RIPARIAN AND WETLANDS SURVEY

PECOS NATIONAL HISTORICAL PARK

Presented to the

National Park Service

by

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Introduction

The Pecos National Historical Park is expanding to encompass what was formerly the central portion of the Forked Lightning Ranch of Pecos, New Mexico. This addition is adjacent to the current national monument and includes approximately 4 kilometers (km) of Pecos River corridor containing riparian and wetland ecosystems along its banks. The purpose of this survey is to describe and map the major riparian and wetlands vegetation communities along the Pecos River within this corridor and provide a prelininary analysis of the ecosystem processes that may be occuring in these communities.

The survey is designed to provide an initial delineation of the major vegetation components of the river ecosystem for National Park Service (NPS) general planning and management purposes, and provide a foundation for future detailed investigations of ecosystem dynamics and patterns to meet site specific needs. The vegetation communities are described on the basis of field sampling and the subsequent classification of samples into community types (associations) that will be compatible with the National Wetlands Inventory of U.S. Fish and Wildlife Service (Wilen et al. 1989), and the New Mexico Natural Heritage Program state community classification system. The descriptions address species composition and environmental characteristics, with specific reference to soils and hydrological regimes. Preliminary assessments of successional status and the landscape relationships among communities are also included. The basic inventory is a map that delineates these communities at the 1:1,600 scale.

Study Area

The study area is inclusive of approximately 4 kilometers of the Pecos River channel within the Pecos National Historical Park addition. The boundaries of this channel with its associated alluvial terraces comprise a Pecos River Corridor whose boundary is shown in Figure 1. The corridor averages approximately 0.3 km across with abrupt boundaries delineated by relatively steep upland colluvial slopes. Elevation ranges from 2,073 meters (6,800 feet) at the north end of the corridor, to 2,048 meters (6,720) feet at the south end along the Los Trigos Land Grant boundary. The surrounding vegetation of the uplands is primarily pinyon-juniper woodland and open blue grama grasslands. The corridor contains scattered mature riparian forest, successional shrublands, meadows, and small inclusions of wetlands with permanent standing water.

The site has been, and continues to be subject to year around grazing by cattle and horses. The only rest period known at this time is during the spring high waters when fences are knocked down. All of the cottonwoods within the study area have been protected from beaver herbivory by caging the lower trunks

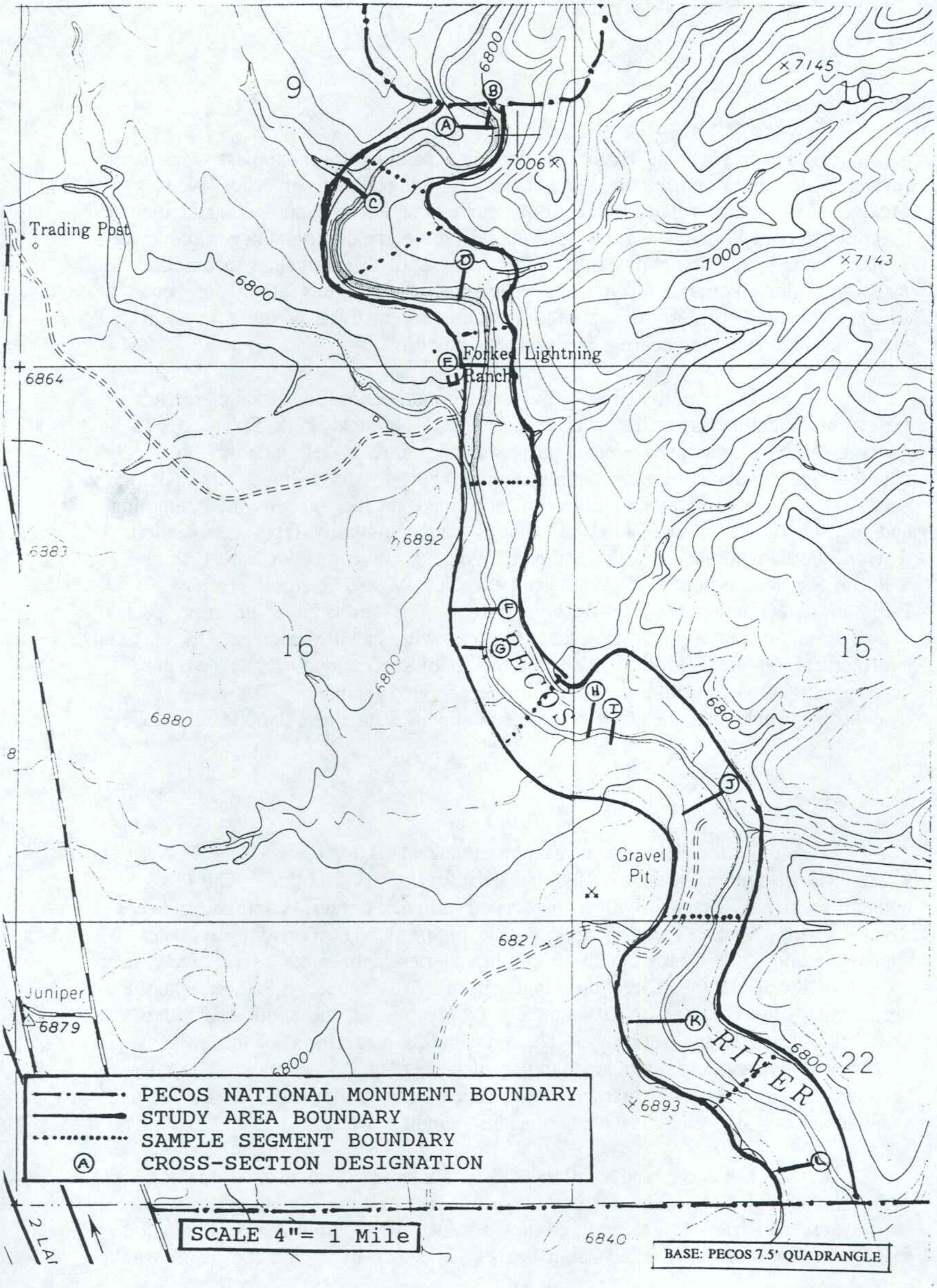

Figure 1. Pecos National Historical Park Riparian and Wetlands Survey -- Riparian Corridor Study Area.

with chicken wire mesh. There is a dirt track that runs the length of the corridor that is occasionally maintained by bulldozer, particularly at river crossings.

Stream discharge records have been kept from a USGS gaging station at the Pecos River near Pecos (nine miles above town) since 1919 (USGS 1991). A flood that occurred in September of 1904 was said by local residents to be biggest since 1886. In September of 1929 a flood was estimated at 4,500 cubic feet per second (CFS) and is thought to be the highest fall flood on record, although there may be some doubt on the reliability of reading (USGS 1960). The highest maximum daily discharge actually recorded since 1919 is 1,960 CFS in May of 1941. The only other flood to approach the 1941 level was this May, 1991 with 1,910 CFS.

Methods

The 4 km river channel length has been divided into eight, 0.5 km sampling segments. Within each segment a cross-sectional transect was established through representative vegetation and a range of fluvial-geomorphic and hydrologic conditions (Figure 1). Four additional transects were also established to detail particular conditions of interest. Elevations corresponding to major breaks in topography along the cross-sections were measured with a transit level, cloth tape, and Philadelphia rod. The current high water mark (May, 1991) elevations and current water levels at the time of sampling (mid-June, 1991) were also recorded.

Sample plots 400 square meters in area were established along the transects in homogeneous stands of vegetation corresponding to particular alluvial terraces or other geomorphic/soil features. Species composition of the tree, shrub, and herbaceous layers were recorded with visual estimates of canopy cover for each species using both analytical and reconnaissance plots (Moir and Ludwig 1983). When possible, detailed measurements of tree species were taken for the analysis of stand structure (basal area and age). Site variables recorded included information on landscape features, channel morphology, plot position in the landscape, and soil profile descriptions. Soils data were collected by auger near the center of the plot.

Sample plots were preliminarily classified into series, and as possible, plant associations in the sense of the Braun-Blanquet method (Becking 1957). Therefore, the plant associations represent actual vegetation, rather than potential climax associations as defined by Daubenmire (1966). The relationship of the plant associations to the potential natural vegetation is discussed separately in the context of successional dynamics and landscape position. Diagnostic species were identified for differentiating between series and associations for mapping purposes. The soils were classified to the family level of the Soil Taxonomy (Soil Survey Staff, 1983). Also, soils were identified as being hydric soils for the purposes of the National Wetlands Inventory (Wilen et al. 1989). Direct and indirect gradient analysis was used to evaluate the general environmental characteristics of the habitat that supports a given plant association, and to evaluate the landscape relationships among associations. Successional trends among associations were evaluated on the basis of stand structure and composition, and landscape position, particularly relative alluvial terrace position (implicit age stratification). Actual transect graphs were constructed using the program XSPRO (Grant, Duval, Koerper Unpub).

U.S. Forest Service color aerial photography of 1:24000 scale from 1978 was used for an initial delineation of vegetation mapping units. This scale of photography is generally in adequate for the mapping of linear features such as vegetation in a riparian corridor. Thus, the mapping units were refined by field reconnaissance at the preferable scale of 1:6000. Mapping units correspond to the Series and Plant Associations as defined by the plot data. Some plant associations had occurrences that were too small to map individually even at the 1:6,000 scale. These have been indicated as inclusions within other units. For example Cattail Swamp is mapped as included within Water Sedge/Baltic Sedge association. Most units on the map are homogeneous, with less than 10% on the average of any given unit being some association other than the one named. The final vegetation map is presented on a stable base material at 1:6000 scale using the USGS Pecos 7.5' quadrangle as the base map.

The information gathered on the vegetation communities (plot data, soil profiles, etc.) is archived in the Biological Conservation Database (BCD) of the New Mexico Natural Heritage Program.

Taxonomic Considerations

Within the study area are groves dominated by cottonwood. The mature individuals appear to belong to the hybrid species Populus acuminata, or lance-leaf cottonwood. This species is considered to be a cross between narrow-leaf cottonwood, P. angustifolia of higher elevations, and plains cottonwood, P. deltoides of lower elevations. Only one P. deltoides was found within the study area. The reproduction appears to be primarily P. angustifolia (although as they mature the P. acuminata characteristics may become more pronounced). In the community descriptions that follow P. angustifolia is used because narrow-leaf reproduction narrow-leaf is dominant, and because the potential for lance-leaf hybrids has been reduced by the removal of plains cottonwood.

Results

A total of fifteen plant associations were identified from the study area. The plant associations can be grouped into four major physiognomic divisions: Cottonwood Riparian Forests, Willow Riparian Shrublands, Wetlands, and Uplands. The plant associations (PA's) are described per division in detail below with respect to vegetation composition and environmental setting. The map unit number, the name of the association, both scientific and common, are given along with the acronym.

Each cross-section is located by letter in Figure 1, and has been diagramed in Figures 2-13 to show the location of a given plant association in the landscape relative to elevation, May 1991 high water mark ("high"), the water level at the time of sampling in approximately mid June, 1991 ("low"), and distance from the active channel(s). Plot numbers, locations and associated soil profile clasification are also indicated on each cross section and referenced in Table 1.

A 1:6,000 scale map of actual vegetation is provided in a separate pocket at the end of the report. Map units correspond to the association descriptions that follow.

Table 1. Reconnaissance plot to cross-section figures cross refernece.

Plot No.	Figure No.	Plot No.	Figure No.	Plot No.	Figure No.
4	2	12	11	20	7
5	6	13	9	21	8
6	3	14	13	22	8
7	2	15	not shown	23	7
8	4	16	not shown	24	2
9	11	17	12	25	5
10	11	18	12	26	not shown
11	11	19	7	27	10

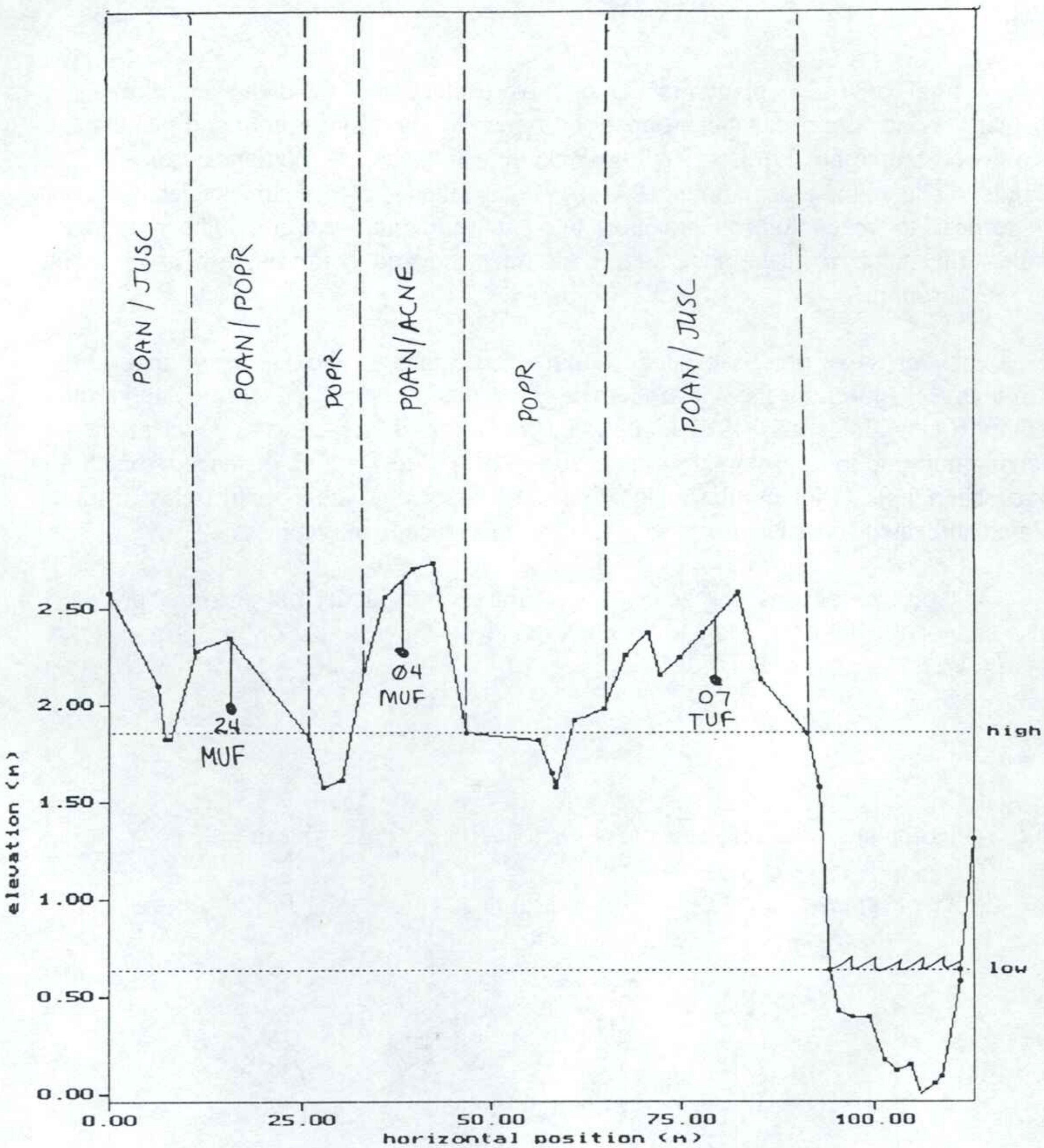

Figure 2. Cross-section A -- Big Flat East-West. MUF=Mollic Ustifluvent, TUF=Typic Ustifluvents.

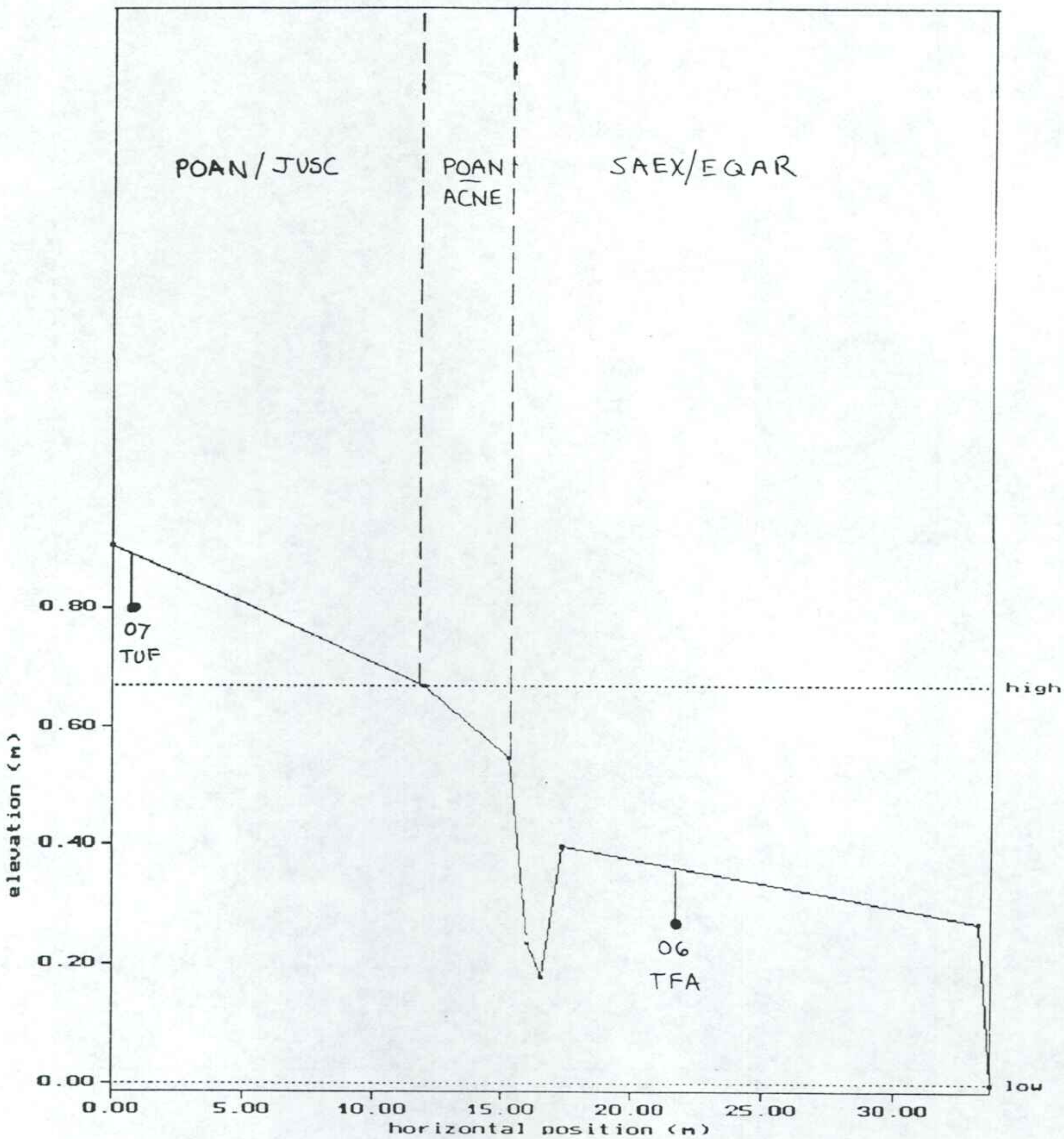

Figure 3. Cross-section B -- Big Flat North-South. TFA=Typic Flavaquent, TUF=Typic Ustifluvent.

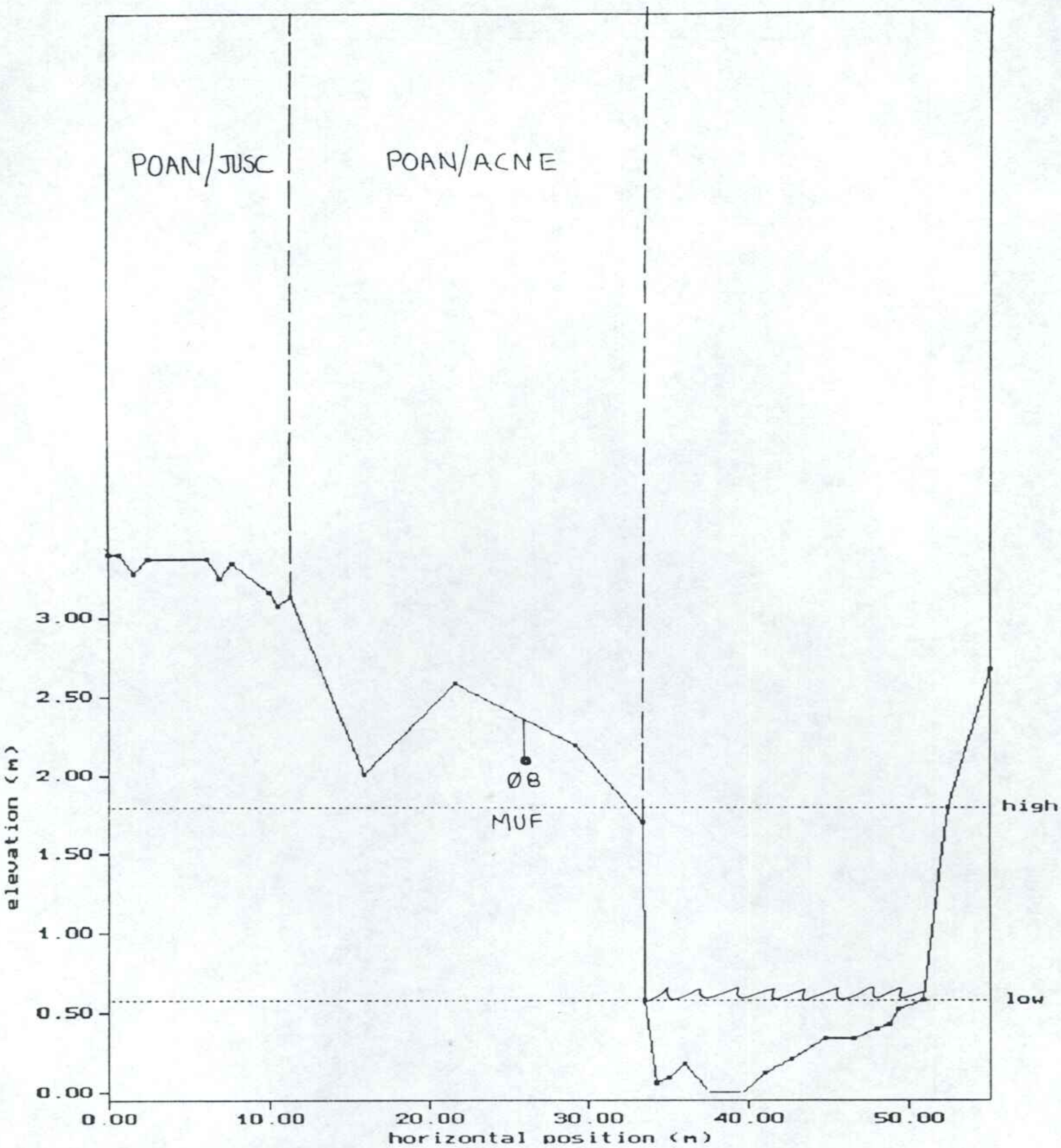

Figure 4. Cross-section C -- Apple Flat West. MUF=Mollic Ustifluvent.

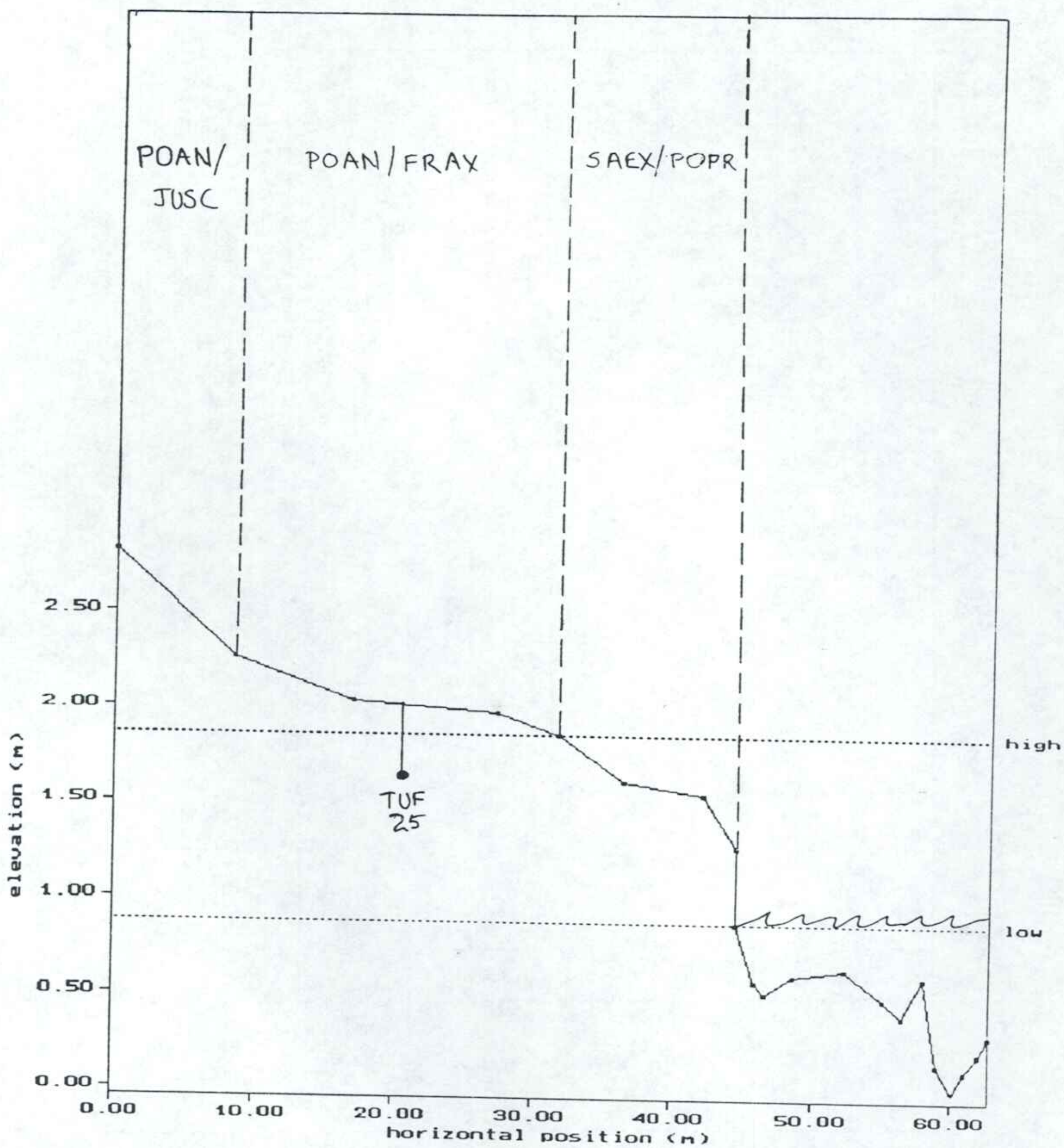

Figure 5. Cross-sectiob D -- Upper HQ Flat East. TUF=Typic Ustifluvent.

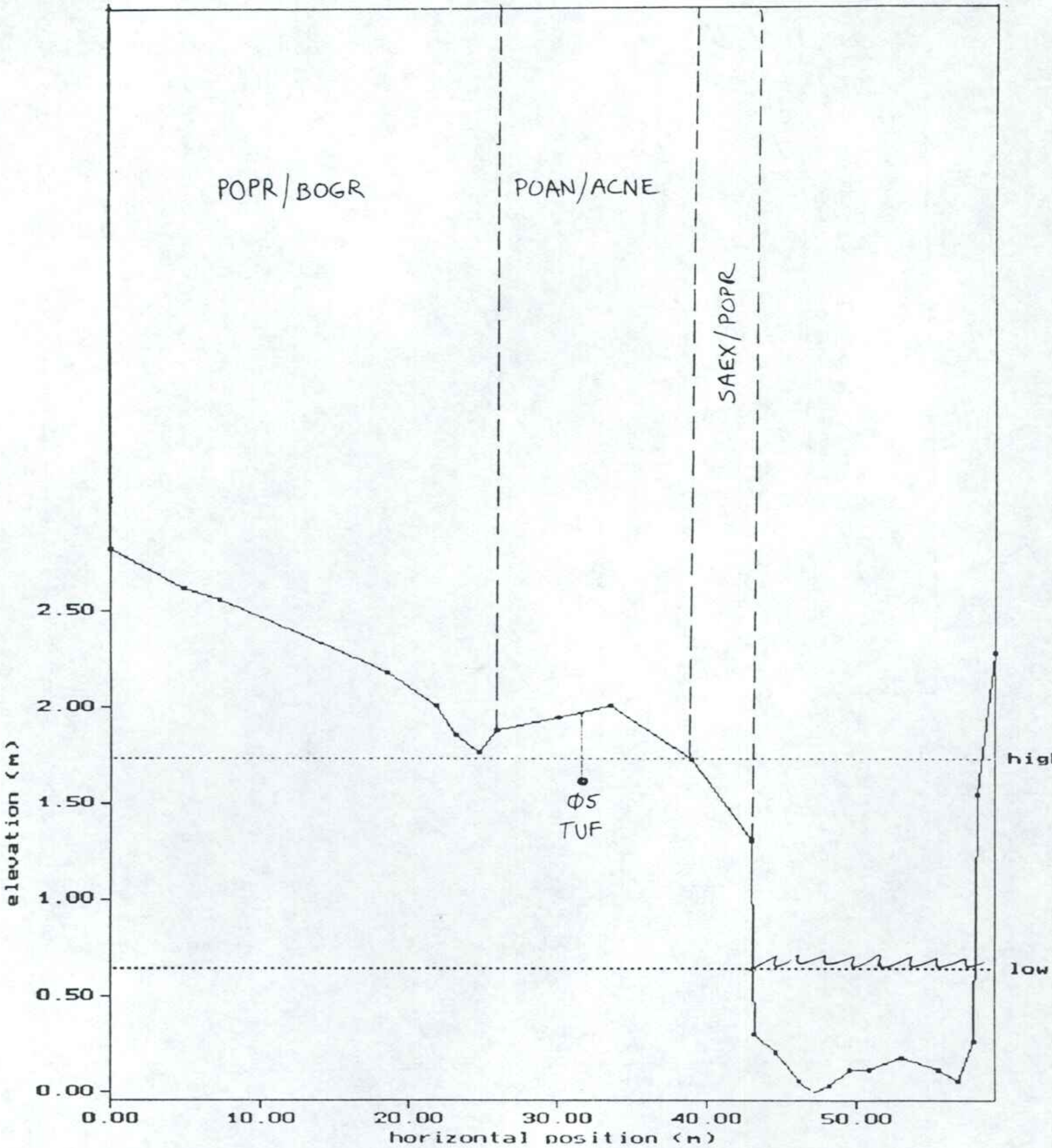

Figure 6. Cross-section E -- Lower HQ Flat West. TUF=Typic Ustifluvent

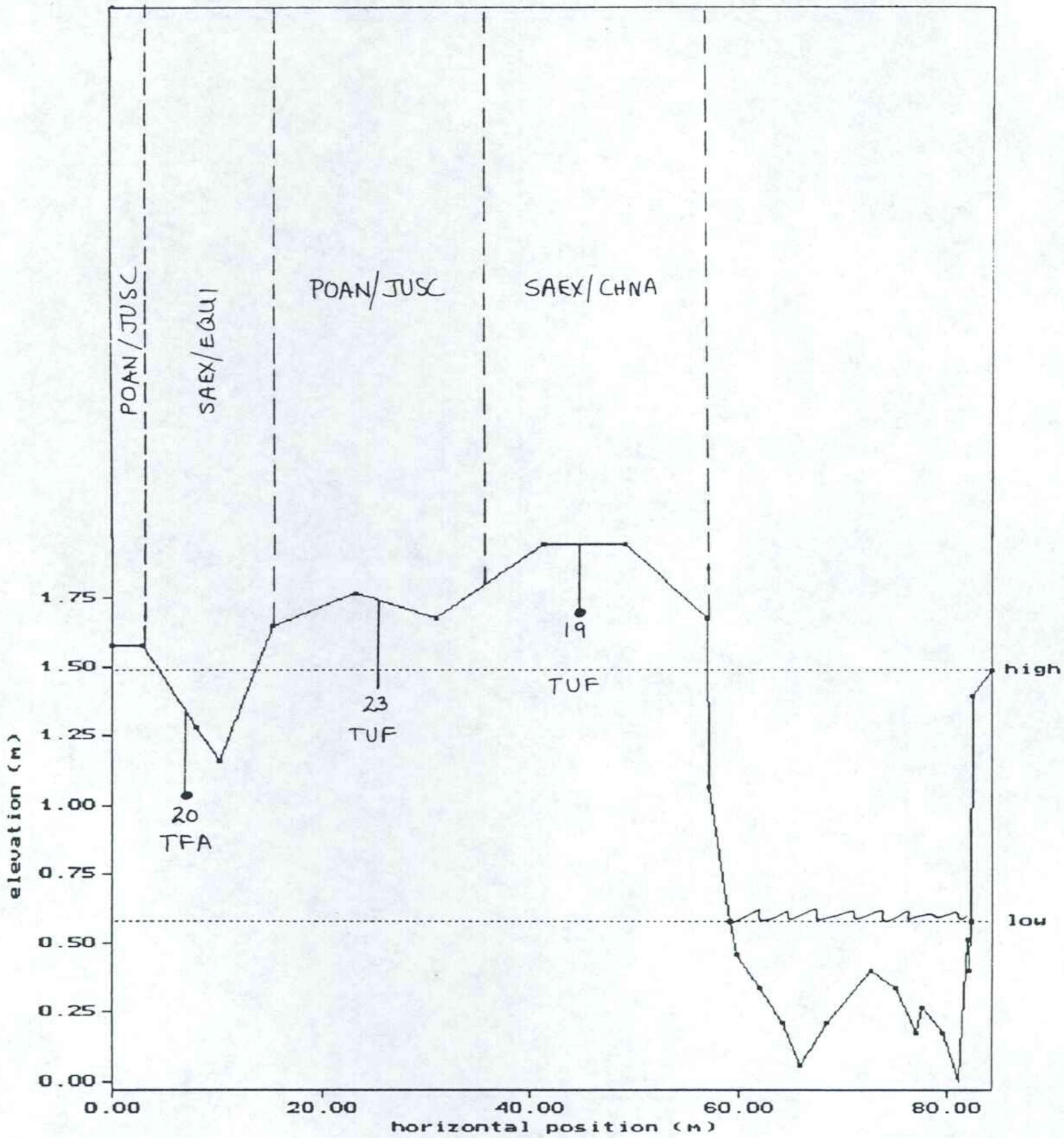

Figure 7. Cross-section F -- Middle Island. TUF=Typic Ustifluvent, TFA=Typic Fluvaquent.

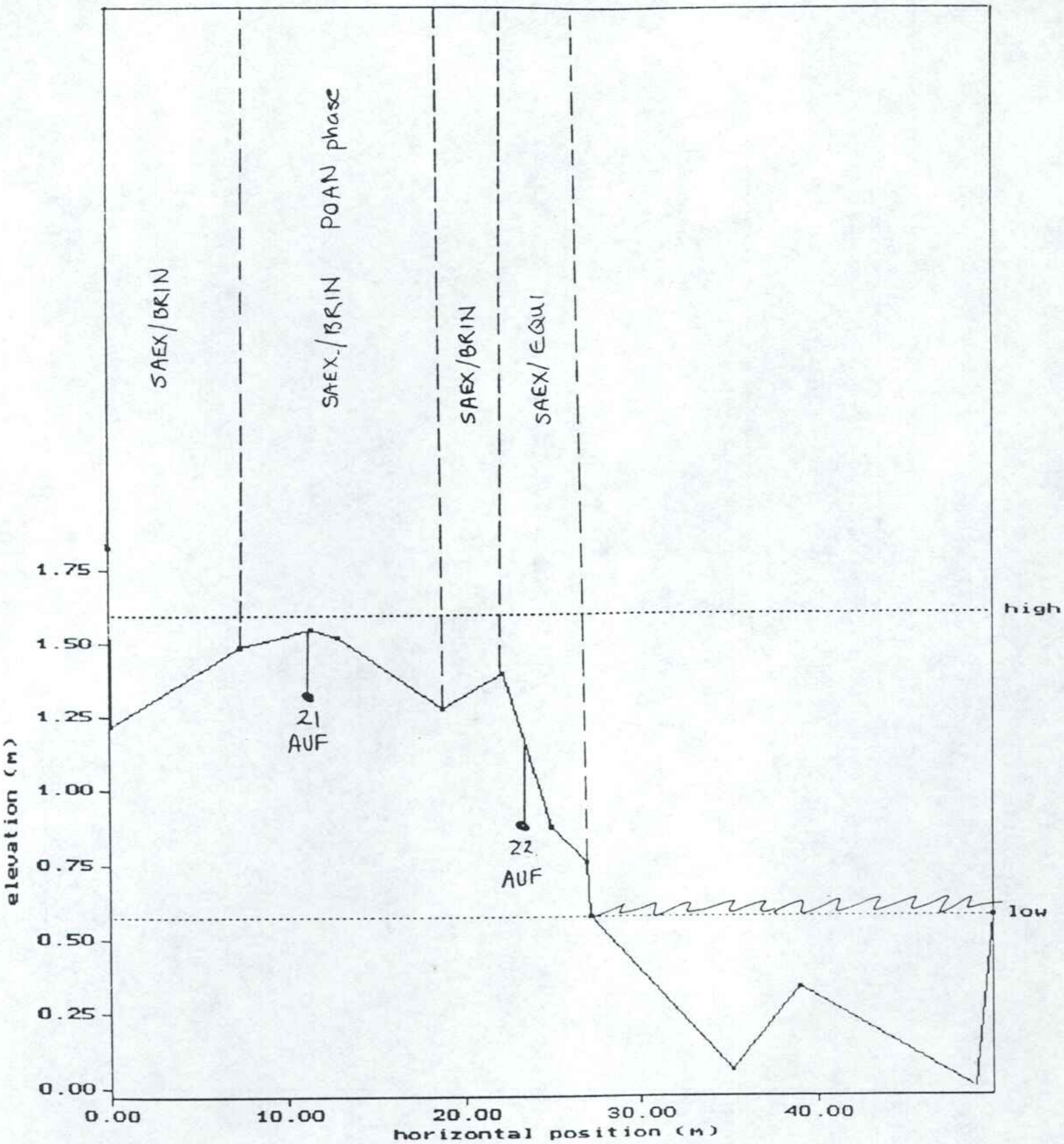

Figure 8. Cross-section G -- Lower Middle Island. AUF=Aquic Ustifluvent.

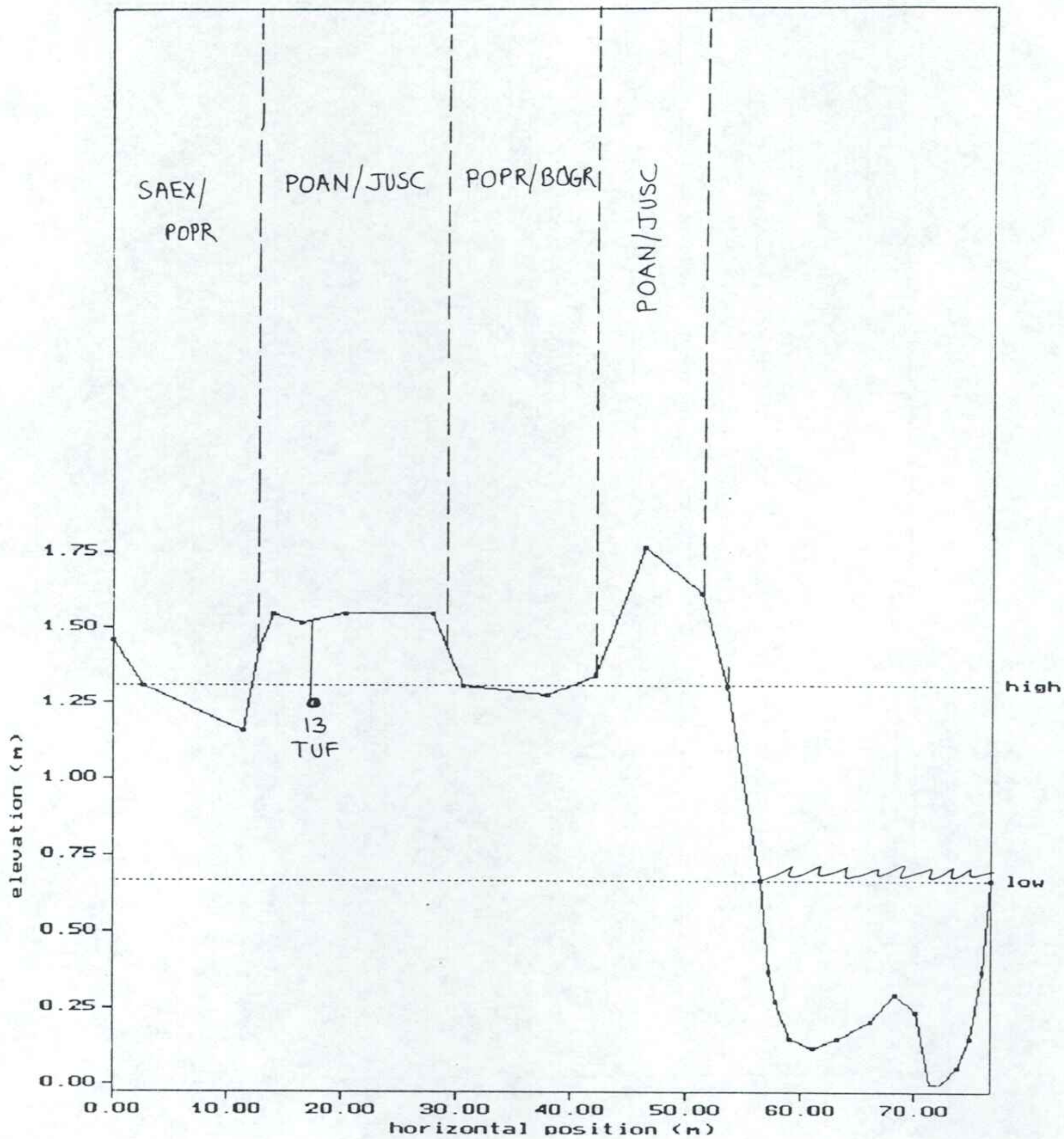

Figure 9. Cross-section H -- Upper Colonias East Side. TUF=Typic ustifluvent.

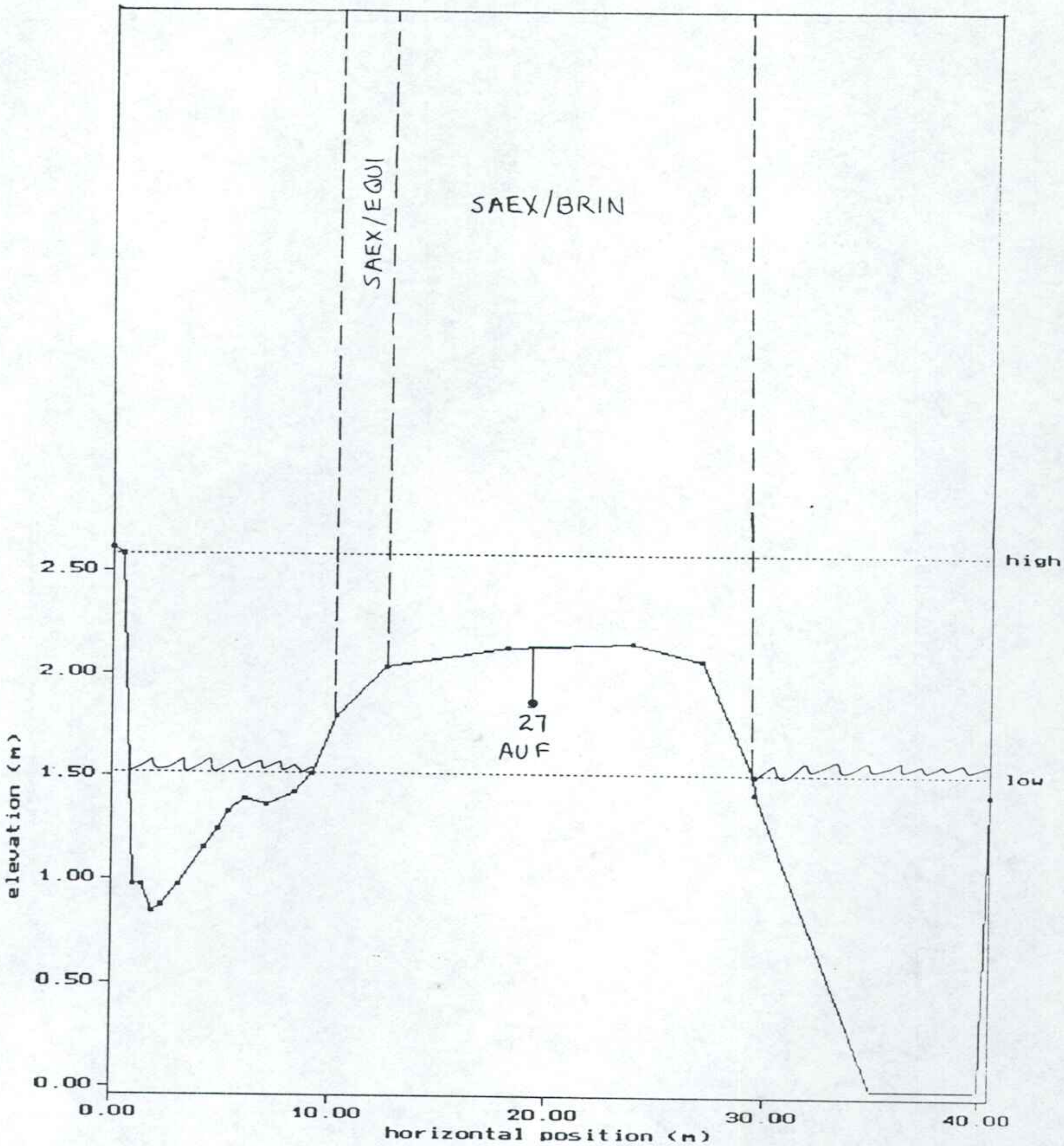

Figure 10. Cross-section I -- Upper Colonias Island. AUF=Aquic Ustifluvent.

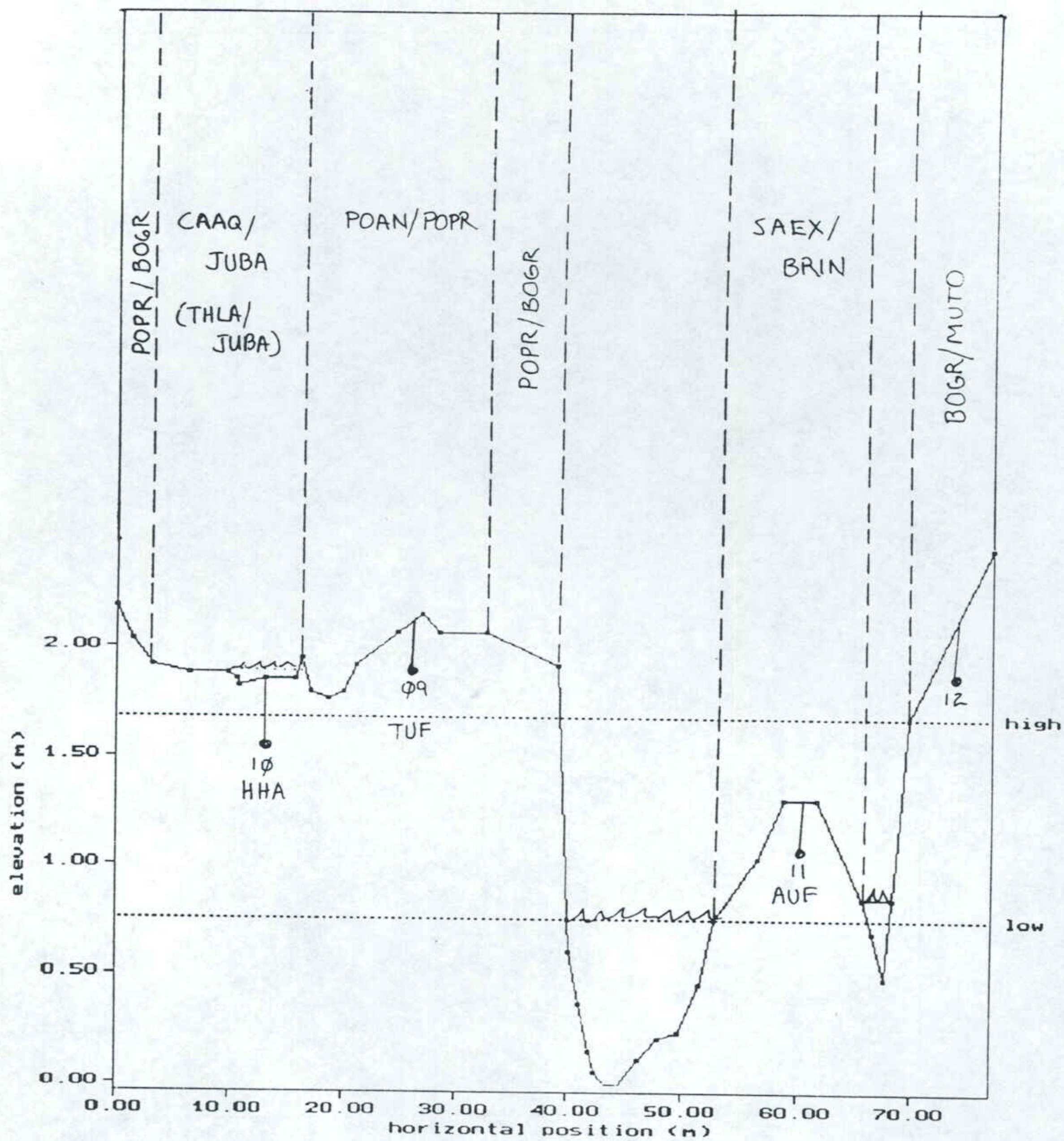

Figure 11. Cross-section J -- Colonias Bridge. TUF=Typic Ustifluvent, AUF=Aquic Ustifluvent, HHA= Humic Haplaquepts.

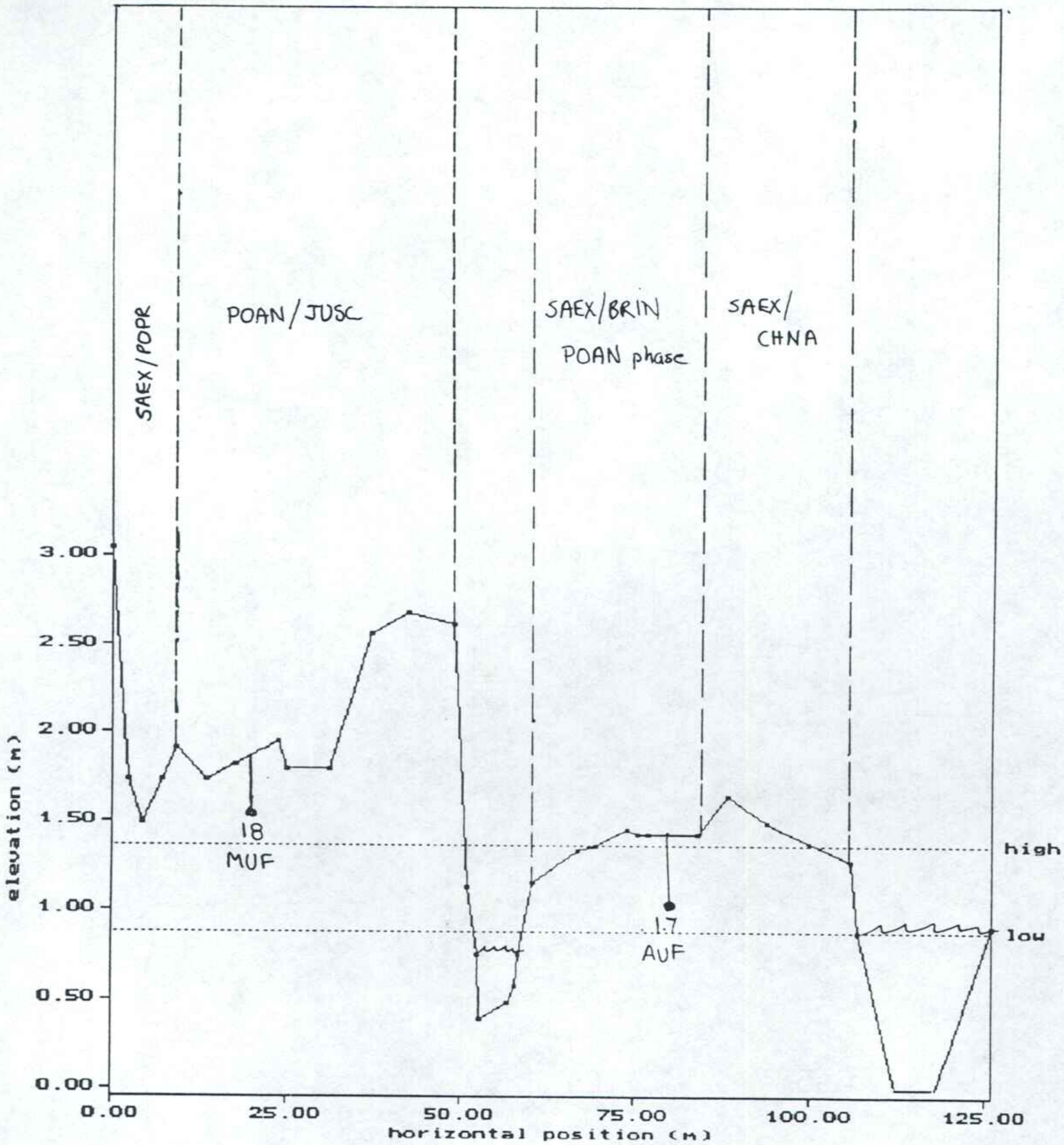

Figure 12. Cross-section J -- Padilla Site. MUF=Mollic Ustifluvent, AUF=Aquic Ustifluvent.

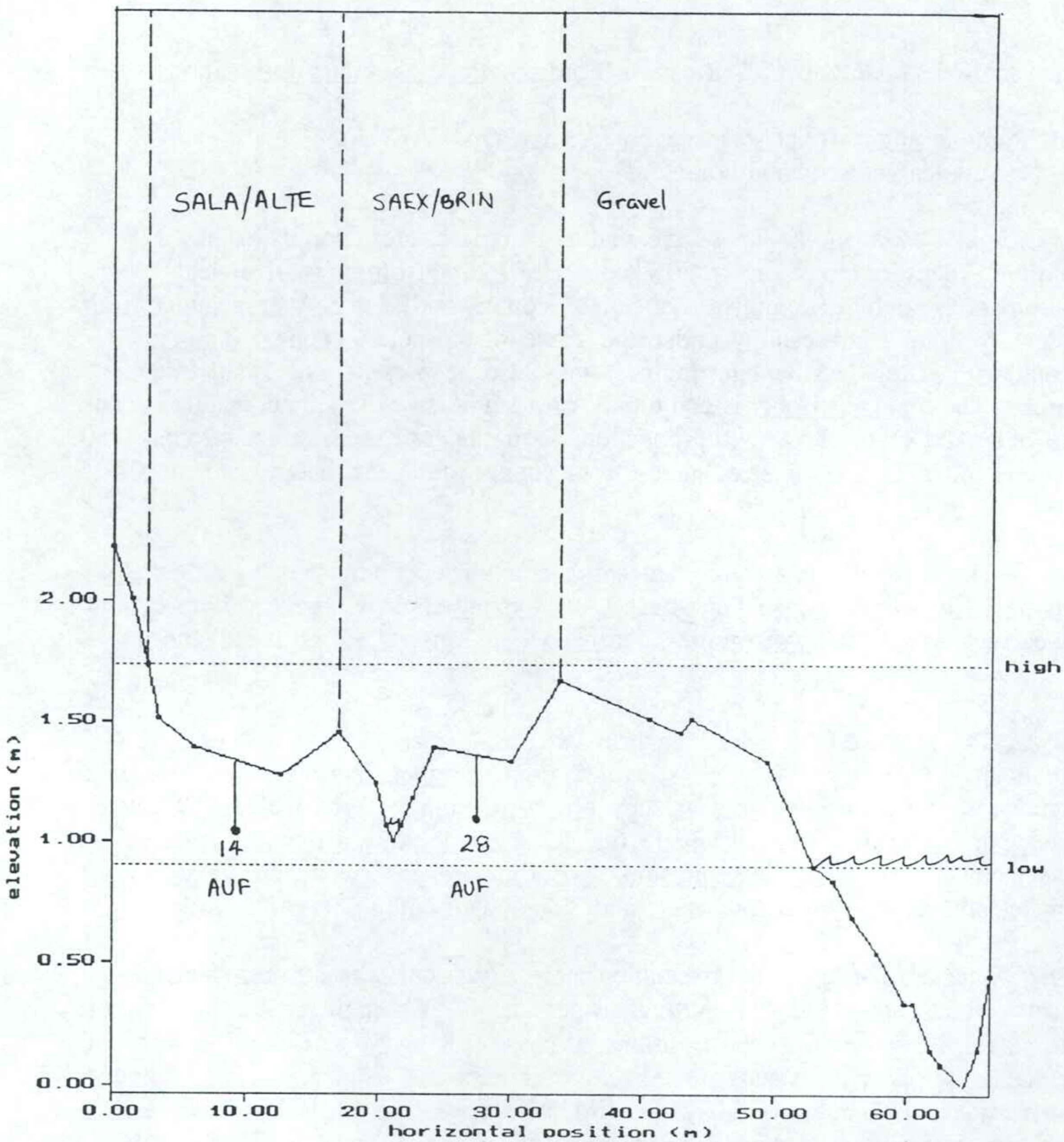

Figure 13. Cross-section L --Los Trigos Boundary Terrace. AUF=Aquic Usistifluvent.

Plant Association Descriptions

A. Narrow-leaf Cottonwood Riparian Forest -- Populus angustifolia Series

A1. Populus angustifolia/Acer negundo PA (POAN/ACNE)
Narrow-leaf cottonwood/box-elder

Vegetation Composition. These are mature riparian forest dominated by a relatively dense canopy (up to 50% cover) of P. angustifolia (narrow-leaf cottonwood) and P. acuminata (lance-leaf cottonwood), with Acer negundo (box-elder) forming a sub canopy under the shade of the cottonwoods. Juniperus scopulorum (Rocky Mountain juniper) may also be present as a small tree or shrub. The P. angustifolia is commonly of a single size class, and mature stands are over 100 years of age. Reproduction is limited to asexual root sprouts. The Acer is found in several size classes from young sapling to mature sub-canopy tree.

There usually is a significant shrub component dominated by either Rosa woodsii, Rhus aromatica (skunk-bush), or Lysium spp. (wolfberry), with twining vines such as Vitis longii (grape), Parthenocissus inserta (Virginia creeper).

The herb layer can be high in cover (>50%) and rich in species. The dominant grasses are Poa pratensis (bluegrass), Bromus inermis (smooth brome), and occasionally Stipa robusta (sleepy grass). Common forbs include Clematis pseudoalpina, Taraxacum officinale (dandelion), Melilotis officinalis (yellow sweet clover), Geranium caespitosum, Trifoilium repens (white clover), Thalictrum fendleri (meadow rue), and Tragopogon dubius (yellow salsify).

Environmental Setting. This association normally occurs on elevated alluvial terraces that are above current high water mark. This high terrace location of the stands is shown in by the positions of plots 4, 8, and 5 in Figures 2, 4, and 6, respectively. But, the stands are not very far removed from the main channel or overflow channels that would receive flood waters, or, as in the case of plot 8, a tributary intermittent stream flows through the stand. The soils are classified as Mollic Ustifluvents (non-saturated soils developed from alluvium with a dark surface horizon) that vary in texture from fine clayey to loamy skeletal. The sites have been removed from the direct influence of floods at the surface. As a result they have attained some degree of soil development, and hence the incipient mollic epipedon (a dark, organic rich surface soil).

A2. Populus angustifolia/Juniperus scopulorum PA (POAN/JUSC) Narrow-leaf cottonwood/Rocky Mountain Juniper

Vegetation Composition. These are mature forests characterized by somewhat open canopies (15-40% cover) of Populus angustifolia and P. acuminata with Juniperus scopulorum as a subcanopy tree and shrub with up to 20% cover, and occasionally J. monosperma (one-seeded juniper). Acer negundo is poorly represented or absent. P. angustifolia is usually represented by individuals of near the same size class, with reproduction limited to root sprouts. Further, many trees in these stands are dead or dying and have J. scopulorum growing up under them.

The shrub layer can be well represented with Lycium spp. or Rhus aromatica, and the saplings of J. scopulorum and J. monosperma.

The herb layer tends to be grassy (20-30% cover) and dominated by Poa pratensis, Bromus inermis, B. anomalus, and Agropyron spp. The dominant forbs are Taraxacum officinale, Vicia americana (vetch), Erigeron flagellaris (fleabane), Heterotheca fulcrata (telegraph plant), Melilotis officinale, and Verbena bipinnatifida.

Environmental Setting. This association occupies the higher terraces in the flood plain and are usually above the current high water mark. The stands are also somewhat removed laterally from the main channel and any overflow channels. This landscape position is represented by Plots 7, 23, 13, and 18 in Figures 2, 7, 9, and 12, respectively. The soils are primarily Typic Ustifluvents with sandy skeletal to fine loamy textures. They seldom develop incipient mollic epipedons, i.e., Mollic Ustifluvents. In general the sites are less watered than other habitats in the study area that support mature forest.

A3. Populus angustifolia/Poa pratensis PA (POAN/POPR)
Narrow-leaf cottonwood/bluegrass

Vegetation Composition. This association is dominated by an open, relatively even sized stand of P. angustifolia (30-40% cover) with little or no sub-canopy trees or shrubs. Acer negundo and Juniperus species are absent or poorly represented.

The understory is meadow like and dominated by such grasses as Poa pratensis, Bromus inermis, or Elymus spp. Forbs are also well represented and include Taraxacum officnale, Melilotus indicus, Melilotus officinale, Trifolium repens, Trifolium andicum, Penstemon whippleanus, Clematis pseudoalpina, Achillea millefolium, and Tragopogon dubius.

Environmental Setting. This association is located on the upper terraces above the current high water mark. Stands may lie near the current main channel or overflow channels, but are usually in an elevated position as shown by plots 24 and 9 in Figures 2 and 11, respectively. The soils are considered Typic Ustifluvents, but with a tendency towards mollic epipedon development. Thus they lie in a intermediate position relative to soils of the POAN/JUSC and POAN/ACNE associations.

A4. Populus angustifolia/Fraxinus pennsylvanica PA (POAN/FRPE)
Narrow-leaf cottonwood/red ash

Vegetation Composition. This community is unusual in that Fraxinus pennsylvanica co-dominates the canopy with P. angustifolia. This Fraxinus is not native to New Mexico, and must have been introduced along with the apple trees that also occur sporadically in the stand. The Fraxinus is limited in extent in the study area. Although some scattered reproduction is occurring, it does not appear to be significant at this time. Acer negundo is absent, but Juniperus scopulorum is present as small trees and shrubs.

The understory is meadow like and dominated by Poa pratensis along with Clematis pseudoalpina, Melilotus indicum, Melilotus officinalis, Trifolium, andicum, and Taraxacum officinale.

Environmental Setting. This community occupies a single alluvial terrace adjacent to the river just north of the old ranch headquarters and is represented by plot 25 in Figure 5. The terrace is above the current high water mark, and probably has not been inundated in the past 50 years. The soil is a Typic Ustifluvent with sandy over coarse loamy texture.

B. Willow Riparian Shrublands.

B1. Salix exigua Series
Sandbar Willow

B1a. Salix exigua/Poa pratensis PA (SAEX/POPR)
Sandbar Willow/bluegrass

Vegetation composition. These are well developed stands of Salix exigua with only an occasional Salix lutea as an associate in the shrub layer. P. angustifolia and Acer negundo are absent. Below the shrubs is a grassy herb layer dominated by Poa pratensis and Agropyron smithii, along with such forbs as Taraxacum officinale, Melilotus indicum, Clematis pseudoalpina, and Erigeron divergens.

Environmental setting. This association occupies alluvial terraces that are at or above the current high water mark, and probably flooded very infrequently. The soils are in the typic ustifluvents, coarse loamy family.

B1b. Salix exigua/Bromus inermis PA (SAEX/BRIN)
Sandbar willow/smooth brome grass

Vegetation Composition. This is an early successional community dominated by shrubby Salix exigua and an occasional Salix lutea. In the typic phase the willows occupy up to 30% cover, but occasionally a phase occurs where Populus angustifolia saplings are the dominant shrubs and the willows are diminished. The understory is sparsely to moderately grassy and dominated by Bromus inermis and Poa pratensis. Forbs are sparse and represented by low covers of Melilotis officinalis, Trifolium andicum, Mentha arvensis, Equisetum arvense, and Taraxacum officinale. It is diffrentiated from the SAEX/POPR by the general dominace of B. inermis and the lower herbaceous cover.

Environmental Setting. This association occurs on sites that are below the current high water mark and where the water table is relatively close to the surface (within a meter) some part of the year. The stands occur adjacent to, or within the current active channel, and are subject to repeated flooding during the spring and fall of most years. The sites for the establishment of vegetation commonly occur behind flood debris dams where sediments accumulate during the floods. Typical sites for Salix exigua dominance are shown by plots 22, 27 and 11 in Figures 8, 10, and 11 respectively. P. angustifolia dominance occurs in plots 21 and 17 in Figures 8 and 12. The soils are commonly Aquic Ustifluvents i.e., well drained alluvial soils, but within contact of the water table some part of the year.

B1c. Salix exigua/Chrysothamnus nauseosus PA (SAEX/CHNA)
Sandbar Willow/rabbit brush

Vegetation Composition. This community is characterized by an open stand of Salix exigua and Chrysothamnus nauseosus, along with Gutierrezia sarothrae (snakeweed) as a sub-shrub. The herb layer is dominated by upland grass species such as Bouteloua gracilis (blue grama), Sporobolus cryptandrus (sand dropseed), along with Poa pratensis. The forbs are also predominantly upland in character and represented by Heterotheca fulcrata, Penstemon whippleanus, Castilleja integra, Phlox gladiformis, Ipomopsis aggregata, and Gaillardia pinnatifida.

Environmental Setting. This association occupies elevated terraces above the current high water mark (plot 19, Figure 7, and Figure 12). Soils are of the Typic Ustifluvent, sandy skeletal family and are well drained.

B2. Salix lasiandra/Alnus tenuifolia PA (SALA/ALTE)
Pacific Willow/thin leaf alder

Vegetation Composition. This association is characterized by the high cover (30-50%) of Salix lasiandra and Alnus tenuifolia, with Salix exigua and Salix lutea as subdominant associates. P. angustifolia is uncommon or absent. The herb layer is dominated by Bromus inermis, Poa pratensis, and Equisetum arvense.

Environmental Setting. This association is limited in extent. The largest stand is represented by plot 14 in Figure 13. This stand occupies an alluvial terrace and over flow channel 40 meters away from the main channel. The terrace is below the current high water mark, and is subject to repeated flooding probably on at least a five year basis, if not more often. The soil is in the Aquic Ustifluvent, coarse loamy over loamy skeletal family. There is a small amount of gley in the soil profile indicating that the water table is within one meter of the surface during much of the growing season (this a is a borderline Fluvaquent).

C. Wetlands

C1. Typha latifolia Series (Cattail Swamp)

Typha latifolia/Juncus balticus PA (TYLA/BUBA)
Catail/baltic sedge

Vegetation Composition. This series is characterized by the presence of Typha latifolia, usually in association with hydric species such as Juncus balticus, Carex aquatilis, and Equisetum spp.

Environmental setting. This Series occurs in small pockets usually associated with spring or ponded overflow flood channels (Figure 11). Standing water is present at the surface for most of the growing season and thus the soils are saturated nearly year around.

C2. Carex aquatilis Series

Carex aquatilis/Juncus balticus PA (CAAQ/JUBA)
Water sedge/baltic sedge

Vegetation Composition. This graminoid wetland is dominated by a dense stand of Carex aquatilis and Juncus balticus in association with Eleocharis spp. and other Carex spp. Forbs and shrubs such as Potentilla hippiana and Salix species are scarce and found at the periphery or on higher ground.

Environmental Setting. This association occupies sites with permanent standing water, usually fed directly by springs. The representative site is plot 10 in Figure 11. At this site a wetland has developed in what might originally have been an over flow channel that is now blocked. The wetland was created by springs emitting directly from the adjacent slope. The soil is of the Humic Haplaquept, fine silty over sandy skeletal family.

C3. Salix exigua Series

Salix exigua/Equisetum arvense PA (SAEX/EQAR)
Sandbar willow/horsetail

Vegetation Composition. This shrubby wetland is dominated by Salix exigua, with Equisetum arvense, Ranunculus spp., Juncus balticus, Bromus inermis, and Poa pratensis as the dominant herbs. The well represented cover of E. arvense and J. balticus is diagnostic.

Environmental Setting. This association occupies alluvial terraces and overflow channels below the high water mark, and are thus subject to periodic flooding, in many cases annually. Plots 6 and 20 in Figures 3 and 7, respectively, are representative of these conditions. The soils are either Typic Fluvaquents or borderline Aquic Fluvaquents that have fine loamy over sandy textures.

D. Uplands

D1 Bouteloua gracilis/Muhlenbergia torreyi PA (BOGR/MUTO)
Blue grama/ring muhly

Vegetation Composition. This grassland is dominated by Bouteloua gracilis in association with Muhlenbergia torreyi, Aristida purpurea (purple three awn), Bouteloua curtipendula (side-oats gram). There usually scattered sub-shrubs of Gutierrezia sarothrae (snakeweed) and Opuntia phaecantha (prickly pear). Common forbs are Leucelene ericoides, Verbena bipinnatifida, and Erigeron divergens.

Environmental setting. This type occurs on ancient alluvial terraces and lower slopes of the uplands within the corridor. The terraces are no longer flooded at any time, but can be eroded away by the river (plot 12, Figure 11).

D2. Pinus edulis/Bouteloua gracilis PA (PIED/BOGR)
Pinyon/blue grama

Vegetation Composition. This woodland savanna type is dominated by Pinus edulis, and Juniperus monosperma in the tree layer, with B. gracilis, and Muhlenbergia torreyi as the dominant grasses. Forb composition is similar to the BOGR/MUTO described above (See U.S. Forest Service (1987) for details).

Environmental Setting. This association occupies the rocky upland slopes, and occasionally ancient alluvial terraces that no longer subject to flooding.

D3. Poa pratensis/Bouteloua gracilis PA (POPR/BOGR)
Bluegrass/blue grama

Vegetation Composition. This meadow association is dominated by Poa pratensis, along with Bouteloua gracilis, B. curtipendula, and Aristida spp. Forbs are varied and commonly dominated by Taraxacum officinale, Plantago lanceolata, Melilotis indicum, Trifolium spp., Achillea millefolium, and Castilleja integra.

Environmental Setting. This association occupies elevated alluvial terraces that are above the current high water mark, and thus probably have not been flooded recently (see Figures 6 and 9)

D4. Chrysothamnus nauseosus/Bouteloua gracilis PA (CHNA/BOGR)
Rabbit brush/blue grama

Vegetation Compostion. This association is characterized by sparse to moderately dense stand of Chrysothamnus nauseosus with a grassy under story dominated by Bouteloua gracilis, in association with B. curtipendula, Oryzopsis hymenoides (indian rice-gras), Sporobolus cryptandrus (sand dropseed), Shizachyrium scoparium (little blue-stem), Poa Pratensis, and Muhlenbergia torreyi. Forbs are scattered and varied with Verbena bipinnatifida, Verbascum thapsus, Heterotheca fulcrata, Melilotus officinalis, Equisetum arvense, Geranium caespitosum, Gaura coccinea, and Tragopogon dubius common.

Environmental setting. This association occupies alluvial terraces at or above the current high water mark and are rarely flooded. Soils are generally Typic Ustifluvents that are well drained.

The National Wetlands Inventory

For the purposes of the National Wetlands Inventory of the U.S. Fish and Wildlife Service (Wilen et al. 1989), in which the NPS is a cooperator, the three wetlands communities described above can be considered as occurring on hydric soils. The soils that underlay the SAEX/EQAR, CAAQ/JUBA, and TYLA/JUBA associations are Typic Fluvaquents or Humic haplaquepts, both of which meet the criteria for hydric soils in being saturated for a significant period or frequently flooded for long periods during the growing season. These wetland associations were classified as by U.S.Fish and Wildlife (1984) using the Cowardin (1979) system as Riverine Upper Perennial, Open Water, and Permanently flooded. The riparian shrublands were similarly classified as Palustrine, Scrub-shrub, Broad Leaved Deciduous, and Temporarily Flooded, and the Riparian Forest were classified as Palustrine, Forested, Broad-leaved, Temporarily Flooded.

Discussion

The communities described above come from a broad spectrum of environments and also fall along a successional sequence. Among the P. angustifolia riparian forests the oldest stands occupy the elevated terraces above the current high water mark. They most likely were established when those terraces were subjected to flooding before the turn of the century. With repeated flooding, terraces aggrade until the stand is above the high water mark. This gives the appearance of a "perched" forest on the older terraces. Also, over time, the current channel has changed position, and more importantly the channel has deepened relative to these terraces, and lowered the water table. Those stands that are still watered by flood overflow channels, or are fed by side upslope drainages, or are immediately adjacent to the main channel, remain vigorous. This is exemplified by the POAN/ACNE Association in Figures 2 and 3. The POAN/ACNE Association can be considered the climax community, or potential natural vegetation under the hydrological regime described above. Acer negundo is very shade tolerant and becomes a sub-canopy dominant in later stages of development. Salix species decline in the shade and the understory becomes richer in shrub and hebaceous species.

Once a community is removed from the effects of the hydrological regime, i.e., when it is no longer subject to flooding or a near surface water table, the vigor of the trees declines and compostion changes. Thus, in the POAN/JUSC and POAN/POPR Associations which are well removed from the high water mark or the main channel, the mature cottonwood trees are dying without replacement (see Figures 7, 9, and 12). As the stand opens open up, Acer negundo also declines, presumably from exposure and the drying of the site. The site may eventually change to open meadow (the POPR/BOGR Association, Figure 11), or dry shrubland (CHNA/BOGR Association), or perhaps even pinyon-juniper woodland.

Natural reproduction of cottonwood can only occur in the context of flooding, specifically during the spring (May). Cottonwood seed will germinate only after a late spring flood. P. angustifolia reproduction at the present appears to be limited to sites that are below the current high water mark and are repeatedly flooded during the spring. Sediment often accumulates behind debris dams in the main channel, forming sand and gravel bars that appear to be ideal sites for P. angustifolia reproduction (Figures 10 and 12 are an example of this condition).

There is a distinct lack of stands from middle age groups in the study area. Every stand was either mature, over mature, or early successional. That P. angustifolia does currently get established on young aged sand bars that are subject to recurrent flooding, would indicate that the potential for reproduction does exist, yet no middle aged stands exist. The intermediate stands either were never established, or were destroyed by floods or herbivory. Stands may never have gotten established because correct flooding conditions were never met in the previous 50 to 100 years. Yet, even with the limited hydrological record only goes back to 1929, there is still no indication that current floods are any less or more in magnitude or frequency then in the previous century. By the same reasoning, the destruction of middle aged stands by floods, although possible, should not have been out of the norm for time. There should be at least some middle aged stands on the basis of hydrological dynamics alone.

Herbivory by beavers and livestock may be responsible for the decline in reproduction. Beavers were removed from the cooridor well over 20 years ago, yet there are still no extensive stands of P. angustifolia saplings or poles. But the lack of beaver may also be a cause of the decline in reproduction. Beavers in the building of their dams with debris, possibly create environments for cottonwood regeneration, similar to debris dams caused by floods. The removal of beavers may protect the older mature trees, but limit reproduction. Regardless, we should still see stands between 20 and 60 years of age.

Livestock impact the cottonwood reproduction by physically crushing or by eating it, by altering the site conditions for reproduction (soil disturbance and erosion). Livestock grazing has been nearly constant within the corridor for the past 100 years. Further, riparian corridors are zones of livestock concentration and use, enhancing the impact. Thus, livestock use has certainly been a major factor in limiting riparian forest reproduction.

When reproduction of P. angustifolia fails, willow stands (SAEX/BRIN, typic phase) may continue to develop, eventually deriving drier mature communities (the SAEX/POPR or SAEX/CHNA Associations), without overstory canopies. There are extensive willow stands in the southern end of the corridor and few riparian forest stands that are healthy (see map).

The Salix lasiandra/Alnus tenuifolia Association may also be an early successional community which will develop into riparian forests if P. angustifolia reproduction can occur. But, the proper site conditions for reproduction do not appear to be available at the present. Alternatively, this association may remain a rather stable willow thicket or low elevation carr indefinitely as long as it continues to be repeatedly flooded.

The wetland communities as a whole are probably rather stable, given constant water availability from independent water supplies such as springs. The Salix exigua/Equisetum arvense Association does occur on flood terraces which may be altered by flood waters to create conditions for P. angustifolia reproduction, and hence the development of a riparian forest. Or the site, over time, may simply fill with fine sediments, dry out and then possibly change towards a meadow (POPR/BOGR Association), rather than forest. The true wetlands (the CAAQ/JUBA, and THLA/JUBA) should remain in a stable state given a constant source of spring water and because they are removed from most flooding events.

The riparian and wetland communities of Pecos River corridor have long been subject to human use, both historic and prehistoric. Prehistoric impacts probably were limited to hunting and gathering, and perhaps occasional water diversion for agriculture. Historically, the Pecos River above the study area has been extensively used for irrigation of agricultural lands. This has had an unknown impact on downstream hydrological conditions. It is questionable if enough water is drawn off and used to impact the ecosytems in the corridor. Within the study area agriculture has been limited to a few homesteads and associated orchards and gardens. But the presence of agriculture has heavily influenced the species composition of the comunities by providing for the introduction of several exotic species (European clovers and grasses, eastern red ashes) that now dominate.

Recommendations for Management and Future Research.

To prevent further deterioration of the riparian vegetation I recommend that livestock grazing be removed permanently from the riparian corridor. The primary landuse over the past 100 years has been livestock grazing. This probably has had a significant impact on riparian forest regeneration (see discussion on riparian forest succession above) and has helped spread and maintain the exotic pasture species. The removal of livestock will enhance cottonwood reproduction and hopefully encourage native plant species to dominate the undergrowth.

The lack of beaver in the ecosystem may also leading to demise of the riparian forest. Beaver may have played a significant role in encouraging cottonwood reproduction and the maintenance of the riparian ecosystem over the long term. Over the short term, beaver are capable of removing mature forest, but normally this would be balanced by increased reproduction of the trees. The question arises if there is enough forest currently available to sustain a beaver population without destruction of what remains. Further research is required on this issue before definitive recommendations can be made on the re-introduction of the animal.

A more detailed analysis of the hydrological regime would be desirable. This should include a comprehensive analysis of the discharge history and flooding events, as well as the relationships of channel morphology to the biological conditions, particularily the impacts of floods on middle and young aged vegetation. Ideally, if this May's high water marks could be surveyed more thoroughly before they are obliterated, this would provide an invaluable data base for analyzing the impacts of major floods.

Research should also be considered on the impacts of the removal of exotic plant species and the re-introduction of natives.

In conjunction with a direct research program, a long term monitoring program needs to be established now to determine the rates of cottonwood reproduction and other changes in community structure and composition. This monitoring will provide the baseline data neccessary for almost any statistical evaluation of change in these ecosystems with respect to floods, grazing removal, beaver introductions and exotic removals.

With careful management the potential exist to create functioning riparian and wetland ecosystems of value to the Park, State, and Nation.

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