National Park Service
Biological Resource Division

Riparian Invasive Plants and Site Restoration: A Careers Worth of Perspective

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Riparian Restoration Conference
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Grand Junction, Colorado

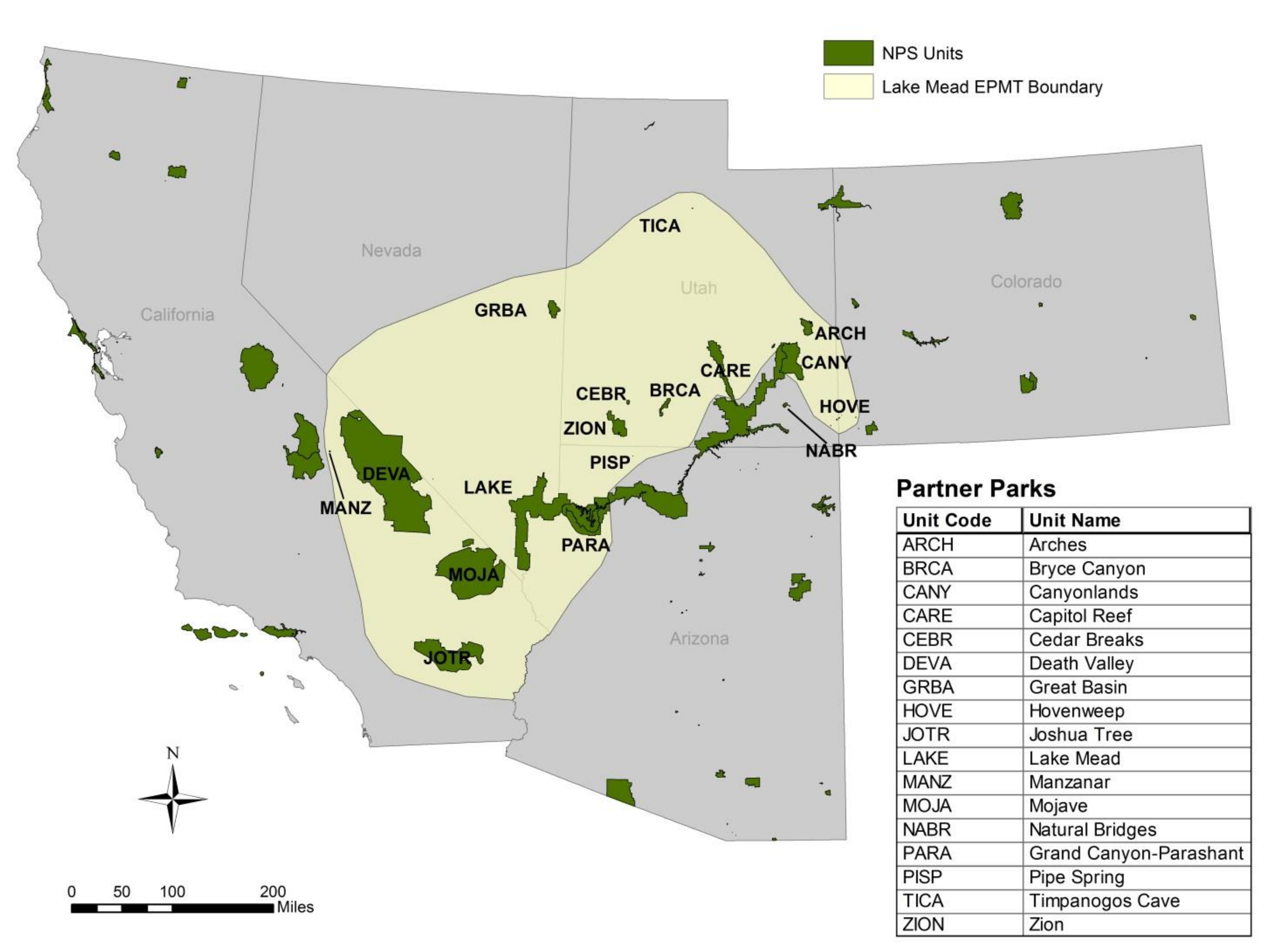
National Park Service
Biological Resource Division

NPS Exotic Plant Management Teams

EPMT boundaries.

National Park Service
Biological Resource Division

Lake Mead EPMT



Partner Parks

Unit Code	Unit Name
ARCH	Arches
BRCA	Bryce Canyon
CANY	Canyonlands
CARE	Capitol Reef
CEBR	Cedar Breaks
DEVA	Death Valley
GRBA	Great Basin
HOVE	Hovenweep
JOTR	Joshua Tree
LAKE	Lake Mead
MANZ	Manzanar
MOJA	Mojave
NABR	Natural Bridges
PARA	Grand Canyon-Parashant
PISP	Pipe Spring
TICA	Timpanogos Cave
ZION	Zion

National Park Service

Lake Mead Exotic Plant Management Team

- Regional travelling crew
- Support Multiple NPS Units
- Interagency partnerships
- USFWS, BLM, BOR
- US Forest Service
- Southern NV Water Authority
- Clark County, NV

Native Plant Recovery Following Invasive Woody Perennial Removal

THE EFFECTS OF TAMARISK REMOVAL ON DIURNAL GROUND WATER FLUCTUATIONS

Richard Inglis

Curt Deuser

Joel Wagner

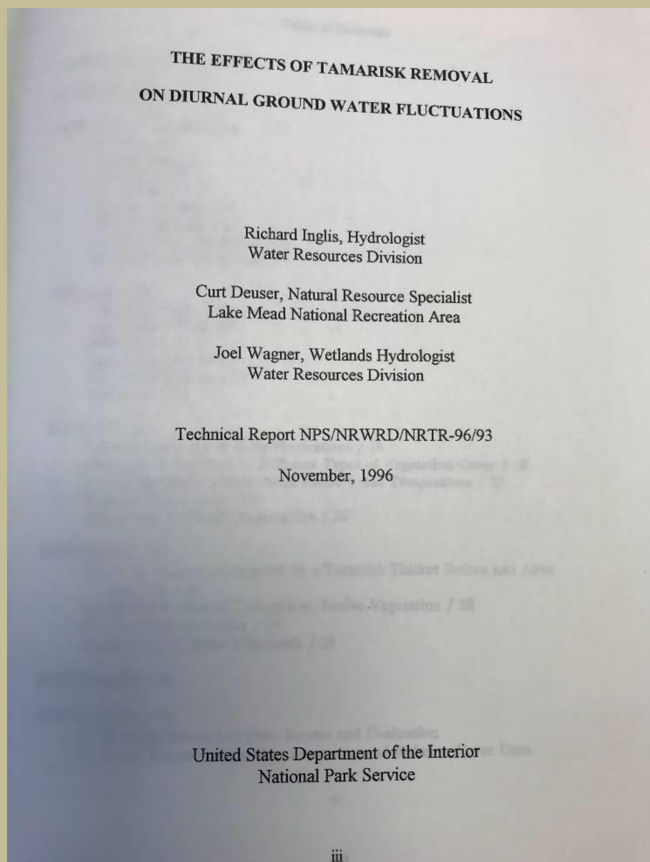
Technical Report NPS/NRWRD/NRTR-96/93

WATER RESOURCES DIVISION

National Park Service - Department of the Interior
Fort Collins - Denver - Washington

United States Department of the Interior • National Park Service

Diurnal Ground Water Fluctuations



THE EFFECTS OF TAMARISK REMOVAL
ON DIURNAL GROUND WATER FLUCTUATIONS

Richard Inglis, Hydrologist
Water Resources Division

Curt Deuser, Natural Resource Specialist
Lake Mead National Recreation Area

Joel Wagner, Wetlands Hydrologist
Water Resources Division

Technical Report NPS/NRWRD/NRTR-96/93

November, 1996

United States Department of the Interior
National Park Service

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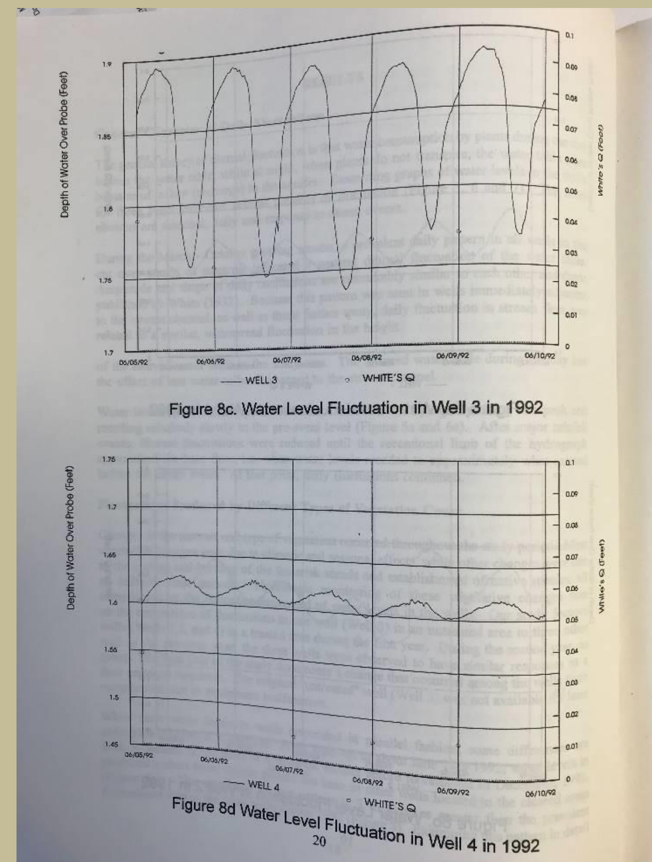

Figure 8c. Water Level Fluctuation in Well 3 in 1992

Figure 8d Water Level Fluctuation in Well 4 in 1992

Study Site: Sacatone Spring, NV
Lake Mead NRA

Site Before Treatment

One-Year
Post
Treatment

Four Year Post Treatment


Cottonwood Regeneration
1Year Post Treatment
Tamarisk stumps

Five Years

Post Treatment

Sugarloaf Spring, AZ Restoration

How Does Recovery Occur?

- Eliminate the direct competition
- **Soil moisture increases**
  - allows for native plant regeneration/recruitment
  - provides for active revegetation..seeding, transplanting, pole planting
- Follow up monitoring and maintenance is critical for first 2-3 years

How long does it take and what plants come in?

- Depends on seed source plants available on site
- Dependent on precipitation, floods, timing
- Recommend active revegetation if trying to create a specific desirable habitat
  - within the first 1-2 growing seasons following removal
  - intervention window due to aggressive colonizers like cattail, quail bush, salt bush and arrowweed

Site Recovery

- Some places may need help to recover (tamarisk dominated sites)
- Mixed sites generally recovery naturally
- Vegetation transition processes can begin if tamarisk is kept out

Go with what the site is capable of…. Site potential

- Remnant species can help/ historical info
- Many high terrace sites (drier) may convert to more xeric: upland shrub, salt bush, quail bush, mesquite or grasslands
- Other places may choose to create desirable or “enhance” the vegetation community

Know your site

- Desirable species
- Soil type
- Hydrology
- History
- Disturbance regime

How to achieve your goal

- Apply effective methods
- Be Persistent
- Adapt
- Monitor
- Expect variable results
- Experiment
- Be Patient

Site Recovery/Restoration

- Passive
- Active
- Site Potential
  - Soil/moisture
  - Hydrology
  - Post treatment WX Precip/Floods
- Grazers/beavers

Restoration Active vs Passive

- Transplanting
  - Rooted
  - Cuttings
  - Deep hole container planting
- Seeding
- Supplemental Irrigation
  - Avoid sprinklers
- Selective Targeted watering

Active Revegetation

- Get control of weeds first then revegetate
- After revegetation occurs make sure to increase survey of weeds to detect early to reduce potential weed control impacts
- Selectively treat weeds/spot treatment or handpull adjacent to transplants
- Use plant exclosures/shelters

Irrigation Plumbing

Create native propagule "Islands"

- Restorable areas
- Small % of total area
- More cost effective/prohibited
- Hydrology
- Soils
- Sustainable

Site Selection

- Amount of native plants/ percent cover, pre-existing on site
- Disturbance history & current regime
  - Flood frequency, stream cross cut elevation
  - Low or high terrace
  - Wildfire potential
- Hydrology
  - Depth to ground water
  - Depth to moist soil/capillary rise
  - Soil type/texture/chemistry

Active Restoration

- Objective based
  - Wildlife habitat/species specific
  - Erosion control
  - Water yield
  - Aesthetics
- May be driven by funding source
- Reduce further weed establishment
- Challenging/Costly

Advantages of Active Restoration

- Rewarding and Favorable
- Provides Competition/more resistent to weeds
- Steer trajectory
- Faster
- Leap frog mother nature
- If it fails you still have natural recovery to fall back on (if you applied minimum impact)

Go with what the site is capable of…. Under current conditions

- Remnant species can help/ historical info
- Many high terrace sites (drier and saltier) may convert to quail bush, halophytic communities mesquite, grasslands or even uplands

Site Recovery

- Some places may need help to recover (tamarisk dominated sites)
- Mixed native sites readily recover naturally
- Recovery can be challenging
  - High salinity
  - Lack of precip or flooding (post treatment)
  - Previously disturbed/site history, seed bank
- Be patient, many sites took years to become degraded, so expect years to recover

Restoration

- Results primarily dependent upon post treatment precipitation and flood timing
- Pre-existing seed bank
- Propagule proximity

Passive Restoration

- Monitor priority weeds during early years while the site is vulnerable/critical during the first 2-3 years post disturbance
- Survey, treat and monitor weeds in adjacent areas to create a buffer around your restoration in process areas
- Survey after nearby disturbance events (floods, fires, adjacent disturbances, etc.)

Advantages of Passive Restoration

- Less expensive
- Natural recovery trajectory
- More sustainable
- Nature knows best
- May be more resilient
- Not forcing a square peg in a round hole

Passive Restoration/Natural Recovery

- Control the weeds first
- Maintain the site/retreatment
- Low impact selective methods
- Stop the human caused disturbance
- Pick your battles wisely (prioritize species)
- Allow for natural recovery
- Monitor

Site Photos

- Canyon De Chelly NM, AZ
- Hubbell Trading Post NHS, AZ
- Virgin River, NV

Vegetation Community Response Following Invasive Tamarisk

(*Tamarix* spp.) Removal by Burning or Cutting

By Rebecca S. Harms

A Thesis

Submitted in Partial Fulfillment

of the Requirements for the Degree of

Master of Science

in Environmental Sciences and Policy

Northern Arizona University

August 2004

Approved:

Ronald Hiebert, Ph.D., Co-Chair

David Ostergren, Ph.D., Co-Chair

Thomas Whitham, Ph.D.

SUCCESS OF ACTIVE REVEGETATION AFTER *TAMARIX* SPP. REMOVAL IN SOUTHWESTERN RIPARIAN ECOSYSTEMS: A QUANTITATIVE ASSESSMENT OF PAST RESTORATION PROJECTS

A Thesis

Presented to

the Faculty of Natural Sciences and Mathematics

University of Denver

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Robin Forest Bay

June 2006

Advisor: Anna A. Sher

Vegetation Response Following Invasive Tamarisk (*Tamarix* spp.) Removal and Implications for Riparian Restoration

Rebecca S. Harms[1,2] and Ron D. Hiebert[3]

Abstract

Using a retrospective study of tamarisk removal sites across five states in the southwestern United States, we investigated (1) decreases in tamarisk cover; (2) the effects of tamarisk removal on vegetation; and (3) whether cutting or burning tamarisk has differing effects on plant communities. Our study provides an important first step in recognizing the effects of removing a dominant invasive species on meeting long-term goals of riparian restoration. We found that (1) both cutting and burning reduced mean tamarisk foliar cover by 82–95%, and this reduction was sustained over time. (2) Native foliar cover was 2- to 3-fold higher on tamarisk removal sites, but total foliar cover remained 60–75% lower than on control transects. No trend toward increases in native cover was noted over time. When tamarisk was included in the analyses, diversity in tamarisk removal sites was 2- to 3-fold higher than in the control sites and vegetation communities differed between treated and untreated sites. When tamarisk was excluded from the analyses, diversity was not greater at tamarisk removal sites, and there were no community differences between the treated and untreated transects. Differences in diversity were found to be driven by differences in evenness; overall species richness did not change following tamarisk removal. Sites in the Mojave showed the strongest increase in native foliar cover and diversity, Chihuahuan-transition sites showed a slight increase, and sites on the Colorado Plateau showed no overall increase. (3) There were no differences between plant communities at burned and cut sites. Our research indicates that vegetation response to tamarisk removal is often negligible. Land managers should be prepared for persistent depauperate plant communities following tamarisk removal if additional restoration measures are not instigated.

Key words: invasive plant management, plant community, riparian restoration, salt cedar, *Tamarix*.

Introduction

Invasive species management has become an important aspect of land managers' responsibilities, with the U.S. government spending $631.5 million on invasive species issues in FY2000 (NISC 2001). Because invasive species become common elements of the communities that they colonize, however, removal projects could have important implications for overall ecosystem restoration. The goal of ecological restoration is to return an ecosystem to its historic trajectory (SER 2002), a process that incorporates vegetation and wildlife communities, disturbance regimes, and ecosystem process and function. In contrast, traditional invasive species management efforts have concentrated on individual species, with an emphasis on the removal or reduction to low numbers of the target organism.

Invasive species removal may have unintended consequences for restoration such as (1) reinvasion by the exotic when the primary causes that facilitated the original invasion are not addressed; (2) the subsequent invasion by other exotic species into areas disturbed by management actions; or (3) a decline in native populations that have come to rely on the exotic species for some type of resource (Westman 1990; Zavaleta et al. 2001). Land managers often assume that invasive species are a primary stressor at sites and that invasive species removal is sufficient to encourage native vegetation recovery (R. Harms 2003, unpublished interview data); yet, little monitoring is done to test the validity of this assumption.

The invasive *Tamarix* spp. (deciduous tamarisk or salt cedar) offer an example of what removal of an invasive species in a whole-ecosystem context might entail. Deciduous tamarisk hybrids (Gaskin & Schaal 2002) have extensively colonized riparian systems throughout the arid southwestern United States and have been estimated to cause billions of dollars in economic losses over the next 50 years (Zavaleta 2000). Riparian areas are centers of biodiversity throughout the region (Naiman et al. 1993; Bogan et al. 1999), and tamarisk has been implicated in driving a reduction in biodiversity. Thus, tamarisk is viewed as a significant ecological threat and has been targeted for control for many years.

There are several potential pitfalls to tamarisk removal. The spread of tamarisk is closely correlated to river

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Effectiveness of Exotic Plant Treatments on National Park Service Lands in the United States

Scott R. Abella*

The United States created national parks to conserve indigenous species, ecological processes, and cultural resources unimpaired for future generations. Curtailing impacts of exotic species is important to meeting this mission. This synthesis identified 56 studies reported in 60 publications that evaluated effects of exotic plant treatments on National Park Service lands. Studies encompassed 35 parks in 20 states and one U.S. territory and included 157 exotic plant species. Eighty-seven percent of studies reported that at least one treatment reduced focal exotic species. Of 30 studies evaluating response of native vegetation, 53% reported that natives increased, 40% reported neutral responses, and 7% reported that natives decreased. For at least some of the neutral cases, neutrality was consistent with management objectives. In other cases, insufficient time may have elapsed to thoroughly characterize responses, or restoration might be needed. Nonfocal exotic species increased in 44% of the 16 studies evaluating them, but the other 56% of studies reported no increase. Results suggest that: (1) a range of exotic species spanning annual forbs to trees have been effectively treated; (2) developing effective treatments often required extensive experimentation and balancing nontarget impacts; (3) presence of multiple exotic species complicated treatment efforts, highlighting importance of preventing invasions; and (4) placing treatment objectives and outcomes in context, such as pretreatment condition of native vegetation, is important to evaluating effectiveness. Attaining the goal in national parks of conserving native species and ecological processes minimally influenced by exotic species will likely require comprehensive management strategies inclusive of treatment interactions with focal exotic species, other potential invaders, and native species.

Key words: Control, effects, nonnative species, vegetation, secondary invasion, response.

National parks in the United States were designated to conserve significant natural and cultural features unimpaired for future generations (Organic Act 1916). The 2006 National Park Service management directive reaffirmed the key objective of preserving indigenous biodiversity and ecological processes within parks unimpaired (National Park Service 2006). The 401 National Park Service units contain irreplaceable features and native species, often harboring the only locations where certain cultural sites and species occur (Shafer 2012). Invasions by exotic species increasingly threaten park resources and undermine the objective of conserving indigenous biodiversity and ecological processes within parks (Jenkins and Johnson 2008). For example, Allen et al. (2009) assessed 216 of the parks and reported that they contained a total of 3,756 exotic plant species. All parks contained exotic plants, with several individual parks containing over 400 exotic plant species. Not all exotic plants severely impact indigenous ecosystems, but effects of high-impact species already are evident and some current low-impact species have potential for severe impacts in the future (Gilbert and Levine 2013; Vilà et al. 2011). As one example of a severe impact, invasion by exotic plants in some parks has increased fuel loads and corresponded with increasing extent and severity of nonindigenous wildfire regimes (D'Antonio et al. 2011). These fires have devastated native communities ill adapted to the novel disturbance regime, in addition to impacting cultural resources and altering anthropogenic visitor experiences (Brisbin et al. 2013).

In response to threats posed by exotic plant invasions, the National Park Service, similar to many other conservation organizations, has initiated treatments seeking to reduce exotic plants while promoting native species (Fraley et al. 2007). Treatments encompass physical methods such as

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and dams and reshaping the site to create a native wetland-riparian system. Although portions of the site would be planted with native species to stabilize soils and promote rapid revegetation, the ecosystem would be designed to be self-perpetuating, with revegetation largely from natural seed sources and processes.

The final grading plan was based on thorough knowledge of site hydrology obtained through a network of 21 wells and surface water gauges, and on an understanding of plant community–soil–hydrology relationships in nearby reference communities. The design called for a number of depressions and mound features, and specified a rough, undulating surface that would allow a diversity of wetland plants to establish where conditions are favorable. The result would be a complex of ponds, wet meadows, willow thickets, and cottonwood galleries modeled after nearby undisturbed habitats.

With funding and assistance from the NPS Water Resources Division, the NPS Geologic Resources Division, the Tierra y Montes Soil and Water Conservation District, and the park, earthmoving began in October 1999. A critical step was stationing a member of the design team on-site to supervise the earthmoving. Most contractors are experienced in creating smooth surfaces needed for roads or parking lots, but may not know how to interpret the degree of undulation or "roughness" called for in this wetland rehabilitation project design. The on-site supervisor interpreted these details for the contractors, checked elevations, and identified issues to be addressed by the full design team during its weekly site visits. By mid-November the contractors had completed this phase, moving over 30,000 cubic yards of material in the process. In early December, upland areas were seeded with native grasses and biodegradable erosion-control blankets were installed where necessary.

In spring 2000, park staff, project cooperators, and volunteers planted more than 1,000 rooted willow and cottonwood cuttings collected from the surrounding area. Additionally, thousands of native sedges, rushes, bulrushes, and other wetland species grown from local seed sources were planted. Park staff have begun a program of weed and exotic plant control, and follow-up monitoring of water levels and plant establishment and survival is planned for the 2000 growing season. Over the longer term the park envisions a trail on the edge of the project area for public enjoyment and interpretation of the cultural landscape; the wetland rehabilitation process; and the waterfowl, songbirds, muskrats, deer, and other wildlife that are expected to thrive there.

The Pueblo Colorado Wash demonstration project

by Pamela Benjamin and Nancy Stone

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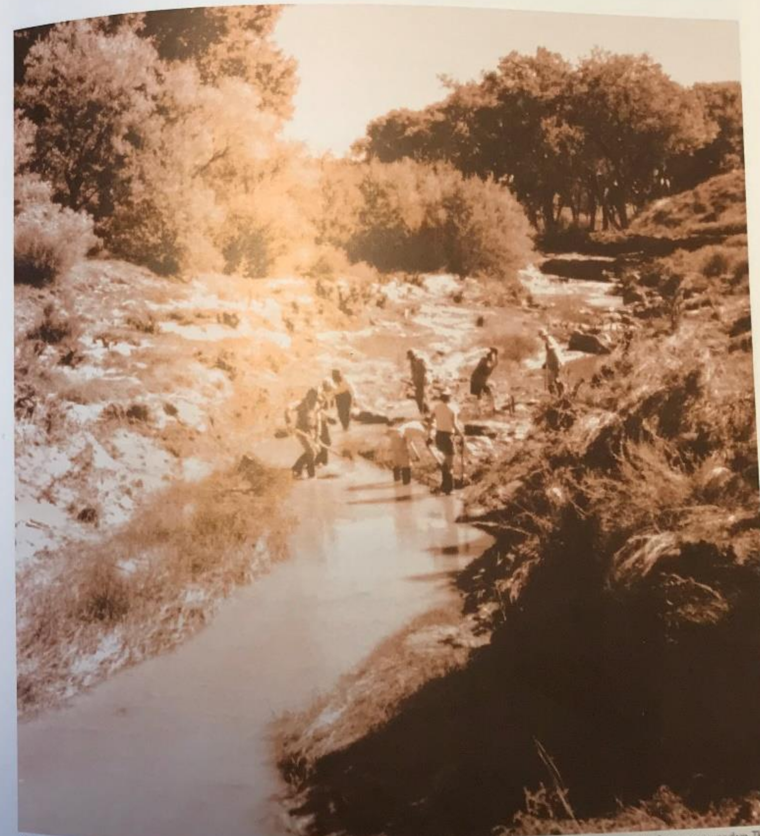
Superintendent, Hubbell Trading Post National Historic Site, Arizona

Hubbell Trading Post National Historic Site (Arizona) is partnering with Navajo Nation agencies and the Arizona Water Protection Fund through a three-year grant (1998–2000) to restore a 1.5-mile section of the Pueblo Colorado Wash. The Pueblo Colorado Wash is the most significant natural resource at Hubbell Trading Post and is by far the most important element responsible for the presence of the cultural resources for which the national historic site was established. As a result of historic and modern disturbances (including stream channeling by the National Park Service), the wash had become severely degraded. These disturbances led to the establishment of dense stands of nonnative vegetation (primarily tamarisk and Russian olive), eliminating the view of the stream channel and de-emphasizing the cultural connection of the waterway for visitors.

In 1998, the Arizona Water Protection Fund awarded the Pueblo Colorado Wash restoration project a three-year grant to promote the use of low-cost, low-tech approaches to stream enhancement and to focus attention on the project as a successful demonstration for other waterway enhancements within the Navajo Nation. Project activities have resulted in removal of livestock and exotic plant species from three-fourths of the 1.5-mile section of the wash. Additionally, a fence has been established to eliminate livestock trespass. Natural materials have been used to build in-stream structures to add sinuosity and floodplain to the channel through induced stream meandering and sediment deposition. Finally, the wash has been revegetated with native plant materials.

Monitoring activities in 1999 have revealed natural recruitment of native in-stream vegetation in addition to natural regeneration of native cottonwoods and willows. Groundwater levels and the quantity of water maintained in the stream have increased as a result of nonnative plant removal. In summer 1999 the increased channel capacity and sinuosity greatly reduced bank erosion during an extremely high-water monsoon event (9,000 cubic feet per second). From its humble beginnings as a volunteer initiative, the project has grown into a multijurisdictional, multi-interest conservation partnership to enhance and conserve this significant waterway. Additional partners, including the U.S. Environmental Protection Agency (EPA), Public Land Corps grants, the Student Conservation Association, and numerous volunteers, have also been critical in the success of the restoration project. In 1999 the project was awarded an additional grant, the EPA "Five Star Restoration Partnership" grant, and the park was presented with a plaque as the first EPA "Five Star Restoration Site." For all its erosion control and native plant revegetation achievements, perhaps the greatest success is that the Pueblo Colorado Wash is again visible to the public, reconnecting the cultural resources at Hubbell Trading Post with their appropriate natural setting.

"The Pueblo Colorado Wash is ... the most important element responsible for the presence of the [site's] cultural resources."



Volunteers construct small water-diversion structures *within Pueblo Colorado Wash to encourage the formation of stream meanders. The work is part of a three-year demonstration restoration project at Hubbell Trading Post National Historic Site.*

Vegetation Responses following treatments

- Canyon De Chelly National Monument, AZ
- Hubbell Trading Post NHS, Ganado Wash, AZ
- Virgin River, NV (Clark County and BLM)

Acknowledgements

- Clark County, NV Desert Conservation Program
- BLM Southern NV District Staff (JJ Smith)
- Lake Mead IPMT Staff (Tarl Norman)
- Keith Lyons, Canyon De Chelly NM

Thank You

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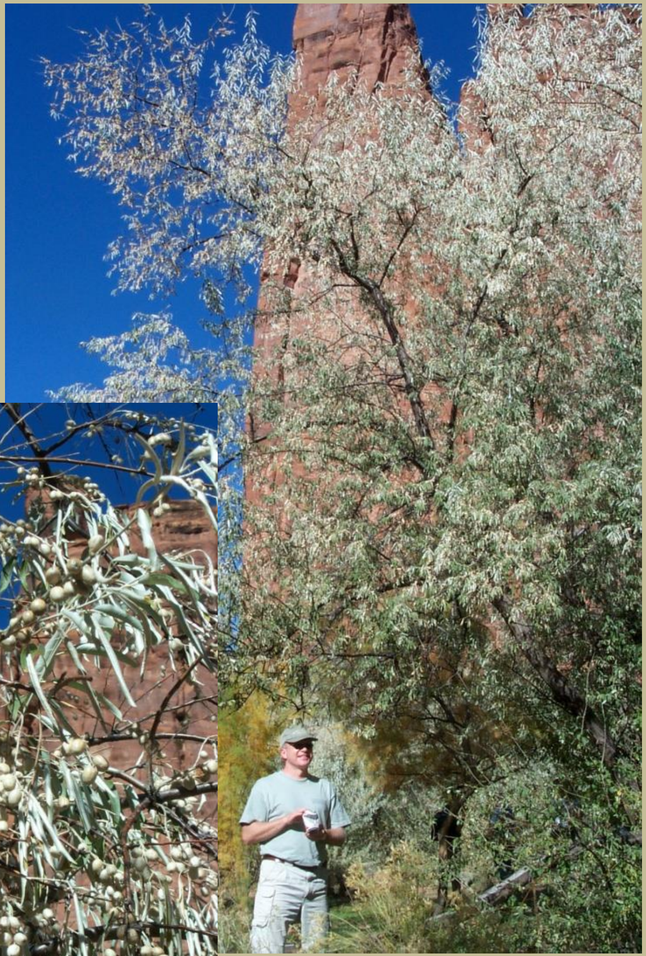
Russian Olive: *Elaeagnus angustifolia*

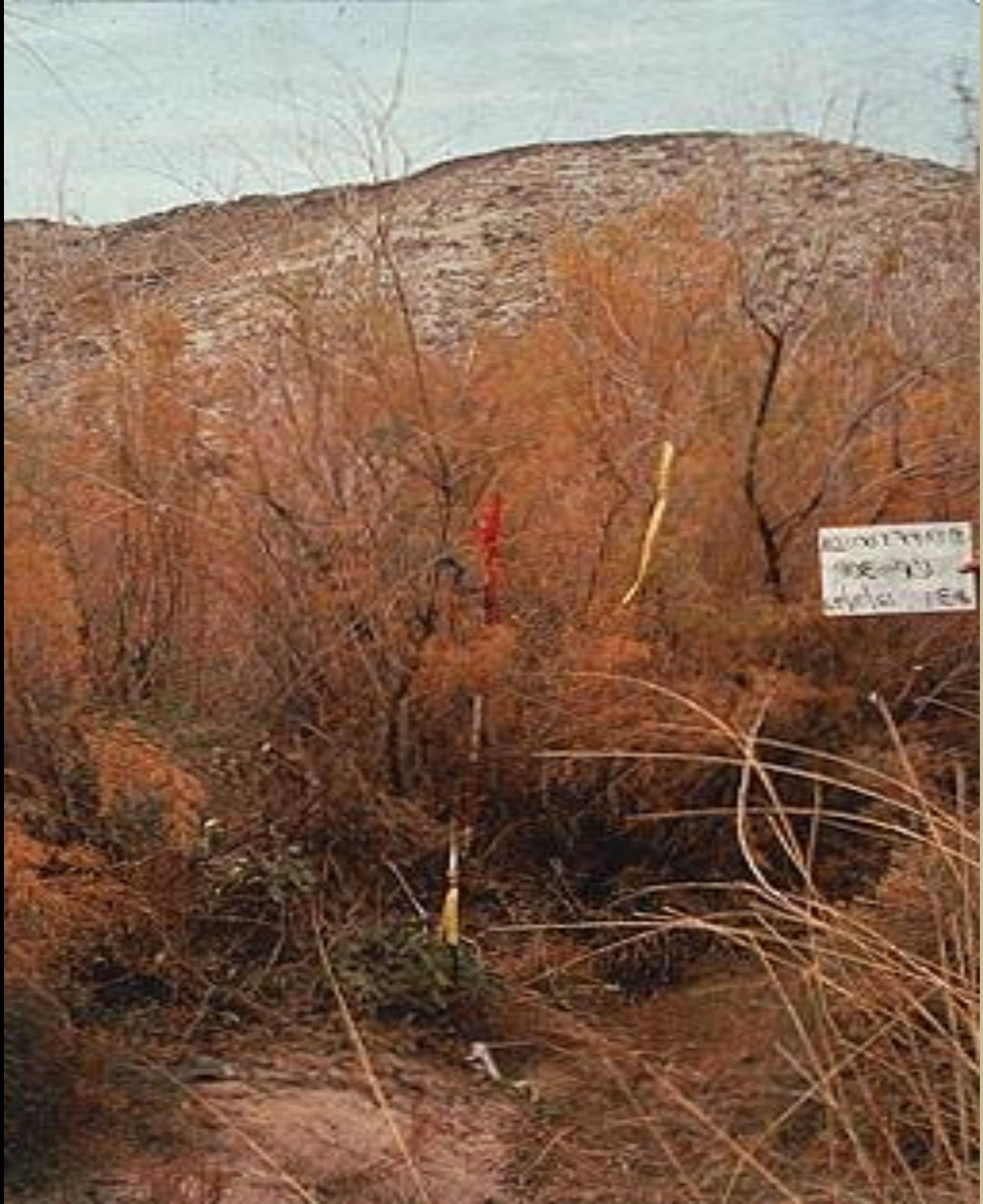
- Tributaries of the Colorado Plateau
- Expanding on the main stem
- Seeds : round small marbles
- Slower spread
- Upper River, Colorado Plateau
- Upper Virgin River



Deep hole planting

Plant Exclosures

Watering



Site Before Treatment

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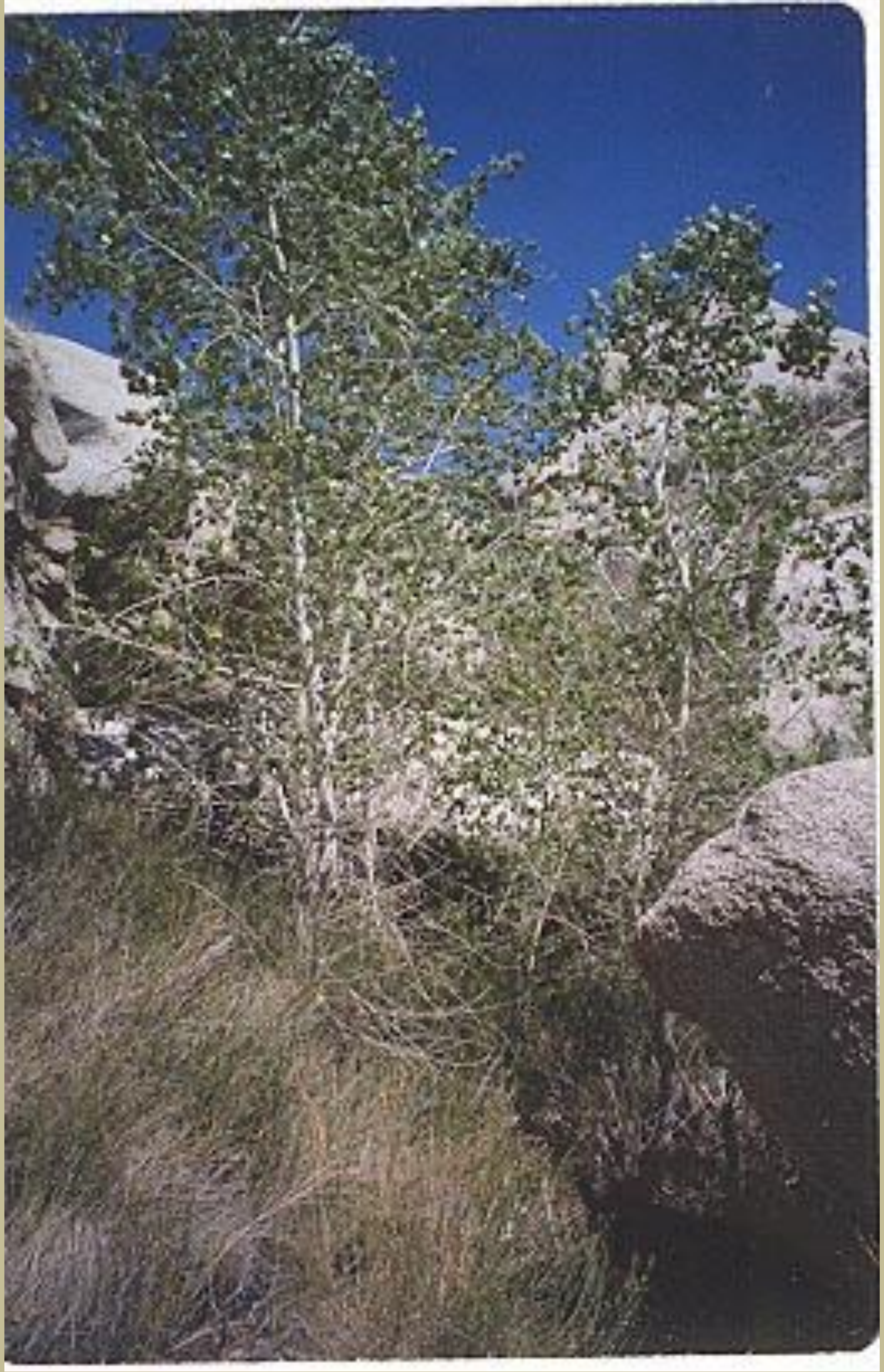
One-Year Post Treatment

Four Year Post Treatment


Cottonwood Regeneration
Second Year Post Treatment
Tamarisk stumps

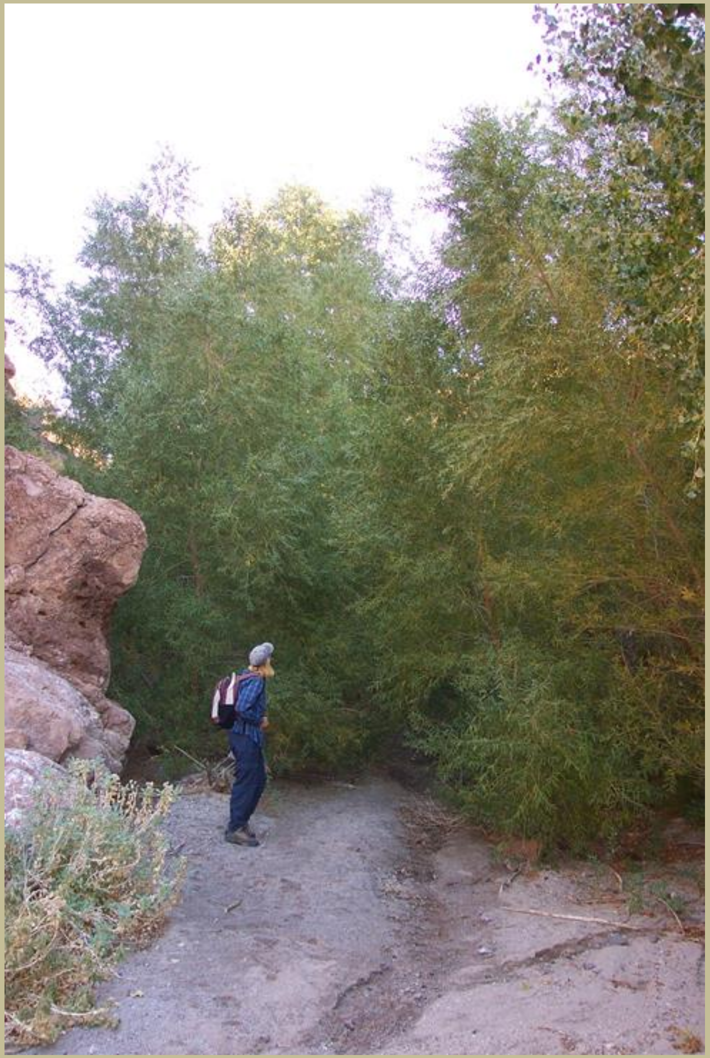


Five Years

Post Treatment

How Does Recovery Occur?

- Eliminate the direct competition
- **Soil moisture increases**
  - from removal of tamarisk
  - allows for native plant regeneration/recruitment
  - provides for active revegetation, seeding, transplanting, pole planting
- Tamarisk and other weed control, monitoring and maintenance is important for first 2-3 years



How long does it take and what plants come in?

- Depends on seed source plants available on site/Seed bank
- Dependent on precipitation, floods, timing
- Recommend active revegetation if trying to create a specific desirable habitat
  - act within the first 1-2 growing seasons following removal
- Russian thistle, kochia and bassia can be problematic