	0380566	4007352	H		
Serpentine b	10/21/00	1107	1	5'							H	Serpentine 2	
Serpentine 2	10/21/00	1107	1	5'	?	37	11	125	0380140	4007309	H	Up canyon at clump of saplings and matures	
Serpentine c	10/21/00	1233	1	5'				infinity			H	Chris and Lori at Serpentine 3 - start of transect #1	
Serpentine d	10/21/00	1233	1	5'				infinity			H	" - wider angle	
Serpentine 3	10/21/00	1235	1	5'	248	30	11	250	0380190	4007327	H	Start of transect #1	
Serpentine 3	10/21/00	1235	2	5'	28	34	8	125	"	"	H		
Serpentine 4	10/21/00	1300	1	5'	76	28	5.6	60	0380146	4007312	H	End of transect #1	Start of transect #1
Serpentine e	10/21/00	1325	1	5'				infinity			H	Chris with board at Serpentine 5	
Serpentine 5	10/21/00	1325	1	5'	314	28	8	60	0380557	4007355	H	End of transect #2	
Serpentine 6	10/21/00	1345	1	5'	134	40	5.6	125	0380505	4007380	H	Start of transect #2	
Hotauta 1	10/21/00	1551	1	5'	266	50	5.6	125	0380803	4010170	H	Up canyon at big table rock	End of transect #1
Hotauta a	10/21/00	1600	1	5'	72			3.5m			H	Chris and Lori at Hotauta 1 - transect #1 start point	
Hotauta 2	10/21/00	1610	1	5'	94	40	3.5	30	0380752	4010167	H	End of transect #1	Start of transect #1 - Lori in photo
Hotauta b	10/21/00	1635	1	5'	170			infinity			V	Creek bed	Folks at Hotauta 3
Hotauta 3	10/21/00	1635	1	5'	30	28	35	30	0380186	4010199	H	Rock ledge on right as walking up canyon	Stream bed
Waltenberg a	10/22/00	1040	1	5'2"	30	20		infinity			V	12.5m on transect #1 tape	Start point of transect #1 below dry fall
Waltenberg 1	10/22/00	1040	1	5'2"	194	40	8	125			V	Start of transect #1	End of transect #1 - can see tapeats above with small TARA stand, baccharis, Aristida, Acacia
Waltenberg 2	10/22/00	1055	1	5'2"	14	28	8	125			H	End of transect #1	Start of transect #1 - shows pools

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	F-Stop	Speed	Focus Distance	Northing	Easting	Vertical / Horizontal	Photopoint Description / Comments	Fred drawing	View From Photopoint
Waltenberg b	10/22/00	1100	1	5'2"				infinity			H	Lower portion of canyon	Shows narrow and scoured portion with little vegetation	
Waltenberg c	10/22/00	1125	1	5'2"				infinity			H	Standing on shist (south) ledge of drainage - first spot after tonto trail drops into drainage	Looking down canyon toward river	
Garnet 1	11/17/02	1010	1	5'	275	70		infinity	0372289	4008469	H			
Garnet 1	11/17/02		2		84	70		infinity	"	"	V		Looking up canyon with view of redwall	
Garnet 1a	11/17/02							infinity	0372292	4008463	V	Standing just east of photopoint	Kate at photopoint	
Garnet 2	11/17/02	1208	1	5'	330	35		infinity	0372380	4008396	V	Standing in middle of drainage on shist rock	Looking downcanyon	
Garnet 2a	11/17/02	1321		5'	150	35		infinity			V	From drainage	Looking up canyon at photopoint	
Elves a	10/22/00	1333	1	5'				infinity			H		Lori at Elves 1 - start of transect #1	
Elves 1	10/22/00	1333	1	5'	260	28	125	2m	0369668	4006613	H	Start of transect #1 - E. side of creek just above 1st fall from river	End of transect #1	
Elves 1	10/22/00	1333	2	5'	222	50	125	infinity	"	"	H		Up canyon	
Elves 1	10/22/00	1333	3	5'	320	30	125	infinity	"	"	H		Down canyon - trees are below 45,000 cfs	
Elves 2	10/22/00	1409	1	5'	80	28	125	5m	0369622	4006599	H	End of transect #1	Start of transect #1	
Elves 3	10/22/00	1423	1	5'	33	28	60	3m	0369690	4006613	H		Shows TARA mixed in with baccharis, redbud and acacia	
Elves b	10/22/00	1423	1	5'	338			infinity			H	Standing above	Lori at Elves 3	
Elves 4	10/22/00	1430	1	5'	242	28	60	5m	0369668	4006579	H	Crack of a house-sized boulder	Scattered TARA	
Elves 4	10/22/00	1430	2	5'	253	28	125	5m	"	"	H		Toward river	
Elves c	10/22/00	1435	1		190			infinity			V		Lori at Elves 4 - can see 3rd waterfall in background	

Photopoint Name Date Time View # Camera Height Compass Bearing Lens Size F-Stop Speed Focus Distance Easting Northing Vertical / Horizontal Photopoint Description / Comments View From Photopoint

Bighorn Wash 1	10/22/00	1620	1	5'	224	35	5.6	60	infinity	0369014	4007125	H	Tapeats ledge W. of large pour off	Upper basin with TARA, cottonwoods and lush riparian vegetation	
Bighorn Wash a	10/22/00	1630	1	5'					infinity			V		Bighorn Wash 1	
Bighorn Wash b	10/22/00	1630	1	5'	266				infinity			H		Bighorn Wash 2	
Bighorn Wash c	10/22/00	1630	1	5'	104				infinity			H		Start of transect #1	
Bighorn Wash 2	10/22/00	1700	1	5'	62	33	5.6	60	5m	0368902	4007036	H	Start of transect #1	End of transect #1	
Bighorn Wash 2a	10/22/02	1635		5'2"	243	35			infinity	0368902	4007036			View of Bighorn Wash 2 - new photo	
Bighorn Wash 3	10/22/00	1730	1	5'	244	35	3.5	30	25m	0368951	4007061	H	End of transect #1	Start of transect #1 - note riparian vegetation and cottonwood tree	
Lower Blacktail 1	10/23/00	1000	1	5'2"	30	85	4.5	60	4.5m			V	Start of transect #1	End of transect #1	
Lower Blacktail 1	10/23/00	1000	2	5'2"	180	28	5.6	60	infinity			V		Down canyon	
Lower Blacktail a	10/23/00	1010	1	5'2"	192				infinity			H		Rachel at start point of transect #1	
Lower Blacktail b	10/23/00	1010	1	5'2"					infinity			H	Along transect #1	Shows TARA seedlings present	
Lower Blacktail 2	10/23/00	1025	1	5'2"	210	35	4	60	infinity			V	End of transect #1	Start of transect #1	
Upper Blacktail 1	11/17/02	1209	1	2'5"	299	35			infinity	0367922	4011815	H	Seep/spring in tapeats layer on R side going up canyon	Across spring seep toward blacktail canyon	
Upper Blacktail 1a	11/17/02	1209		5'6"	119	35			infinity			V		Kim at photopoint	
Upper Blacktail 2	11/17/02	1519	1	5'5"	345	35			infinity	0368084	4012322	H	Looking R to L heading upstream across drainage at V in tapeats	Mature and saplings across canyon	
Upper Blacktail 2a	11/17/02	1520		5'5"	74	35			infinity			H		Kim at photopoint	
Forster 1	10/23/00	1332	1	5'8"	252	35	8	125	infinity	0363437	4011992	H	Start of transect #1	End of transect #1	
Forster 1	10/23/00	1332	2	5'8"	68	37	8	125	infinity	"	"	H		Down canyon	
Forster 1	10/23/00	1332	3	5'8"		35	56	60	1m	"	"	H		Chris's feet at start point of transect #1	
Forster a	10/23/00	1337	1		171				infinity			H	Mid-drainage	Dave and Lori at start of transect #1	
Forster 2	10/23/00	1350	1	5'8"	72	28	8	125	infinity	0363390	4011974	H	End of transect #1	Start of transect #1	

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	F-Stop	Speed	Focus Distance	Nothing	Eastings	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint	
Forster 3	10/23/00	1403	1	5'	20	28	11	125	3m	0363340	4011389	H	E. side of bend in creekbed - near small seep 410m from river	
Forster 3	10/23/00	1404	2	5'	328	28	11	125	3m	"	"	H		
Forster b	10/23/00	1420	1	5'					infinity			H		Sapling TARA growing out of ledge near seep
Forster c	10/23/00	1420	1	5'					infinity			H		Forster 3 with Fred
Specter 1	10/24/00	1040	1	5'2"	322	28	11	125	1.5m	0366731	4020182	H	Start of transect #1	End of transect #1
Specter 1	10/24/00	1040	2	5'2"	222	28	11	125	infinity	"	"	H		Toward wash with TARA opposite transect #1
Specter a	10/24/00	1050	1	5'2"	16				infinity			H	Wash below transect	Specter 1 - transect #1 start point with Chris and Tim
Specter b	10/24/00	1050	1	5'2"					infinity			H		Dave transecting
Specter 2	10/24/00	1100	1	5'2"	148	28	11	250	2m	0366700	4020224	V	End of transect #1	Start of transect #1
Specter c	10/24/00	1105	1	5'2"					infinity			V		TARA washed over
Specter 3	10/24/00	1120	1	5'2"	267	28	8	125	3m	0366757	4020184	H	Start of transect #2	End of transect #2
Specter d	10/24/00	1130	1	5'2"					infinity			H		Rachel at start of transect #2
Specter 4	10/24/00	1149	1	5'2"	95	28	11	125	2.5m	0366699	4020170	H	End of transect #2	Start of transect #2
Specter 5	10/24/00	1149	1	5'2"	106	85	5.6	125	infinity	0367243	4019773	H		Toward river
Specter e	10/24/00	1200	1	5'	332				infinity			H		Lori at Specter 5
Cranberry a	10/25/00	1310	1	5'2"					infinity			H	11.5m from transect #1 start	Dave at Cranberry 1
Cranberry 1	10/25/00	1315	1	5'2"	10	28	11	250	infinity	0361693	4029519	H	Start of transect #1	End of transect #1
Cranberry 1	10/25/00	1315	2	5'2"	357	28	11	125	infinity	"	"	V		Up canyon - shows cottonwoods
Cranberry 1	10/25/00	1315	3	5'2"	214	28	11	125	infinity			V		Down canyon - shows next layer below tapeats
Cranberry b	10/25/00	1335	1	5'2"	90				infinity			H	W. side of drainage looking East	Dave in seep willow and TARA
Fishtail 1	11/20/02	1020	1	5'5"	19	35			infinity			H	Standing on large rock in rockfall	View of TARA grove
Fishtail 1a	11/20/02	1020		5'5"	270	35			infinity			V		Kim in rockfall with camer

Photopoint Name	Date	Time #	Camera Height	Compass Bearing	F-Stop	Speed	Focus Distance	Northing	Easting	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
142 mile spring 1	10/24/02	1106	1	5'2"	16	35	infinity	0356703	4029027	H	From beach	Spring and veg below
142 mile spring 1	10/24/02	1106	2	5'2"	112	35	infinity			H	From beach	Upriver
142 mile spring 1a	10/24/02	1108		5'2"		35	infinity			H	From beach	Lori at photopoint - looking up river
148 Mile Spring 1	11/19/02	1130	1	5'	19	35	infinity			V	Big limesonte rock just downstream of spring	Looking upstream at mature TARA in seep
148 Mile Spring 2	11/19/02	1145	1	5'	100	35	infinity			H	From behind spring on muav shelf	Looking into spring
148 Mile Spring 2a	11/19/02	1148		5'	280	35	infinity			V		Kate on Muav shelf photopoint
Ledges a	10/26/00	1115	1	5'8"	290		infinity			H		Lori at Ledges 1
Ledges 1	10/26/00	1119	1	5'2"	241	45	60			H	2nd ledge layer	Shows lower vegetation - diverse with some TARA
Ledges 2	10/26/00	1135	1	5'	162	85	125			H		TARA in pools with riparian vegetation
Ledges 2	10/26/00	1135	2	5'	302	28	45			V		Upper spring - no TARA
Ledges b	10/26/00	1140	1	5'	300		infinity			V		Chris at Ledges 2
Slimey Tick 1	10/26/00	1330	1	5'2"	300	40	11	0342562	4021270	H	Before final drop down into the canyon	Some TARA mixed in with cattails, willows and grasses
Slimey Tick 1	10/26/00	1330	2	5'2"	220	28	11	"	"	H		Lower pool above steep Muav drop off above river - no TARA
Slimey Tick a	10/26/00	1335	1	5'2"			infinity			H		Chris at Slimey Tick 1
Slimey Tick 2	10/26/00	1345	1	5'2"	342	28	11	0342533	4021296	V	Muav ledge below stairstep falls	Shows ash, monkey flowers, phragmites, cattails - up canyon
Slimey Tick 2	10/26/00	1345	2	5'2"	155	28	11	"	"	H		Down canyon
Slimey Tick b	10/26/00	1350	1	5'2"	170		infinity			H		Chris at Slimey Tick 2
Last Chance 1	10/26/00	1530	1	5'8"	82	28	5.6	0342146	4020880	H	Muav slab ~8m from dripping spring - start of transect #1	End of transect #1
Last Chance 1	10/26/00	1530	2	5'8"	36	32	5.6			H		Up river toward Zoroaster rapid
Last Chance 1	10/26/00	1530	3	5'8"	152	84	5.6			H		Down river

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	F-Stop	Lens Size	Speed	Focus Distance	Northing	Easting	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
Last Chance a	10/26/00	1545	1	5'8"					infinity			H	Chris and Lori at Last Chance 1	
Last Chance 2	10/26/00	1558	1	5'8"	264	28	5.6	60	1.4m	0342172	4020889	H	25m on transect tape - 45,000 cfs	Start of transect #1
Last Chance b	10/26/00	1600	1	5'8"					infinity			V	Chris at Last Chance 2	
Last Chance 3	10/26/00	1602	1	5'8"	320	28	4.5	125	infinity	0342176	4020878	H	Sand 4m from drainage	Shows TARA st spring with Lori
Stairway 1	11/21/02	1443	1	5'	48	35			infinity	0323699	4012003	V	On R side of drainage in Muav	Looking up canyon
Stairway 1a - missing														
Stairway 2	11/21/02	1500	1	5'	12	35			infinity	0323743	4012056	H	L side of drainage on rock	Up canyon
Stairway 2a	11/21/02	1505		5'	194	35			infinity			V	Left side of drainage on rock	Person at photopoint
Cove 1	10/28/00	1020	1	5'2"	196	28	5.6	60	1.75m			V	Start of transect #1 - large boulder clump ~100m below pour off at end of lower Cove	End of transect #1
Cove 1	10/28/00	1020	2	5'2"	285	28	5.6	60	2.5m			H		
Cove 1	10/28/00	1020	3	5'2"	144	28	5.6	60	2m			H		
Cove a	10/28/00	1030	1	5'2"	68				infinity			H		Chris and Rachel at Cove 1
Cove 2	10/28/00	1040	1	5'2"	196	30	8	60	2.5m			H	30m along transect tape	End of transect #1
Cove 2	10/28/00	1040	2	5'2"	267	28	8	60	2.5m			H		Toward wall
Cove 2	10/28/00	1040	3	5'2"	98	28	8	60	1.5m			H		Dense TARA
Cove b	10/28/00	1043	1	5'2"					infinity			H		Large pour over, pools, TARA
Cove 3	10/28/00	1045	1	5'8"	8	28	8	60	3m			H	Start of transect #2 - large boulder mid-drainage ~100m from transect #1 start	End of transect #2
Cove 3	10/28/00	1045	2	5'8"	292	28	8	60	3m			H		
Cove c	10/28/00	1045	1	5'8"					infinity			H		Rachel and Roy at Cove 3 - start of transect #2
Cove 4	10/28/00	1100	1	5'8"					infinity			H	35m on transect	End of transect #2
Cove 5	10/28/00	1105	1	5'8"	188	28	8	60	3m			H	End of transect #2	Start of transect #2
Cove 5	10/28/00	1105	2	5'8"	226	28	8	125	3m			H		
Cove 6	10/28/00	1110	1	5'8"	321	28	8	125	5m			H	NE side of drainage where there is a small drainage entering with pour over	
Cove 6	10/28/00	1110	2	5'8"	292	28	8	60	4m			H		
Cove 6	10/28/00	1110	3	5'8"	228	28	8	60	5m			H		
Cove d	10/28/00	1120	1	5'2"	60				infinity			V		Chris at Cove 6

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	F-Stop	Speed	Focus Distance	Northing	Easting	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
Cove 7	10/28/00	1127	1	5'	180	28	11	125	2m		H	mid-drainage rock	
Cove e	10/28/00	1130	1	5'				infinity			H		Lori and Chris at Cove 7
Upper Cove 1	11/22/02	0955	1	25"	338	35		infinity	0318942	4012760	H	Standing on white rock on R side or drainage	View of TARA grove
Upper Cove 1a	11/22/02	0955		6'				infinity			H		View of Kim standing at photopoint

*NOTE - The shaded rows depict photographs used for transect or photopoint relocation; they are general photographs and not intended to be photopoints.

Appendix D
Arizona Water Protection Fund
Grand Canyon National Park / Grand Canyon Wildlands Council
Tamarisk Eradication and Tributary Restoration Project
October 2002 Volunteer and Matching Hours

	10/8	10/9	10/10	10/11	10/12	10/13	10/14	10/15	10/16	10/17	10/18	10/19	10/20	10/21	10/22	10/23	10/24	10/25	10/26	10/27	10/28	10/29	Total
Alison Steen	6	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2	187
Anne Hadley	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	0	108
Bob Dye	0	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	179
Chris Londerback	6	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	185
Donna Koster	0	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	179
Emily King	0	0	9	9	9	9	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	72
Fred Phillips	0	2	9	9	9	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	2	0	67
Herman Grtego	0	6	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2	179
Kate Waters	2	2	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	179
Kelly Burke	8	8	8	9	9	9	9	9	9	9	9	0	0	0	0	0	0	0	0	2	9	8	115
Kim Crumbo	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	171
Kim Fawcett	10	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	193
Lisa Leap	0	0	0	9	9	9	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	63
Lori Makarick	0	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	188
Matt Goutram	0	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	179
Regis Mayo	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	5	0	95
RJ Johnson	0	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	179
Simone Sellin	0	6	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	181
Steven Till	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	0	99

NPS matching hours	323	PAID hours	1470	Total Hours	2798
				Total Volunteer Hours	1005
				Total Paid Hours	1470
NO FILL - Volunteer Hours				Total NPS Hours	323
				Total Project Hours	2798

Appendix E
Arizona Water Protection Fund
Grand Canyon National Park / Grand Canyon Wildlands Council
Tamarisk Eradication and Tributary Restoration Project
November 2002 Volunteer and Matching Hours

	11/6	11/7	11/8	11/9	11/10	11/11	11/12	11/13	11/14	11/15	11/16	11/17	11/18	11/19	11/20	11/21	11/22	11/23	11/24	11/25	11/26	Total
Alison Steen	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	179
Anne Minard	0	0	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
Beth Eisenberg	4	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	179
Bob Dye	0	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	180
Chris Landertbach	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	179
Dan Hall	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	179
Donna Koster	0	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	180
Johanna Divine	0	0	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	27
Kate Waters	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2	182
Kim Fawcett	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2	182
Lori Makarick	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	180
Margie Erhart	0	0	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
Matt Goutram	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	179
Mike Whalen	0	0	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	27
Monte Timminghast	9	9	9	9	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	9	9	90
Rona Lavein	0	9	9	9	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	63
Shawn Edwards	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9	0	117
Sheila Yokers	4	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	179
Simone Sellin	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	180
Steve Lomadafkie	0	0	0	0	0	0	4	9	9	9	9	9	9	9	9	9	9	9	9	9	0	121
Tom Schiavone	0	0	0	0	0	0	4	9	9	9	9	9	9	9	9	9	9	9	9	9	0	121

NPS matching hours 180

PAID hours 1368

Total Hours 2796

Total Volunteer Hours 1248

NO PHL - Volunteer Hours

Total Paid Hours 1548

Total NPS Hours

Total Project Hours 2796