RIPARIAN/WETLANDS VEGETATION ASSESSMENT

FOR THE

RESERVOIR REMOVAL AND FLOODPLAIN RESTORATION

PROJECT ON GLORIETA CREEK

PECOS NATIONAL HISTORICAL PARK

FINAL REPORT

Submitted To

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Pecos, New Mexico

by

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INTRODUCTION

The Pecos National Historical Park (PNHP) is in process of developing a plan for reservoir removal and floodplain restoration on Glorieta Creek (project NHP 15-002). This project will be focused on the riparian/wetland zone for lower Glorieta Creek from the NM63 bridge to its confluence with the Pecos River (Figure 1). As a cooperator in this effort, the New Mexico Natural Heritage Program (NMNHP) was responsible for developing a preliminary map of riparian/wetland vegetation communities of the project area and for conducting an assessment of the ecological condition and status of these communities, and the impact the proposed project may have on them. In this report we detail the methods used to develop the map along with a draft aerial photo version of the map with associated map unit descriptions. Also provided are the results from our ecological assessment focusing on an analysis of the current conditions in an historical context and on the potential effects of the restoration effort on wetland/riparian ecosystems of the site.

METHODS

Map Development

Prior to going into the field, a preliminary air-photo vegetation map of the site was developed using 1:3,000 natural color aerial photography taken on July 7, 1996. Preliminary map units were developed based on air-photo interpretation and on earlier map units developed by Durkin et al. (1994); these units are defined in terms of one or more vegetation community types previously known from the monument. Map unit polygons were delineated in stereo on 9 x 9-inch mylar sheets overlain on the photos. These mylar overlays were taken directly to the field for ground-truthing with color photocopies of the photographs.

From July 27 through July 29, 1997, the entire study reach was walked to carefully ground-truth the mapped delineations. Boundaries and unit descriptions were modified as needed. The community types that occurred within map units were identified and documented with vegetation plots as needed (community types previously described by Muldavin [1991] were not re-sampled).

Upon completion of the field survey, map delineations were transferred in ink to acetate overlays registered to the fiducial marks of the photography. Non-overlapping mapping segments were delineated near the center of each photo to minimize distortion. Each polygon was numbered with a single digit representing the map unit. In this form the photos and overlays could be used directly in a stereo transfer process to a base map of choice, and a final map constructed. The area of each map unit was estimated using a dot grid.

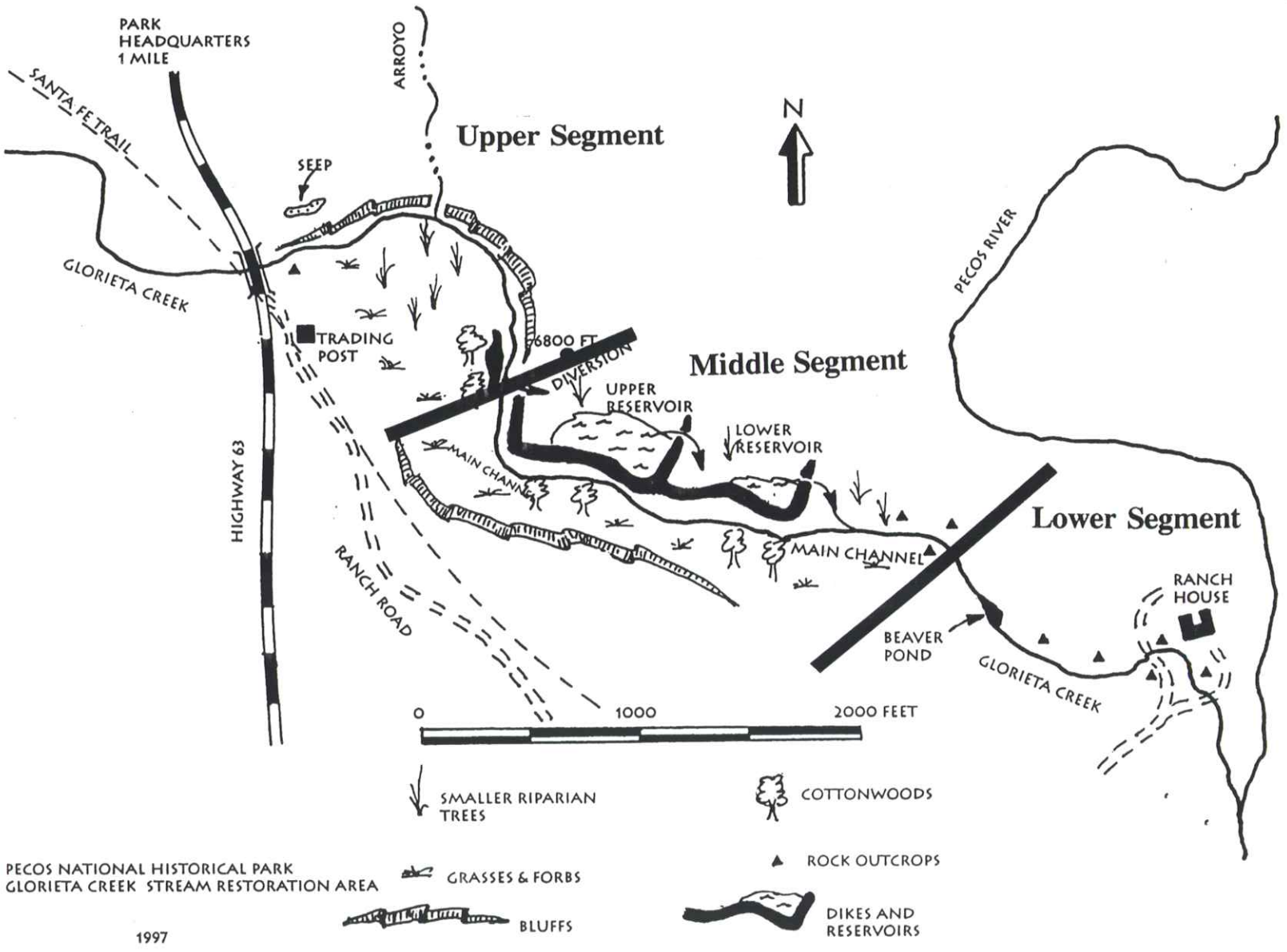

Figure 1. Project study area of lower Glorieta Creek with stream segment delineations as defined by the NMNHP.

Ecological Assessment

Extensive discussions with PNHP and associated personnel were conducted on the history of the site and the nature of the project. These were followed by an intensive survey of the site for both mapping purposes (see above), and for on-the-ground assessment. The vegetation communities of the study area were identified and assessed for condition and quality following guidelines developed by NMNHP for riparian areas of New Mexico. Assessment issues surrounding species diversity were limited by the early sampling date. Although most of the dominants were identifiable, many species were not yet flowering and not yet identifiable to the species level.

Current Condition Assessment

Site assessment for ecosystem quality is based on the condition and quality of individual stands of vegetation community-type occurrences within a site, and on the overall condition of the site in a landscape context. Sites are ranked using a combination of quantitative and qualitative parameters based on the field data, the vegetation map and other maps (topographic, soils, geology etc.). Since landuse history can have a significant bearing on an ecological assessment, sites (or sub-sites) should be delineated in such a way as to represent relatively uniform past impacts or management. In this case, the Glorieta Creek reach within the study area was subdivided into three sub-sites (Upper, Middle and Lower) based on differential historical uses. Each sub-site was individually assessed and an overall site rank was applied.

The details for site ranking are provided in Durkin et al. (1997). In summary, ranking follows a two-step protocol whereby a "community rank" from A (high quality) to D (low quality) is first determined for each occurrence of a community type reflecting current conditions and impacts at the stand level. Stand-condition variables considered are the degree of grazing and herbivory, number and size of roads, buildings and other structures, along with direct hydrological alterations such as dams and ditches within the stand and degree of bank stabilization. Stand quality in terms of structure and species composition are also evaluated. For example, are all the structural layers present (trees, shrubs, grasses, forbs and cryptogams)? Is the species composition within the normal range for the community type in terms of species richness and composition, particularly with respect to exotics? And finally, is the occurrence large enough to be viable within the context of local impacts on the stand? Evaluations are based on designated "reference" occurrences that we consider to represent the best known conditions and quality for a given community type.

Once all occurrences of community types within a site are ranked, an overall "site rank" from A to D is applied that takes into account not only community ranks, but also examines the stream segment as a whole and emphasizes landscape level indices of condition. At the landscape level, condition is based on the status of upland and riparian vegetation and the degree of fragmentation of the site by roads, agriculture, pastures, buildings or structures. Also taken into consideration is the status of the hydrologic regime both within site boundaries and upstream as well. For example, to what degree do upstream dams and

diversions affect natural site dynamics? Does a site support all or most of the expected natural wetland/riparian community types (both mature and successional stages) in appropriate ratios for the area? Overall landscape quality is taken into account by evaluating the natural mosaic of communities in the floodplain.

Final site rankings are based on the above criteria, plus a critical consideration of long-term issues such as restoration potential, viability and defensibility. As a result, final rankings generally reflect the degree of human impacts on the ecosystem and potential for recovery to natural conditions as follows:

- "A" Sites: sites dominated by "A" ranked community occurrences in a diverse landscape mosaic where human impacts are minimal and the hydrological regime has received little or no alteration. These sites have been left undisturbed, or have nearly recovered from human disturbance, and are considered highly viable over the long term with minimal management intervention.

- "B" Site: sites dominated by "A" and "B" ranked communities, with an expected community element absent from the landscape mosaic or one element is much more prevalent than others. Limited impacts have affected the communities and the hydrological regime, but recovery is occurring or can occur with minimal management intervention.

- "C" Site: sites dominated by "B" and "C" ranked communities (A's are absent) in a landscape mosaic that may lack several expected elements, or that is strongly dominated by one element. The hydrological regime commonly has been altered significantly, or stand-level impacts are intensive and ongoing. These sites are considered restorable, but significant management intervention and time may be required.

- "D" Site: sites dominated by "C" and "D" ranked communities in a highly altered landscape mosaic where many expected community elements are absent or poorly represented. The hydrological regime has been completely modified, or the on-site conditions are highly degraded. These sites are commonly strongly dominated by exotic species and will require intensive rehabilitation for even partial restoration of the natural ecosystem.

Representativeness and Regional Importance

In addition to an analysis of current conditions, communities of the study area were evaluated in terms of their intrinsic rarity and importance in a regional perspective. Most of the wetland/riparian communities in New Mexico, and in the West in general, have been ranked with respect to rarity, and are tracked as such in the NMNHP Biological and Conservation Database (BCD) following Heritage Network protocols. Communities documented for the site were compared to those in the database and their regional to global importance assessed.

Assessment of Restoration Effects

Three restoration options are being considered for the study area (no action, moderate intensity and high-intensity restoration). Each of these options was assessed in terms of impacts on individual stands, long-term viability of the vegetation communities, and how they may affect the reach as a whole.

RESULTS

Stream Segment Delineation

Based on field reconnaissance and air photo interpretation, the study reach was subdivided into three segments, Upper, Middle and Lower (Figure 1). Each segment has a unique hydrological configuration that conforms to both natural landscape features and past land uses. These segments provide convenient units for the study area description and ecological assessment.

Both the Upper and Middle segments have relatively broad floodplains with few natural control points of exposed bedrock. The Upper segment has a very low stream gradient at around 1% or less, and the stream tends to meander more. This configuration may be natural in part because the segment is below a release point where a set of rock outcrops (at the highway bridge) were confining and slowing flows; once through the constriction the waters would spread out into the floodplain and drop sediment. The low gradient and higher sinuosity may also have resulted from a sand quarry operation that could have directly lowered the gradient and modified the stream channel location. The upper segment also contains old agricultural fields.

In the Middle segment, the stream gradient increases (1-2%) and the stream meander is significantly reduced. This segment is also the location of artificial ponds that were developed following the abandonment of a rock and gravel quarry operation and is the focus of the restoration project. Although agricultural conversion is not strongly evident in this segment, it has been highly modified hydrologically.

The Lower segment is characterized by a narrow floodplain that is confined by steep upland slopes and rock outcrops. Lateral movement of the channel is very limited. The Lower third was not subjected to sand and gravel removals or other major hydrological modifications, but there is evidence of natural beaver dams and subsequent ponding. As with the other segments, the Lower segment had been subjected to long-term grazing by livestock until acquired by the park.

Preliminary Vegetation Map

The vegetation air-photo map in the form of acetate overlays on the original aerial photography is provided in the back pocket of this report. There are four aerial photos with approximately equal amounts of mutually exclusive mapped delineations. Each delineation is annotated with a map unit (MU) number. Nine map units were derived representing a wide range of vegetation types (Table 1). In its current form, the air-photo map can be stereo-transferred directly to a base map, as needed.

Table 1. Map units for the Riparian/Wetlands Vegetation Map for the Reservoir Removal and Floodplain Restoration Project on Glorieta Creek, Pecos National Historical Park. Map unit number is followed by the unit name, area estimates and relative percent for that map unit (MU) per sub-site, % of total area and area per MU.

Map Unit	Map Unit Name	Area Upper Segment Ha (%)	Area Middle Segment Ha (%)	Area Lower Segment Ha (%)	MU % of Total Area	MU Area Ha (Acres)
1	Emergent Herbaceous Wetland	0.9 (50)	0.7 (41)	0.1 (9)	14	1.7 (4.2)
2	Coyote Willow Shrub Wetland	0.5 (24)	1.2 (50)	0.5 (24)	18	2.2 (5.4)
3	Rabbitbrush Shrubland	1.3 (50)	1.1 (43)	0.2 (7)	21	2.6 (6.3)
4	Old Field/Disturbed Ground (Upland Toeslope)	1.4 (64)	0.5 (24)	0.3 (12)	18	2.2 (5.4)
5	Pond	0.0 (0)	0.65 (93)	0.05 (7)	6	0.7 (1.8)
6	Narrowleaf Cottonwood Forested Wetland	0.1 (7)	0.4 (58)	0.2 (35)	6	0.7 (1.8)
7	Juniper/Bluegrass Meadow	0.05 (10)	0.4 (70)	0.1 (20)	4	0.5 (1.2)
8	Plains/Narrowleaf Cottonwood Forested Wetland	0.75 (50)	0.75 (50)	0.0 (0)	12	1.5 (3.6)
9	Rock Outcrop	0.0 (0)	0.0 (0)	0.1 (100)	1	0.1 (0.3)
	Totals	5.0(41)	5.8 (47)	1.5 (12)	100	12.2 (30.0)

Map Unit Descriptions

Map Unit 1: Emergent Herbaceous Wetland

This map unit includes the wettest communities and is dominated by obligate wetland herbaceous species, species that are either in or line the active channel, or occur around the edges of ponds and springs. These sites are usually subject to ongoing inundation throughout the year, and normally occur where the stream gradient is very low (1.8 % or less), and hence base stream-flow energy is very low. The unit is most common in the upper segment of the study area. Here, flat portions of the reach may be the result of historical sand dredging that may have altered the gradient and channel characteristics. The low gradient of the stream results in extensive ponding, and the development of herbaceous wetland communities. The unit is made up of four community types and includes the active non-vegetated channel. In descending order of importance they are:

a) Cattail/Spike Rush (*Typha latifolia/Eleocharis parishii* CT; *TYPLAT/ELEPAR)*

This community type (CT) occupies the lowest position in the floodplain, usually along the active channel or in ponded areas. It occupies a small percentage of the floodplain, occurring in a few scattered patches in and along the channel, particularly in the upper segment of the study reach.(a typical stand is 30 x 15m or less). Cattails and spike rush strongly dominate the community in the wettest portion of the sites, with field horsetail (*Equisetum arvense)*, Nebraska sedge (*Carex nebrascensis*) and American bulrush (*Scirpus americana)* less common and on the margins, along with occasional willows (*Salix* spp.). Algae can also occupy a considerable portion (up to 30%) of the water surface.

b) Baltic Rush/American Bulrush (*Juncus balticus var. mexicanus/Scirpus americana var. longispicatus* CT; JUNBALM/SCIAME)

This is one of the more common community types, occurring in linear strips adjacent to the channel and within the one to two-year floodplain. The soil is usually fully saturated with the margin of the occurrence in the water. Stream gradient is ca. 1.5%. Baltic sedge and American bulrush are the typical dominants, but other well represented species include spikerush (*Eleocharis parishii)*, tall fescue (*Festuca arundinacea)*, field horsetail (*Equisetum arvense)*, and scattered willows (*Salix* spp.).

c) Baltic Rush/Yerba Mansa (*Juncus balticus var. mexicanus/Anemopsis californica* CT; JUNBALM/ANECAL)

This minor CT occurs at middle positions in the floodplain, between the lower bars that are adjacent to the channel and the upper terraces. Stands are probably in the five- to ten-year floodplain, but appear to be receiving supplemental ground water from sources other than the main channel (possibly tributary springs). In general, these *Anemopsis*-dominated communities occur infrequently and in small patches and occupy a small percentage of the

floodplain. Well represented grasses include creeping muhly (*Muhlenbergia repens*), Kentucky bluegrass (*Poa pratensis)* and tall fescue along with several forbs, many of which are exotics such as yellow sweetclover (*Melilotus officinalis*).

d) Tall Fescue/Field Horsetail (*Festuca arundinacea/ Equisetum arvense* CT; FESARU/EQUARV)

This community is limited to a few locations, representing only a small portion of the floodplain. Tall fescue, an exotic pasture and hay species from Eurasia, is the dominant, probably escaping from adjacent old field areas (it also is prevalent in other communities along the creek). This community generally occurs at mid elevations (five- to ten-year floodplain), and infrequently adjacent to the channel. In some stands, *Festuca* is abundant enough to substantially limit cover of other species. In others, a variety of other species may occur such as Baltic rush, Kentucky bluegrass, and yellow clover. Shrubby coyote willow *(Salix exigua*) and narrowleaf cottonwood (*Populus angustifolia*) can also be present.

e) Active channel

The active channel contains aquatic plant communities, but has no terrestrial plant cover. The channel is mostly open water, with a low gradient (1-2%) along the entire reach. Much of the channel has a sandy substrate, with some small portions that are gravely or cobbly.

Map Unit 2: Coyote Willow Shrub Wetland

This unit is characterized by shrub wetland communities dominated by coyote willow (*Salix exigua)* that occur on the lower sidebars adjacent to the channel and up to the middle bars (usually within the five-year floodplain). The stream gradient ranges from 1 to 2%. There are also inclusions of active channel (see MU 1) and rock outcrop (see MU 9). Four community types were identified for the unit:

a) Coyote Willow/Baltic Rush (*Salix exigua/Juncus balticus* var. *mexicanus CT*; SALEXI/JUNBAL)

This is a common type that typically occurs adjacent to the channel up to the middle bars; usually within a two- to ten-year flood zone. Besides coyote willow, bluestem willow (*Salix irrorata*) can be abundant. Narrowleaf cottonwood in shrub form may also be well represented. Baltic rush typifies the herbaceous layer, but tall fescue, American bulrush, spikerush, and field horsetail are other hydric indicators that may be present.

b) Coyote Willow/Sparse Undergrowth (*Salix exigua*/Sparse CT; SALEXI/Sparse)

This CT occurs at low to mid landscape positions in the floodplain. Coyote willow forms an open canopy, but the undergrowth is sparse and low in diversity. This may be due in part to scouring by floods or the after-effects of sand and gravel mining. Although coyote

willow is an obligate wetland species, the soil surface layers can be rather dry, and some upland species are possible.

c) Coyote Willow/ Tall Fescue (*Salix exigua/Festuca arundinacea* CT; SALEXI/FESARU)

This is a similar CT to the Coyote Willow/Baltic Rush CT, except that the exotic tall fescue displaced much of the native herbaceous cover. The native Baltic rush, American bulrush, spikerush, and horsetail are still commonly present, but definitely not dominant or co-dominant. The native and obligate riparian coyote willow still dominates the shrub layer along with bluestem willow and narrowleaf cottonwood as common associates. On drier sites, the facultative riparian species, Rocky Mountain juniper (*Juniperus scopulorum*), sometimes occurs.

d) Coyote Willow/Kentucky Bluegrass (*Salix exigua/Poa pratensis* CT; SALEXI/POAPRA)

The exotic Kentucky bluegrass dominates the undergrowth of this common, coyote willow shrubland type. It occurs adjacent to the channel up to the middle bars; it is typically within a two- to ten-year flood zone where stream gradient approaches 2%. Other species include bluestem willow, narrowleaf cottonwood, Baltic rush, American bulrush, spikerush, horsetail and more. There is a diverse mixture of herbaceous species intermingled with the bluegrass (bluegrass does not dominate the site as strongly as does fescue in the SALEXI/FESARU type).

Map Unit 3: Rabbitbrush Shrubland

This unit contains rabbitbrush (*Chrysothamnus nauseosus*) dominated sites which occur on the middle bar and up on the higher terraces; typically in the ten-year or greater flood-return zone. Upland species tend to be dominant to well represented. Where the CT's occurs lower in the floodplain, obligate riparian species become common in the understories. Two community types were identified along with open barren sites for the unit:

a) Rabbitbrush/Sparse Undergrowth (*Chrysothamnus nauseosus*/Sparse CT; CHRNAU/Sparse)

This CT occurs at mid and upper floodplain elevations on disturbed sites (either by flood or human activity). Interspersed among the rabbitbrush are scattered riparian species including coyote willow, cottonwood, rush, fescue at lower floodplain positions closer to the water table, and upland species such as blue grama (*Bouteloua gracilis*), or snakeweed (*Gutierrezia sarothrae*) higher in the floodplain. Higher elevation stands may remain stable for a long period, barring major changes in the channel.

b) Rabbitbrush/Blue Grama (*Chrysothamnus nauseosus/Bouteloua gracilis* CT; CHRNAU/BOUGRA)

This is essentially an arroyo riparian/upland type occurring at the highest elevations of the floodplain. Rabbitbrush forms moderately dense canopies with an understory of upland species dominated by typical range grasses (blue grama, sideoats grama [*Bouteloua curtipendula*], dropseed [*Sporobolus spp.*]). Some riparian species do still occur, such as horsetail and the exotics yellow sweetclover and dandelion, along with scattered cottonwoods, willows and rushes (particularly where there may be lateral ground water inputs).

c) Sparse Bar

Sparse bars are on middle bars and terraces, resulting from both natural (flood) and human (sand and gravel mining) disturbance factors. These bars support little vegetation, at most a few scattered rabbitbrush or herbaceous graminoids and annuals, hence they are most closely related to the Rabbitbrush/Sparse CT.

Map Unit 4: Old Field/Disturbed Ground (Upland Toeslope)

This unit includes areas heavily disturbed by human activity, usually fallow fields or old quarry sites, but may also include sites dominated by upland vegetation at the upper margin of the floodplain. The old fields occur at various elevations in the floodplain depending on disturbance history, but commonly occur on the higher terraces that are not subject to regular flooding. They occur primarily in the upper segment are becoming revegetated with semi-natural vegetation, but exotic species are still prevalent. The quarry sites are also becoming revegetated and are found at lower elevations in both the middle and upper segment.

a) Old Field

Old field vegetation is what remains after farming. This type is usually dominated by tall fescue, with dropseed occasionally dominating, and typically occurs in the middle bar zone and ten-year or greater floodplain. The presence of the fescue may be the result of its introduction as a haying species or in animal feed when the sites were used as pastures. Commonly found are species which increase on disturbed sites such as yellow sweetclover, dandelion, and white clover (*Trifolium repens*).

b) Disturbed Ground

This type includes areas disturbed during sand and gravel mining (excluding the ponds and associated levees). These are flat surfaces or depressions in the floodplain which occur low in the two- to ten-year floodplain. Some depressions appear to be lower than the active channel. Vegetation varies considerably depending on degree of disturbance and floodplain

elevation, but exotics and disturbed site indicators are most prevalent (fescue, sweetclover, dandelion and horsetail).

c) Upland Toeslope

The outer edge of the riparian zone and the toeslopes of the upland support vegetation dominated by upland species. The Oneseed Juniper/Blue Grama woodland type is most common. Additional species include Rocky Mountain juniper, rabbitbrush, snakeweed, yellow sweetclover, Kentucky bluegrass, sideoats grama, salsify (*Tragopogon dubius*) and others.

Map Unit 5: Pond

This unit contains only the Ponds, found primarily in the study area's middle segment where the bulk of historic quarrying occurred. These ponds were created by levee construction followed by diversions of surface flows form the active channel. They were maintained for livestock watering until PNHP acquisition. Typically the rims of the ponds occur at middle elevations in the floodplain while their bases occur below levels of the active channel. But because of their distance from the active channel (and possibly because of the surrounding levees), they probably receive little or no subsurface inputs from the active channel. The vegetation is aquatic, with algae a major component.

Map Unit 6: Narrowleaf Cottonwood Forested Wetland

This unit occurs predominately in the lower portion of the study area along narrow middle bars and terraces that are often shaded by the surrounding bluff. The forests are represented by a single community type:

a) Narrowleaf Cottonwood/Kentucky Bluegrass (*Populus angustifolia/Poa pratensis* CT; POPANG/POAPRA)

This type is typically on middle bars in the five- to ten-year floodplain. Narrowleaf cottonwood is a strong dominant with cover typically 40 to 90%, heavily shading the understory. The exotic Kentucky bluegrass is also abundant, with cover often greater than 25%. Some stands are comparatively old, with tall cottonwoods and relatively open canopies, while others are young, with short stature cottonwood regeneration. Other species which may be well represented are fescue, yellow sweetclover, white clover and fleabane (*Erigeron flagellaris*). Willow and juniper species also occur. The type is usually found in the highest position in the floodplain. Above the CT is usually a rocky bluff, while below is either MU 1 or 2. Lateral subsurface flow, coming from under a rocky bluff, may contribute substantially to sub-surface water availability.

Map Unit 7: Juniper/Bluegrass Meadow

On upper bars and terraces where cottonwoods have been removed either by woodcutting or where natural changes in hydrology and geomorphology have led to their senescence, Rocky Mountain juniper and bluegrass become dominants on the sites forming open woodlands and meadows. Two community type are recognized for the unit:

a) Rocky Mountain Juniper/Kentucky Bluegrass (*Juniperus scopulorum/Poa pratensis* CT; JUNSCO/POAPRA)

This open woodland type occurs primarily on middle bars in the five- to ten-year floodplain, or on upper terraces that are flooded very infrequently. Rocky Mountain juniper is a common upland species of higher elevations, but occurs here as a facultative upland species because of enhanced moisture conditions in the riparian zone. The open canopy creates a warm, yet productive site dominated by the exotic Kentucky bluegrass and other graminoids such as blue grama, sideoats grama along with various forbs. The shrub component is minor, with an occasional rabbitbrush or snakeweed.

b) Kentucky Bluegrass/Silverleaf Cinquefoil (*Poa pratensis/Argentina anserina* CT; POAPRA/ARGANS)

This meadow type is similar to the JUNSCO/POAPRE CT, but it lacks the tree component. The pattern and processes are probably similar, but conditions are probably somewhat drier. Herbaceous species are well represented and diverse and include some riparian species such as horsetail and cinquefoil (*Argentina anserina*) and riparian exotics and invaders such as yellow sweetclover, dandelion, and fescue.

Map Unit 8: Plains/Narrowleaf Cottonwood Forested Wetland

This unit contains four cottonwood-dominated CT's, including two Plains cottonwood types. These occur primarily on mid-bar positions in the broader floodplains of the middle to upper segments.

a) Plains Cottonwood/Coyote Willow (*Populus deltoides/Salix exigua* CT; POPDEL/SALEXI)

The open-canopied forested-wetland type is found on the lower and middle bars (five- to ten-year flooding), and occasionally on the higher terraces (where there may be significant lateral sub-surface flow). Larger, older Plains cottonwoods tend to predominate on the higher less-frequently flooded bars, while saplings and poles dominate the wetter sites. Cover of the obligate riparian coyote willow is moderate (some sites show significant young coyote willow regeneration, suggesting high potential willow cover). Other common species include rushes, horsetail, fescue, yellow sweetclover, and bluestem willow. A broad range of species are possible including common upland species such a grama grasses, snakeweed, Rocky Mountain juniper and rabbitbrush.

b) Narrowleaf Cottonwood/Coyote Willow (*Populus angustifolia/Salix exigua* CT; POPANG/SALEXI)

This type occurs primarily on middle bars with estimated five- to ten-year flood recurrence intervals. Large cottonwoods predominate, but young trees can be abundant. Coyote willow coverage is moderate, with some areas showing many young willow, suggesting potentially heavy willow cover. Baltic rush, common horsetail and other obligate riparian species are common.

c) Plains Cottonwood/Sparse Undergrowth (*Populus deltoides*/Sparse CT; POPDEL/Sparse)

This open-canopied forested wetland is similar to the Plains cottonwood/Coyote willow, but lacks a significant ground cover. It occurs primarily on lower and middle bars. Disturbance indicator species are sometimes present in the understory such as yellow sweetclover, dandelion, fescue, and Kentucky bluegrass.

d) Narrowleaf Cottonwood/Sparse Undergrowth (*Populus angustifolia*/Sparse CT; POPANG/Sparse)

This is an open-canopied forested wetland that is similar to the Narrowleaf cottonwood/Coyote willow, but generally lacks significant undergrowth. Narrowleaf cottonwood cover is also somewhat lower (perhaps a function of human disturbance). This occurs primarily on middle bars.

Map Unit 9: Rock Outcrop

Bedrock outcrops occur throughout the reach. The outcrops are important as channel controls, restricting vertical and lateral movement of surface and subsurface waters. Subsurface water may surface at an outcrop, creating a local change in water availability for vegetation. It is especially prevalent in the lower segment of the study reach, helping to create a narrow floodplain. Vegetation is quite variable but low in cover, and can include cottonwood, willow individuals, or juniper, along with a herbaceous component of Kentucky bluegrass, and fescue.

Spatial Distribution of Map Units

Approximately 50% of the site is occupied by wetland/riparian communities. The most abundant map unit in this group is the shrublands dominated by coyote willow (MU 2). These shrublands are distributed throughout the reach, but are particularly prevalent in the Middle segment, where most of the restoration work will occur. The forested wetlands of Map Units 6 and 8 together make up a total of 18% of the reach. These are important habitats which add significant structural and species diversity to the ecosystem. Narrowleaf cottonwood stands are particularly important in the Lower segment where the floodplain is narrow. Scattered stands of plains and narrowleaf line the channel of the Upper and Middle segments. This reach is in a transition zone between the two species and the hybrid lanceleaf cottonwood (*P. acuminata*) does occur. Emergent Herbaceous Wetlands (MU 1) make up about 14% of the area and are particularly strong in the Upper segment where the gradient is very low and there is considerable natural ponding.

Other natural vegetation is made up of the arroyo riparian-like Rabbitbrush shrublands (MU 3) covering 21% of the area, and juniper and meadow (MU 7), representing 4% of the area once occupied by cottonwood forest. Rabbitbrush is common in both the Upper and Middle segments. In the Middle, it is mostly found on the man-made levees and out of the floodplain. These drier site riparian zone communities make up a total of 25% of the area.

The 25% remaining is in Old field/Disturbed Ground (MU 4), man-made ponds (MU 5) and rock outcrop. The majority of the old field habitat is found in the Upper segment where relatively recent agricultural activity is readily apparent (fences are still present in some cases). The constructed ponds are in the Middle segment. Overall, 75% of the site is in natural vegetation, with inclusions of bare ground and active channel.

Ecological Assessment

The ecological assessment of the study reach focuses on impacts to the natural hydrological regime along with the direct impacts of past grazing and agricultural use. There have been numerous impacts that have resulted in modifications in ecosystem expression, particularly with respect to vegetation composition and spatial pattern. There have been natural hydrological modifications resulting from flood events along with significant manmade hydrological modifications, and the effects of past resource extraction (grazing, sediment mining, and agricultural conversion) are still evident.

Flood Impacts

The most recent flood in 1993 was the largest in 50 years (personal communication PNHP staff). The evidence of the flood is mostly in the form of debris deposits on bars and terraces throughout the study area. This flood may also have delivered large amounts of

sediment, particularly in the Upper segment, contributing to the observed low gradient of that reach.

Sand, Gravel and Rock Removals

Within the last 30 years sand and gravel mining occurred in the riparian zone of the Upper and Middle segments resulting in several excavations ranging in size from 0.25 to 1.0 acres in size. The Upper segment was impacted primarily by a sand removal operation that probably modified the channel position and altered the overall gradient (the channel may have been diverted away from the main quarry areas). A large sand pile (5 X 25 meters and over 5 meters high) found at the lower end of the segment is the most obvious legacy of operation, but the stream gradient seems exceptionally low leading to several ponded areas, and the current position of the active channel now appears shifted to the north and against the upland slope (which is eroding in some places).

In the Middle segment there was apparently a gravel and rock operation for road building that resulted in large and deep excavations. These were later converted to two ponds by the creation of two sequential dams and partial diversion of the stream into the ponds to maintain water levels. These ponds were used to water livestock, particularly when the creek was low. Since PNHP acquisition, this is no longer an appropriate use, and the ponds have been nearly drained. The active channel was diverted south around the ponds by a large levee-like structure. This has also resulted in a rather straight channel through most of the segment, with little or no sinuosity. The gradient also increases and there is little or no ponding until below the artificial ponds.

The Lower segment has not to our knowledge been subjected to direct hydrological modifications.

Watershed Conditions and Hydrological Regime Impacts

The watershed above the study site has had considerable residential and business development, particularly in the last 15 years. There has been increased pumping of ground water as more subdivisions occur and the Glorieta Baptist Assembly grows in size. Alternatively, there may be increased surficial flows on Glorieta Creek resulting from inputs of treated Assembly wastewater. Effluent from this site and the many septic tanks along the creek may also be affecting water quality.

The upper watershed has also been subjected to long-term grazing that is possibly leading to increased runoff and sediment loads, particularly in the lower watershed where the study site is located.

Direct Livestock Impacts

Prior to PNHP acquisition in the early 1990's, the property was managed primarily for cattle for over 100 years or more. Livestock was removed about five years ago. The primary legacy of this use is the reduction of willow and cottonwood stands, and the significant introduction of exotic grass and forb species. At times livestock preferentially forage on young willows and cottonwoods, effectively preventing the development of large stands of forested and shrub wetlands. Currently, there is good willow and cottonwood reproduction, but the stands are young, and the amount of area occupied by these species is lower than would be expected in an un-impacted stream.

Agricultural Conversion

Agricultural conversion is most evident in the Upper segment where upper terraces appear to be old fields that once were use for growing primarily hay crops. These fields are now fallow and are reverting to a semi-native state, although exotics are still predominant.

Fuelwood/timber

Fuelwood or timber extraction does not appear to have been significant.

Vegetation Condition and Quality

Past landuse has had a significant impact on vegetation community condition. Exotics such as tall fescue, Kentucky bluegrass, sweet clovers and alfalfa now dominate the herbaceous cover of several communities throughout the study reach. These were probably brought in with hay feed and have escaped from neighboring fallow agricultural fields where hay had been grown. Exotics are most prevalent in shrub and forest types with grassy, meadow-like undergrowths. This exotic dominance, particularly by tall fescue and the clovers and alfalfa, significantly reduces the quality of these vegetation communities relative to other occurrences in New Mexico. (Kentucky bluegrass is an aggressive invader in riparian zones throughout the Southwest).

Some communities have only minor impacts from exotics. Widespread but native wetland species such as Baltic rush and American bulrush dominate the emergent wetlands and willow shrublands that line the channel. Furthermore, because of the removal of livestock grazing, willow and cottonwood regeneration is increasing, and salt cedar (*Tamarix ramosissima*) incursion is minimal. There are some remnant patches of native herbaceous vegetation where yerba mansa (*Anemopsis californica*) is dominant. These emergent wetlands represent the highest quality communities in the study area.

From a landscape perspective, the wetland/riparian vegetation has been fragmented significantly by past land uses. Only 50% of the riparian zone supports emergent herbaceous, shrub and forested wetlands. Elsewhere in the Pecos River drainage and in New Mexico where impacts have been fewer, these types of communities can occupy anywhere from 75%

to 99% percent of the floodplain. Currently, much of the area is occupied by drier shrublands of levees, old fields, and open water of artificial ponds (Table 1). In the Upper and Middle segments, forested wetlands in particular tend to occur in small patches scattered on mid-bars and terraces. In the Lower segment individual riparian forest patches tend to be larger. The increased reproduction of cottonwoods and willows suggest that there is significant potential for increasing shrub and forested wetlands, and that natural recovery is occurring along the study reach..

Vegetation Community Status

Most wetland/riparian communities of New Mexico are considered threatened based on NMNHP surveys and analysis throughout the state (Durkin et al. 1994, 1995, 1996 & 1997; Muldavin, Sims and Johnson 1993). The most threatened are forested wetlands dominated by plains cottonwood that occur along the heavily utilized lowland floodplains. Perhaps as much as 90% of their prior distribution has been eliminated in the state in the Southwest. On the other hand, there are considerably more narrowleaf cottonwood forests and they are less threatened. They occur at higher elevations where agriculture conversion and hydrological modifications have been fewer. But they still have been significantly impacted by cattle throughout their distribution. Similarly, the shrub and herbaceous emergent wetlands described here have a wide distribution in western North America, but they have been the target for removal in past decades and are in decline. Only with enactment of various wetlands protection legislation have these wetlands received the necessary attention to halt the decline, but they remain threatened in the Southwest.

In this regional context, the wetlands of the study area are of interest. Since they are now protected from on-site impacts such as grazing and quarries, and because there is evidence of a trajectory towards recovery, over time this site has the potential to support regionally significant wetland/riparian communities. Exotic invasion of the site by herbaceous species and past hydrological modifications are still an issue, but with careful management some degree of restoration is possible.

CONCLUSIONS

Site Rank

On the basis of the existing conditions resulting from historical impacts and the consideration of restoration potential, a C+ rank has been assigned to this site (the entire reach). There have been significant modifications to hydrology and floodplain structure, and past impacts have led to exotic invasions and fragmentation of wetland/riparian communities. But there is a significant amount of extant wetland/riparian vegetation, and evidence of increased reproduction of obligate riparian species indicating that recovery is already beginning to take place (hence the "+" designation).

On a segment basis, the Lower segment is the least impacted and is assigned a B-rank . There is less fragmentation of the riparian habitat, and past impacts have been fewer.

However, exotics are still problematic in the undergrowth. The Middle segment is the most impacted. The presence of the artificial ponds and levees and the modification of the channel location has significantly altered the character of this reach. This segment is given a C- rank. Only through active and intense restoration efforts can this reach be restored. The Upper segment has been assigned a C rank. There are significant amounts of herbaceous emergent wetlands along with cottonwood and willow reproduction. But the legacy of the past sand quarry operation that probably significantly modified the gradient and channel location and the fallow fields lower the rank of this segment. It is recoverable with modest management intervention, however. Simply allowing natural processes to occur will help restore this segment, i.e., allowing natural flooding events to reshape the floodplain. These processes can be assisted by mechanical intervention such as the removal or redistribution of the sand pile at the lower end of segment, which will encourage channel migration over old fields.

Potential Impacts of the Restoration Project

Three restoration alternatives have been identified that focus on the Middle segment:

1) No action.
2) Partial levee/dam removal and elimination of the artificial ponds.
3) Complete levee/dam removal and elimination of the artificial ponds.

No action implies leaving the levees intact and allowing natural hydrological processes to reshape the floodplain over a long period of time. Under this alternative, the rank for this segment is unlikely to go up in the near future. The levees are well armored, and hence natural modification of floodplain morphology will be slow. Increases in wetland/riparian vegetation will be limited because there will be little channel migration and the propagation of new sites for reproduction of these communities.

Partial levee removal accompanied by channel movement will lead to some changes in the floodplain and the enhancement of wetland/riparian vegetation. But partial removal still leaves well armored, resistant pieces of levees in place, and hence limits the degree of restoration in this segment. A positive attribute of this alternative is that it limits immediate downstream impacts on the Lower segment by limiting the amount of sediment release. High sediment releases may significantly impact the riparian zone in the short term, particularly understory vegetation, but long-term negative impacts are not likely to be significant.

Complete levee removal will potentially allow the full restoration of the middle segment by encouraging the natural hydrological processes to reshape the floodplain. Allowing natural channel migration and flooding will enhance native wetland/riparian communities and increase the rank of this segment, and of the site overall.

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