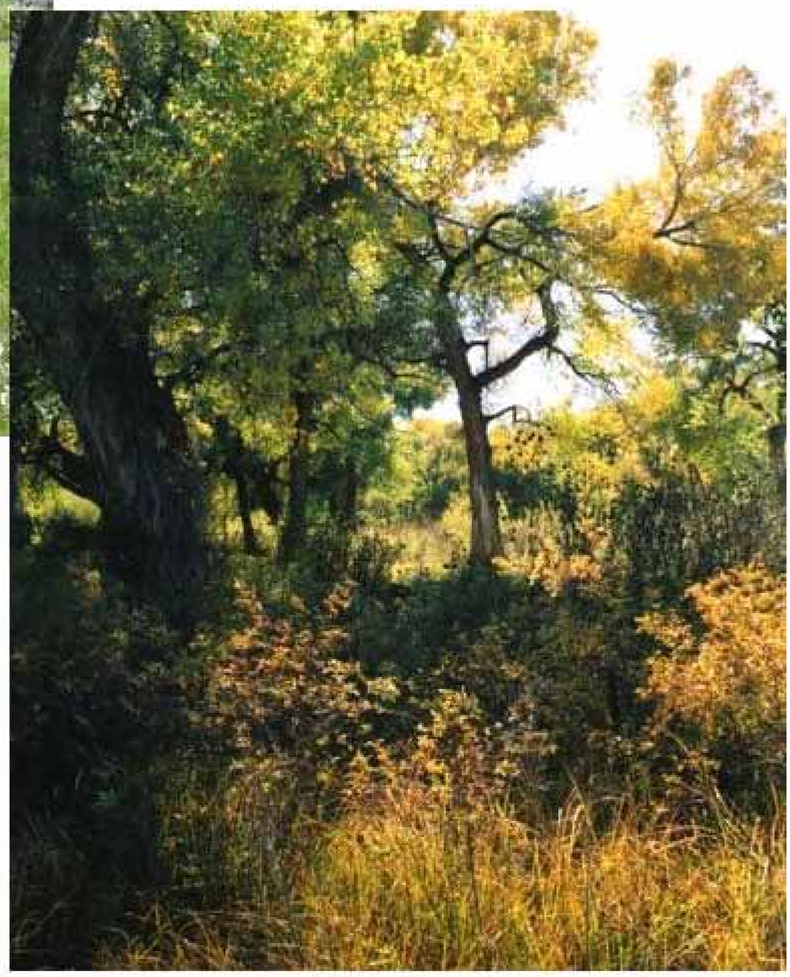
Riparian Forest Restoration in San Juan Pueblo and Española

Ohkay Owingeh (San Juan Pueblo)
CFRP Project 03-DG-11031000-008



PROJECT CLOSEOUT REPORT

La Calandria
associates, inc.

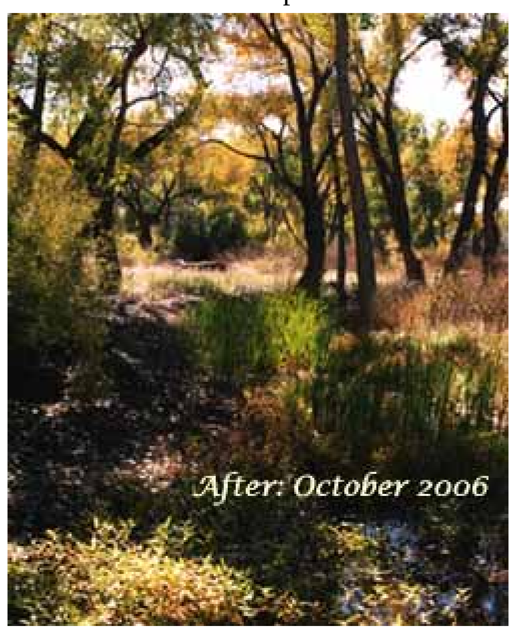
Riparian Forest Restoration in San Juan Pueblo and Española
CFRP Project 03-DG-11031000-008 - Ohkay Owingeh (San Juan Pueblo)

Project Closeout Report

Introduction

This project has been the catalyst for an important expansion in bosque restoration at Ohkay Owingeh (then San Juan Pueblo). It has treated over 200 acres and created a successful high-flow channel for the Rio Grande that carried significant flows during the 2005 spring runoff. In collaboration with the City of Española, a highly visible 20-acre reach of the Rio Santa Cruz within the City was also restored.

Work began on the project with pre-treatment monitoring in November of 2002, followed by the first phase of invasive tree removal using mechanical brush-cutting and mulching equipment in the winter of 2002-2003. Over the four-year course of the project former river channels were excavated to expand wetland area and restore some of the former floodplain hydrology lost due to channelization of the Rio Grande. Cleared areas were replanted with native plants, invasive resprouts were cut and treated with herbicide, and the vegetation community in the project area was monitored before and after restoration work. In addition, some of the larger and straighter Russian olives were harvested and milled to evaluate their suitability for lumber and see whether any commercial demand for Russian olive lumber products might exist.



Outreach, training, and partnership-building activities included a conference funded supplementally by the CFRP, as well as Youth Conservation Corps (YCC) and other summer job training, interpretive tours and project explanations for neighboring land-owners and other interested people, and events for Pueblo residents in the bosque.

A total of 249 acres have been restored – 39 acres, or almost 20% more than proposed. Collaboration with project partners has generally worked well. No major setbacks or problems were encountered, and we believe the project has been a great success.

Milestones

The table below summarizes key milestones in the project schedule from the original proposal, comparing proposed and actual completion dates for key activities, along with explanatory notes. Highlights of project activities are explained in more detail in the following section.

ACTIVITY	COMPLETION		COMMENTS
	PROPOSED	ACTUAL	
Remove invasive trees from 90 acres	March 2003	March 2003	Milestones refer to mechanical removal of standing Russian olive and other invasives; hand cutting and herbicide treatment of resprouts continued throughout the project.
Cut and mill Russian olive	March 2003	August 2003	About 1000 board-feet of Russian olive was milled by August 2003; another 1000 feet or more was milled into flooring and other lumber later in the project.
1st-year excavation	June 2003	May 2003	All excavation work on the project was completed ahead of schedule.
Remove invasive trees from 60 acres	March 2004	November 2003	The second year of invasive tree removal was completed ahead of schedule.
2nd year excavation	June 2004	May 2004	Completed ahead of schedule.
Remove invasive trees from 60 acres	March 2005	May 2006	Total acreage treated was nearly on target by March 2005; but additional work was done in winter 2005/06 raising the total acreage where invasives were removed to 249, or 39 acres more than originally proposed.
3rd year excavation	June 2005	April 2005	Completed ahead of schedule.
Native revegetation planting completed	June 2006	September 2006	Revegetation planting on Ohkay Owingeh was completed on schedule. Additional replanting was done at the City of Española site along the Rio Santa Cruz, and the site was not ready until summer 2006.
YCC/youth job training programs	Summer 2003, 2004, 2005, 2006	Summer 2004, 2005, 2006	Through 2004 Ohkay Owingeh depended on collaboration with Hands Across Cultures for YCC programs; but because of unreliability the Pueblo has provided its own summer youth training from 2005 onwards.
Other outreach activities			Interpretive tours and other activities with Rio Grande Restoration took place in the summer of 2004, at a bosque restoration conference (supplementally funded by the CFRP). Ohkay Owingeh undertook other activities such as “bosque barbeques”, tours, and external presentations to provide alternative outreach activities in other years.
Monitoring	Pre-treatment Sep. 2002; post-treatment Jun. 2006	Pre-treatment Nov. 2002; post-treatment Sep. 2006	Monitoring plots were established and methodology developed by the Four Corners Institute in 2002. Plots were resampled independently in 2003 and again by Four Corners Institute at the end of the project.

Project Highlights

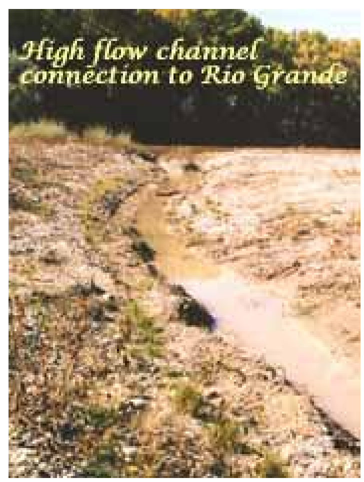
Removing Invasive Trees and Shrubs

Mechanical cutter-mulcher machines removed invasive trees - mostly Russian olive and Siberian elm - were they were dominant or co-dominant species and where ground disturbance by tractors would be minimal and native trees easily avoided. Where machine access was impractical (where the ground was too soft or uneven, for instance) or where native vegetation to be preserved was too thick for machines to avoid it properly, clearance was done by hand with chain saws. Piles of slash from manual removal were either mulched by mechanical brush cutters or burned in the winters of 2004-5 and 2005-6. Some of the larger slash and tree trunks were left on site to provide habitat for insects, small mammals, and similar fauna. Mulch thickness remaining after treatment seldom exceeded about two inches in depth, and does not appear to be hindering grass and forbs from sprouting.

Following manual removal of invasive trees by hand crews, cut stumps were treated with Garlon® 4 herbicide. In places where in-vasives were re-moved mechani-cally, resprouts were treated with Garlon during the 2004, 2005, and 2006 growing seasons. Herbicide was not allowed to come in contact with any open water so as to prevent any chance of affecting newly-planted wetland plants or other non-target plants or animals. Prior surveys had confirmed that no willow flycatcher habitat existed within the project area, but areas of dense vegetation bordering the Rio Grande were left intact just in case, and all mechanical tree removal was carried out during the winter when disturbance to any migratory birds would be minimal.

Excavation and hydrologic modification

The basic excavation strategy was to enhance remnants of former river channels and other relict topography still present from before channelization: to deepen, expand, and connect low places to create as much new wetland as possible. Deepened channels allow plant roots better access to ground water throughout the year, and in many places they create seasonal open water where none was present before. Irrigation of nearby fields, along with somewhat higher river levels, raises the water table in the restoration site by two to three feet during the growing season. This supports characteristic bosque wetland vege-tation even when the site is not inundated by direct surface flow from the Rio Grande. However, the entire site would have been inundated by springtime runoff occasionally, prior to river channelization in the 1950s. To see if these conditions could be re-created in at least part of the site, a small channel was cut from the current course of the Rio Grande to the nearest of the enhanced former channels.



Excavation was intended to permit surface water from the Rio Grande to flow through the site during spring runoff and other high-flow events. A connection was made to the Rio Grande to allow this, and the success of this approach was confirmed in the runoff during the spring of 2005, when flow levels in the Rio Grande above the Chama confluence reached 6,570 cubic feet per second (cfs) and flows of 200 or 300 cfs or more ran through old river channels parallel to the current Rio Grande channel for a mile and a half or more. This river level falls between the calculated 5-year return period flow of 5,720 cfs and the 10-year flow level of 7,770 cfs, and is in fact the highest level observed since 1995. Flows like this through the site are precisely the conditions that occurred in much of the Ohkay Owingeh bosque before river channelization in the 1950s, and the conditions we seek to restore as much as possible. Although originally intended just as an experiment or pilot project, the results of re-connecting the former river channels were much better than expected and are highly encouraging for the prospects of re-creating appropriate hydrological patterns in the future.

Revegetation

Our overall intention in revegetating the site was to create a diverse and hopefully complete community of all kinds of native wetland and riparian vegetation, both woody and herbaceous. There were multiple sources of plant material: purchased woody seedlings and herbaceous wetland plants, native sedges, rushes, and grasses transplanted from nearby wetland areas within Ohkay Owingeh, and coyote willow roots dug up nearby on the Pueblo, pruned, and transplanted. Passive restoration, in the sense of recruitment from existing vegetation (such as cottonwood seed) or the soil seed bank, was also an important revegetation component.

Purchased plant material came from Hydra Aquatic, Inc. of Tijeras, NM. The purchased species transplanted into this project are listed in the tables below.

WETLAND HERBACEOUS SPECIES	
Scientific name	***Common name***
Anemopsis californicus	Yerba manza
Aster hesperius	Marsh aster
Calamagrostis canadensis	Bluejoint reedgrass
Carex aquatilis	Water sedge
Carex hystricina	Porcupine sedge
Carex lanuginosa	Wooly sedge
Carex microptera	Small winged sedge
Carex nebraskensis	Nebraska sedge
Carex praegracilis	Clustered field sedge
Carex rostrata	Beaked sedge
Deschampsia caespitosa	Tufted hair grass
Eleocharis palustris	Creeping spikerush
Glyceria striata	Fowl manna grass
Helianthus nuttallii	Marsh sunflower
Juncus balticus	Baltic rush
Juncus confusus	Colorado rush
Juncus interior	Inland rush
Juncus mertensianus	Merten's rush
Juncus nodosus	Knotted rush
Juncus saximontanus	Rush species
Juncus torreyi	Torry's rush
Mimulus guttatus	Yellow monkey flower
Oenothera elata	Riparian primrose
Potentilla gracilis	Slender cinquefoil
Sagittaria latifolia	Arrowhead, duck potato
Scirpus acutus	Hardstem bulrush
Scirpus microcarpus	Small fruited bulrush
Scirpus olneyii	Olney's bulrush
Scirpus pungens	Common three square
Scirpus validus	Softstem bulrush
Sidalcea neomexicana	N. Mex. checkermallow
Sporobolus airoides	Alkalai sacaton
Sporobolus wrightii	Giant sacaton

WOODY SPECIES	
Scientific name	***Common name***
Acer negundo	Box elder
Amorpha fruiticosa	False indigo bush
Prunus americana	Native plum
Prunus americana	Native plum
Prunus virginiana	Chokecherry
Rhus trilobata	Three leaf sumac
Ribes aureum	Golden currant
Salix amygdaloides	Peachleaf willow
Salix goodingii	Goodding's willow
Salix exigua	Coyote willow
Shepherdia argentia	Silver buffaloberry

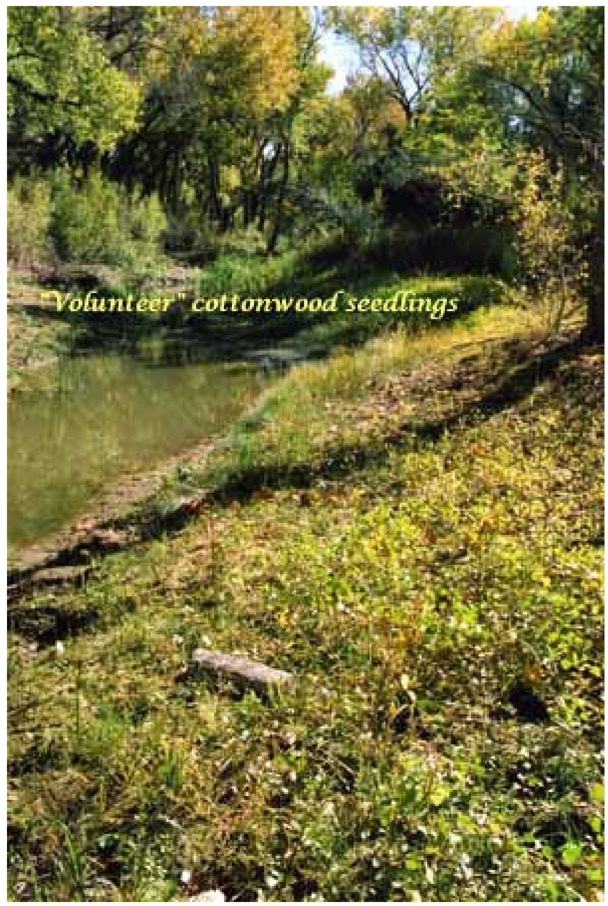
Purchased plant material was intended to maximize the chances that a complete community of plant species would be present after restoration, since the project area has been cut off from flooding, dried out, and invaded by Russian olive for many years. Plant lists were developed in consultation with Ross Coleman of Hydra Aquatic, based on his field experience and observations at Ohkay Owingeh, as well as a review of plants found in New Mexico Natural Heritage Program reference sites, and consideration for plants listed as occurring in north central New Mexico by Corell and Corell in *Aquatic and Wetland Plants of the Southwestern United States*. Coyote willow seedlings purchased in addition to local transplants were intended to maximize the area, and hasten the maturity, of potential habitat for southwestern willow flycatchers.

Native wetland plants were purchased to enhance species diversity, but the majority of plant material for the project by total quantity was transplanted from nearby in the Ohkay Owingeh bosque. Principally, this was made up of coyote willow and typical native wetland sedge-rush-grass communities near the restoration area. It was not possible to inventory all plant species in every shovelful of local wetland transplants, but the species typically dominant in Ohkay Owingeh wet meadows and shallow backwaters are shown in the table below.

Native wetland plants	
Carex aquatilis	Water sedge
Carex microptera	Small-winged sedge
Carex nebraskensis	Nebraska sedge
Carex rostrata	Beaked sedge
Eleocharis spp.	Spikerushes
Juncus balticus	Baltic rush
Scirpus microcarpus	Small-fruit bulrush
Scirpus pallidus	Cloaked bulrush
Scirpus pungens	Three-square bulrush

Coyote willow root crowns were excavated from nearby fields with a backhoe, pruned severely, and then transplanted into moist soil in the project area. Our experience has been that this technique permits transplanting willows more or less any time of year (instead of only in the winter for pole plantings that need to develop roots before springtime). In addition, transplanted willows sprout more vigorously and produce more stems than pole-planted coyote willows or purchased seedlings.

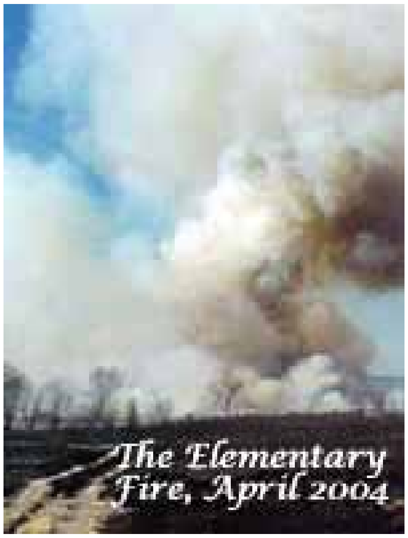
Several hundred Rio Grande cottonwood and Goodding's willow were planted as 8 to 12 foot poles in the part of the project north of Highway 74 during the winter of 2003/4, but we found that native cottonwood seed would sprout by the hundreds per square meter in areas where restoration work had created appropriate conditions: bare, saturated soil in full sunlight when cotton was flying. Allowing cottonwood to regenerate naturally from seed not only ensures propagation of local native genotypes, but is a great deal more cost-effective unless the height of a pole-planted sapling is needed. Survival among in-situ seedlings is good, and there are few places where they are overtopped by weeds.



Restoring the natural fire regime

The dominance (before restoration) of Russian olive throughout the project area, along with Siberian elm and tamarisk in some areas, had dramatically increased the risk of fires to which native vegetation is very poorly adapted. Russian olive is relatively flammable compared to the Rio Grande cottonwood-willow-New Mexico olive community it supplanted, and every fire accelerated the invasion of Russian olives since they are relatively fire-adapted and resprout vigorously even after crown fires. Native riparian vegetation, in contrast, often resprouts poorly after fire. Under natural conditions, fire was infrequent or absent in the Ohkay Owingeh bosque. Because of the scarcity of coniferous (resinous) trees, the relatively high moisture content of native riparian vegetation, and the high moisture content of riparian soils (many of which were saturated or inundated much of the time), naturally occurring fires were extremely rare in the bosque and probably limited to areas with unusual concentrations of dry deadfall or grass.

As discussed in the **Monitoring** section, efforts to measure fuel loading using upland forest methodology were unsatisfactory in comparing pre- and post-treatment fire risk or likely severity in the bosque. However, an interesting comparison of pre- and post-restoration fire behavior presented itself during the project. In April of 2004, an accidental fire started adjacent to the project area, along an irrigation ditch being cleared of weeds. The resulting fire spread northwards into the restoration area because of brisk south winds, typical of springtime weather. The resulting "Elementary" fire covered 36 acres, most of it in the CFRP project area that had been cleared of Russian olives and replanted with native vegetation.



It is interesting to compare this fire with the 1996 "Gobbler" fire that started very nearby at almost exactly the same time of year and under almost identical weather conditions: a windy spring day in a dry year. The Gobbler fire, however, spread through a bosque dominated by dense Russian olive, and eventually consumed 331 acres on both sides of the Rio Grande. The areas affected by the two fires are compared in the map below. These two fires come about as close to a replicated experiment as is possible with wildfires, and certainly seem to provide a strong indication that bosque restoration substantially diminishes the risk and severity of wildfires in southwestern riparian areas.

River Restoration in Espanola

The City of Española was a key project partner, as a neighboring jurisdiction to the Pueblo. In fact, the City actually exists on private land claims within either the Ohkay Owingeh or Santa Clara Reservations. This land tenure situation posed a challenge in implementing a CFRP project, since funds can be spent only on public land – and the City itself owns hardly any bosque or riparian property. The original intent when the project was designed and proposed was for restoration work to be done on newly-acquired City land at the location of the former Prince Ranch, where a new City water treatment plant is to be built. However, as discussions took place with City staff, it seemed less and less workable to do ecological restoration at a site where industrial development was in progress, and more desirable to do something in a place where it would be more visible and hopefully accessible to City residents. The only catch was that any such location would be on Santa Clara land, so the project in effect acquired another partner in Santa Clara Pueblo.

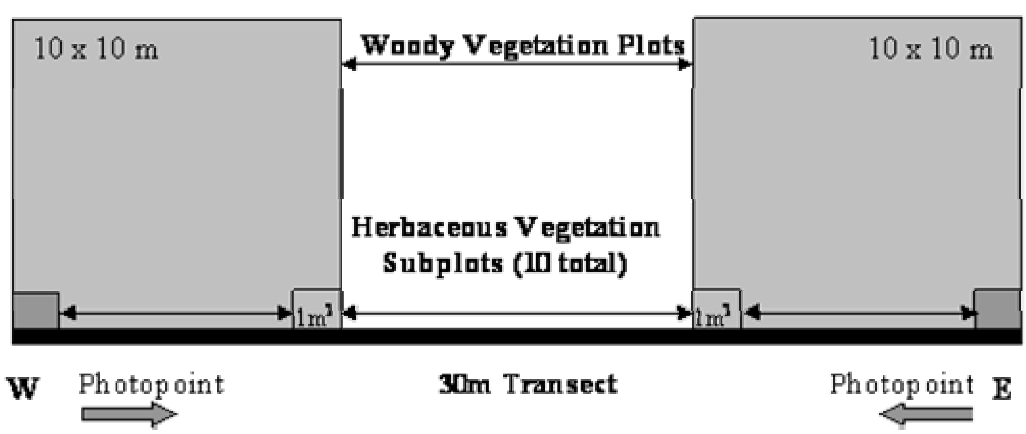
Fortunately it was not difficult to come to an agreement between the two Pueblos and the City that an ideal site for bosque restoration, visible and accessible for City residents and manageable within the project budget, would be the mouth of the Rio Santa Cruz at its confluence with the Rio Grande: an area of about 20 acres between the two downstream bridges over the Rio Grande. Following a public presentation and approval by the City Council's Public Works Committee, work began by removing invasive trees along the Rio Santa Cruz in the spring of 2006, and finished with a final round of planting native wetland plants along the river in the autumn of 2006.

Ecological Monitoring

Ecological monitoring for the project was designed and carried out by the Four Corners Institute, one of our project collaborators. Sampling design and field work was done under the direction of Dr. Melissa Savage. Other project partners were invited to observe and/or participate in the monitoring program, but did not choose to do so. Twelve sampling transects, as illustrated below, were sampled. Transects 1-9 were located within the project area on the east side of the Rio Grande and control (untreated) plots 10-12 were located on the west side of the Rio Grande. Baseline data was collected in 2002, interim data was collected in 2003 and 2004, and post treatment data was collected in 2005 for the control sites and in 2006 for treated sites.

The transects were intended to remain as permanent sampling locations, but the rebar monuments (as frequently happens) were obliterated in the course of excavation and invasive tree removal. Transect locations were noted using GPS coordinates, although even with GPS data, plots could not always be relocated with complete accuracy. Consequently, repeat measures were not always done precisely at the same plot location. Current Ohkay Owingeh monitoring procedures and are illustrated in the diagram below and differ only slightly from monitoring procedures used during the course of this project. Separate monitoring reports provide more details of sampling protocol, data, and results. The Baseline Data Report 2002 and Final Monitoring Report 2006 from the Four Corners Institute discuss differences in monitoring methodology over the lifetime of the project and more detailed numerical results.

Transect and sampling plot layout is shown, conceptually, in the diagram below. In 2002, transects were 50m in length and the woody vegetation plots were 15m by 10m. Herbaceous vegetation was recorded as it intercepted the 50m baseline. Subsequent years' transects were 30 meters in length, oriented east-west as illustrated below. The two ten-meter square (or $100m^2$) plots located on the north side of the transect line were used for measuring woody species composition. To measure herbaceous species composition, $1m^2$ subplots were sampled on the interior, southern boundary of each larger plot to give ten subplot measurements. Current monitoring procedure uses only four herbaceous vegetation subplots instead of ten.



Monitoring Plot Layout

Sampling Parameters

Sampling parameters are summarized in the table below. "Original" parameters were those sampled for in the pre-treatment sampling in 2002. "Added" parameters were included in subsequent sampling (since they came to be part of a standardized Ohkay Owingeh monitoring protocol for all restoration sites).

Original Parameters	Added Parameters
Tree density by species	Overstory canopy cover
Snag density	Understory species composition list
Mean tree and snag diameter	Hink and Ohmart Community Classification
Shrub density	Percent litter and bare ground cover
Percent herbaceous cover	Mean litter depth
Dead and down wood volume	
Photopoints	

Photopoints

Two photo points were established for each transect. One photograph faces west from the end of the transect and the other faces east. Photographs were taken at each monitoring period to record visible changes in vegetation community composition over time.

Hink and Ohmart Community Classification

Structural classification of the vegetation community as established by Hink and Ohmart (1984) was added to the monitoring protocol after the baseline data was collected in 2002.

Density of Woody Species

Individual woody plants were recorded by species within the $100m^2$ plots. Trees were recorded by diameter at breast height (dbh), except in the case of multi-stem trees or shrubs branching at ground level, in which case the diameter was measured at root crown height (rch). If a cottonwood or similar large tree branched below dbh, the individual trunks were measured as individual trees. Shrub species were counted as clumps where clumps could be identified, with a separate measure for total stem number and percentage of canopy cover by the species for each $100m^2$ plot. The monitoring reports categorize woody vegetation into "seedling", "sapling", and "tree" size classes.

Overstory Canopy Cover

Overstory canopy measurements were added to the monitoring protocol after baseline data was collected. Overstory canopy cover was measured with a densiometer with recordings taken in the four cardinal directions every 3m along transects for a total of ten values per transect.

Herbaceous Species Composition and Cover

Herbaceous plant species composition was recorded using a different methodology in 2002 than that used in subsequent monitoring events. Data collected in 2002 was line intercept cover of herbaceous species along a 50m transect. No specific data on species composition was recorded as it was done too late in the year to be able to identify many of the herbaceous plants to species. After the 2002 baseline monitoring, herbaceous vegetation cover was recorded in ten, 1m squared subplots along the baseline transect. Only species rooted in the plot were counted. Species were recorded by growth form (e.g. forb, shrub, or woody), and the number of different species within each growth form category encountered within on 1m2 plot was recorded to obtain an estimate of species richness. Understory herbaceous canopy cover data was sampled in the ten subplots based on visual estimation of percentage cover. Percentage cover was recorded for herbaceous plant canopy cover, litter cover, and bare ground.

Dead and Down

The methodology for measuring fuel hazards for dead and down woody material was not consistent throughout the project and therefore results are not easily comparable between the control and treated areas, or even over the time sequence of monitoring events. In 2002, three measurements were recorded for dead and down fuels crossing the 50m transect line: 1) point intercept of dead and down fuels crossing the transect line, 2) dead and down fuels occurring in the plots, and 3) dead standing fuels. After the baseline data was collected in 2002, the surface fuels method was changed to Brown’s surface fuel protocol.

Once the thick layer of Russian olive is removed, the necessity for measuring downed woody fuel loses its relevance. The ladder fuel has been removed, which reduces the likelihood and easy spread of bosque fire.

Results

Live tree and snag density

Tree density was, of course, changed by treatments (note that for monitoring purposes a “tree” is defined being over 4 centimeters in diameter and 1.5 meters tall). Numbers of native trees remained essentially constant while non-native trees went from being dominant to being uncommon. Average density of adult cottonwoods in the sampling plots was 152 trees/hectare (ha). After restoration treatments, Russian olive decreased from an average of 307 trees/ha to 0 trees/ha. Total non-native tree density in the project area was 422 trees/ha in 2002, with no non-native trees observed in the 2006 sampling. Before restoration treatments the Russian olive, Siberian elm, and tamarisk made up 68% of the tree density. At the control site (outside the project, across the Rio Grande) density of non-native trees increased during the course of the project even though tree density at both the treated and control sites were initially similar. Restoration treatments reduced the number of snags from 84/ha to 33/ha, taking out many dead Russian olive but leaving all the large cottonwood snags.

Seedling and sapling density

No cottonwood seedlings or saplings were identified in the baseline measurements from 2002. However, in the treated area, by 2006, there were many cottonwood seedling observed as well as those of other native species. Before treatments began, all seedling and sapling species were Russian olive. After treatment, non-native seedlings were more likely to be Siberian elms. In initial monitoring, 75% of the seedlings and 51% of the saplings were non-native species, predominantly Russian olive. After treatment, more native species were regenerating at the treated sites as compared to the control sites where native species were not regenerating to keep pace with the proliferation of non-native species.

Tree size

The cottonwood canopy appears to be relatively evenly aged, suggesting that most mature cottonwoods sprouted in the last significant flood years of 1941 and 1942. The non-native trees were all smaller in diameter than the cottonwoods, suggesting that in general the invasion of the community by non-native trees largely took place after the cottonwoods had become established.

Shrub density

In the shrub understory at the project site, New Mexico olives were abundant before treatments began, but increased in number and vigor after restoration treatments and release from shading and crowding by Russian olive – even though some were unintentionally cut and mulched along with the invasives. Wild rose also increased slightly in density post restoration treatments. Willow density did not appear to change substantially between 2002 and 2006.

Herbaceous cover

Herbaceous cover declined in the sampling plots over the course of the project. This is likely a result of the disturbance cause by the restoration treatments. Herbaceous cover is expected to increase over time as the system recovers from the mechanical treatments to remove non-native vegetation and excavation to expand wetland area.

Litter and bare ground

Litter cover occurred over a larger percentage of the sampling plots than herbaceous vegetation and bare ground in the treated areas. Average litter depth was the same in the final year of sampling between the treated and the control sites.

Dead and down surface fuels

The fuel-loading sampling methodology employed in monitoring found an average of 23 tons/acre of dead and down fuels in the treated area.

However, methodology that measures only dead and down material as fuel load entirely misses the point of bosque fire danger. Woody debris on the ground in the bosque is more likely to be in contact with damp ground or even to be partly inundated (with appropriate hydrology), and thus less likely to burn or to provide a fire ladder than dead branches still attached to standing, live trees – especially Russian olives. An important characteristic of Russian olives in particular, and tamarisk and elm to some degree, is that a living tree normally produces many dead branches throughout the tree, extending right down to the ground, and this contributes a great deal to the increase in likelihood and severity of fire in the bosque as these trees become more common. Another factor in the increased fire risk posed by Russian olive seems to be the increased flammability of living biomass itself, because of natural oils in the tree that are not present in native riparian vegetation. None of these factors that significantly influence bosque fire dynamics are measured by sampling methodology that attempts to isolate dead-and-down fuels only.

Because the dense mid-canopy layer of Russian olive and other invasives was removed, fire hazard was clearly reduced, even though the amount of dead and down fuels *per se* has little impact in terms of bosque fire dynamics.

Overstory canopy cover

Overstory canopy cover is extremely variable in the bosque and was little affected by restoration treatments, since all existing cottonwood trees were undisturbed.

Hink and Ohmart Community Classification

Prior to treatment, there were several Hink and Ohmart vegetation community types. After restoration treatments, most of the transects were classified as Type 1 (tall trees with well-developed shrub mid- and understory). Interim classifications of several transects, after invasive trees and some native shrubs were removed but little regrowth or re-planting had occurred, were Type 2 (tall overstory with little mid-story at all), but by the final monitoring period, the New Mexico olive understory had recovered enough for most of these transects to once again be classified as Type 1.

Photopoints

Repeat photography shows that the understory of invasive Russian olive was quickly replaced by the native woody species, frequently New Mexico olive resprouting from roots if it had been cut, or growing vigorously in response to release following the removal of invasives. Photographs are available in the Final Monitoring Report submitted by the Four Corners Institute.

Socio-economic monitoring

This project enabled a major expansion in the scale and permanence of the Ohkay Owingeh forest restoration program. Prior to securing CFRP funding, our restoration work was smaller in scale, typically involving 20 or 30 acres at a time and supporting a part-time contract workforce employed as funds became available. Once this project (and the hazardous fuels reduction project that complemented it and provided the cost match by removing non-native trees) got underway, a full-time crew of four restoration technicians could be employed year-round. As the project continued and others were started, the full-time restoration crew increased from four members in 2003 to seven by the end of the project in March of 2007.

Bosque and other ecological restoration at Ohkay Owingeh is funded through a variety of channels, and even though the CFRP was critically important in “jump-starting” year-round full-time restoration employment, other funds help support restoration field crews and the Ohaky Owingeh Office of Environmental Affairs and Accounting Department staff that in turn support them. It may be helpful to provide some explanation of the organizational structure for restoration and bosque work at Ohkay Owingeh. Project strategy and management, along with other services like document management and some GIS mapping, are provided by the Office of Environmental Affairs. Accounting and financial management are done by the Accounting Department (funded through indirect charges). Restoration technicians are employed, and field work coordinated by, the Pueblo's restoration contractor La Calandria Associates. Technicians are all from Ohkay Owingeh and work primarily on Pueblo projects, although their expertise is increasingly in demand at other Pueblos and even on non-tribal projects for neighboring private landowners – another example of the 'jump-staring' effects of this CFRP project.

The tables that follow summarize the direct economic effects of the federal funds in this CFRP project on employment at Ohkay Owingeh. The first table considers only wages paid directly to the crew in the field – the restoration technicians from Ohkay Owingeh, working for La Calandria Associates. The table also only reflects federal funds for the project – it does not include cost-match funding, which is difficult to isolate for the project (but would approximately double the figures in the table for hours worked and wages paid). Figures are given for calendar years, which to not correspond exactly to the four project years, but give a reasonable (if conservative) idea of the level of employment on the ground made possible by the project. The table does not include subcontract services like excavation or mechanical tree removal, non-field staff at La Calandria, or suppliers of plant material, herbicide, and so on – so of course actual total employment created or sustained by the project is greater than that reflected in the table.

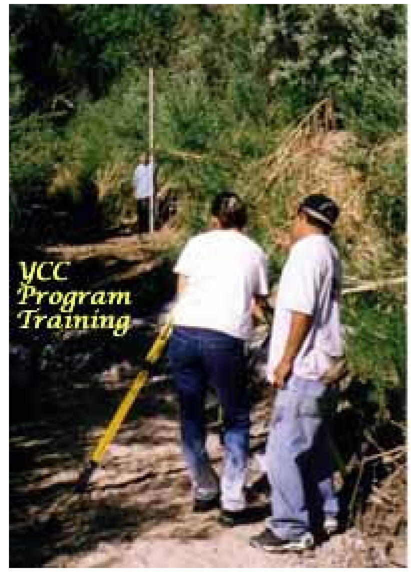
Year	Field crew hours	FTE (hrs/2080)	Total field crew wages	Average wage	Total no. on crew
2003	1183	0.57	$15,967	$13.50	4
2004	1628	0.78	$22,580	$13.87	4
2005	1562	0.75	$25,069	$13.40	5
2006	1160	0.56	$16,302	$14.05	7

Actual gross hourly wages paid to technicians varied between $10 and $16 an hour in 2003, and between $10 and $18 an hour by 2006. Crew members also receive approximately 25 paid holidays or days off per year. The average wage shown in the table is calculated by dividing the actual total hourly wage paid to the crew members involved in the CFRP project in that year by the number of crew members, and is not weighted by hours worked (although it would change very little if it were).

Significant effort and employment were generated within the Pueblo in addition to the field technicians, as described above. The next table estimates these effects, by looking at the funds paid to Environmental Affairs or Accounting staff, and adding this employment to that calculated above for an estimate of total directly-funded project employment.

Year	OOEA personnel	Indirect	FTE (at salary of $35K/yr)	FTE for field crews	Total FTE supported by CFRP
2003	$13,259	$9,078	0.64	0.57	1.21
2004	$15,902	$12,187	0.80	0.78	1.59
2005	$15,906	$11,794	0.79	0.75	1.54
2006	$3,978	$2,431	0.18	0.56	0.74

Although there was no systematic survey of opinions or reactions to project activities or to restoration in general, significant efforts were made throughout the project to explain restoration work and include tribal members and neighbors in the project. These included a conference for over 200 riparian and bosque restoration practitioners, made possible thanks to generous additional funding by the CFRP during the summer of 2004. At the conference, several different tours of both restored and unrestored Ohaky Owingeh bosque were offered to participants, including trips by raft down the Rio Grande stopping at many points along the way to visit a number of restoration projects in many stages of completion. Many tours and site visits were conducted throughout the project in addition to those at the conference, along with powerpoint presentations and talks to several meetings or groups outside the Pueblo. Interviews were conducted with Pueblo elders to document their recollections of conditions along the river as far back as they could remember.



A Youth Conservation Corps (YCC) program was active in the bosque in the summer of 2004, involving about 15 young people from Ohkay Owingeh and from surrounding non-Indian communities in our bosque work. In 2005 and 2006 the Ohkay Owingeh Boys' and Girls Club organized a summer youth job training program in the bosque with four participants in 2005 and six in 2006.

Neither last nor least, a "bosque barbeque" was held each summer of the project for members of the Pueblo and families of YCC or summer youth program participants. The barbeque was held each year in August, to celebrate the end of the youth programs, thank the participants for their help, and to encourage as many community members as possible to come out into the bosque and see what's been accomplished.

Russian Olive Wood Products

When the bulk of the non-native trees were cut and mulched in place by mechanical brush cutting equipment, a number of the larger and straighter trees were cut down and hauled to the Conley Sawmill in Arroyo Seco (near Española) to see if they could be sawed up into usable timber products.

As it turns out, they can be – and, after sawing and air-drying, some of the resulting boards were milled into 1x random width and length lumber, and into flooring. A small cabinet was made out of the boards (as shown in the photograph on the right), and the flooring was installed in a home in Hernandez, New Mexico.

Russian olive seems to have acceptable dimensional stability and resistance to excessive warping (unlike Siberian elm, which is hard and would seem to offer excellent prospects for lumber uses, but is said to be very difficult to dry without twisting, and more likely than most lumber species to warp in use). Russian olive may expand and contract more than some species in response to changing humidity, but has been acceptably stable in the applications that were tried. As can be seen in the photographs, its color is somewhat lighter and warmer than American black walnut – closer to European walnut or even some teak, although it is much softer than teak and slightly softer than walnut (but a good deal harder than pine, cedar, willow, or poplar). Since Russian olive in bosque situations grows quite rapidly (some annual growth rings when the tree is 6 to 12 inches in diameter, or about 10 years old, can be over ¾ inch wide), grain or figure in the sawn wood is likely to be large, open, and fairly pronounced.

Some interest was shown by local woodworkers in Russian olive lumber, but the cost proposed by the Conley sawmill based on the very small initial run - $8 to $10 per board foot – seemed too high to generate much demand. Unfortunately, before additional discussions could take place as to whether a way could be found to cut and mill larger volumes of timber at a lower cost, our lumberman partner, Mr. Chuck Conley who was rather elderly and had nominally retired some years previously, passed on in 2005. No one else has been found with the ability to continue with the Russian olive lumber experiment, so since then it has not been pursued as much as we envisioned at the beginning of the project.

We have been delighted with the success of this project, and with the collaboration with our partners (the City of Española, the Bureau of Indian Affairs Northern Pueblos Agency, Conley Sawmill, La Calandria Associates, the Four Corners Institute, and Rio Grande Restoration – along with Santa Clara Pueblo). The photographs that follow give a little more perspective on the many different kinds of landscape in the project area as four years of restoration work draw to a close and ecological succession takes over.