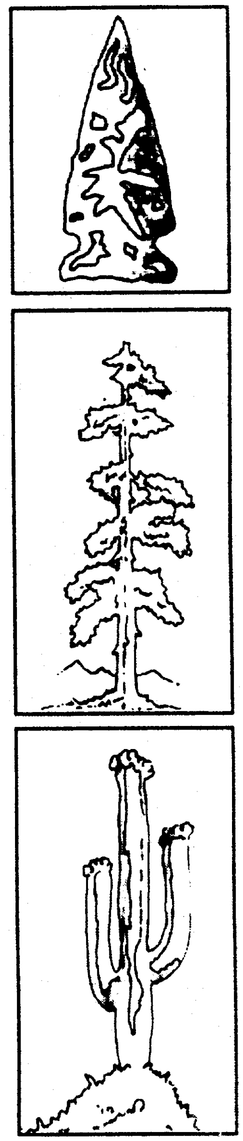
FINAL REPORT

MONITORING AND EVALUATING THE IMPACTS OF GLEN CANYON DAM INTERIM FLOWS ON RIPARIAN COMMUNITIES IN LOWER GRAND CANYON



Submitted to

HUALAPAI TRIBE

Submitted by

SWCA, INC.
Environmental Consultants

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SWCA

Final Report

Monitoring and Evaluating the Impacts of Glen Canyon Dam Interim Flows on Riparian Communities in Lower Grand Canyon

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EXECUTIVE SUMMARY

A riparian research program was conducted along the Colorado River corridor on Hualapai Tribe and Grand Canyon National Park lands from 1992 to 1994. The primary goal was to identify, where possible, the impacts of Glen Canyon Dam interim flows (a moderate river flow regime instituted in 1991) and changing Lake Mead levels on the riparian communities of lower Grand Canyon. To do this, a three-year research program was developed to study vegetation, avian, mammal and reptile communities in the 110-mile river corridor from National Canyon to the Grand Wash Cliffs.

Vegetation Studies

Twenty vegetation study sites were chosen throughout the study area (Figure 1). Rectangular 5 x 10m quadrats were used to sample river-influenced sites, and belt transects were used to survey Lake Mead silt terraces. Three marsh sites were established and monitored. No statistically significant variations were found in basal cover, species diversity or exotic species dominance between zones or between study years. Total vegetation volume was measured at each rectangular quadrat and in each of eight avian study sites. Herbarium collections were made throughout the river corridor.

Mapping of vegetation types on a Geographic Information System (GIS) based upon aerial photography and site sampling showed that the lower 30 miles of Grand Canyon supported over 1,200 hectares (ha) of riparian vegetation, of which approximately 630 ha (53%) were exotic species and 570 ha (47%) were native. Vegetation at avian sites was profiled, and the potential flooding effects of rising Lake Mead levels were modeled.

Avian Studies

Bird density and species richness were measured at eight riparian study sites between National Canyon and RM 273 from April through June in 1993 and 1994. Bird densities based on the absolute count method were estimated in two ways. Based on the maximum detection technique, avian densities ranged from 217 to 1,764 individuals/40 ha in 1993 and from 283 to 1,840 individuals/40 ha in 1994; based on the mean detection technique, avian densities ranged from 154 ± 12 to $1{,}098 \pm 121$ individuals/40 ha in 1993 and from 177 ± 75 to $1{,}238 \pm 200$ individuals/40 ha in 1994. Twenty-nine species known or suspected to nest were detected in riparian vegetation at the eight study sites.

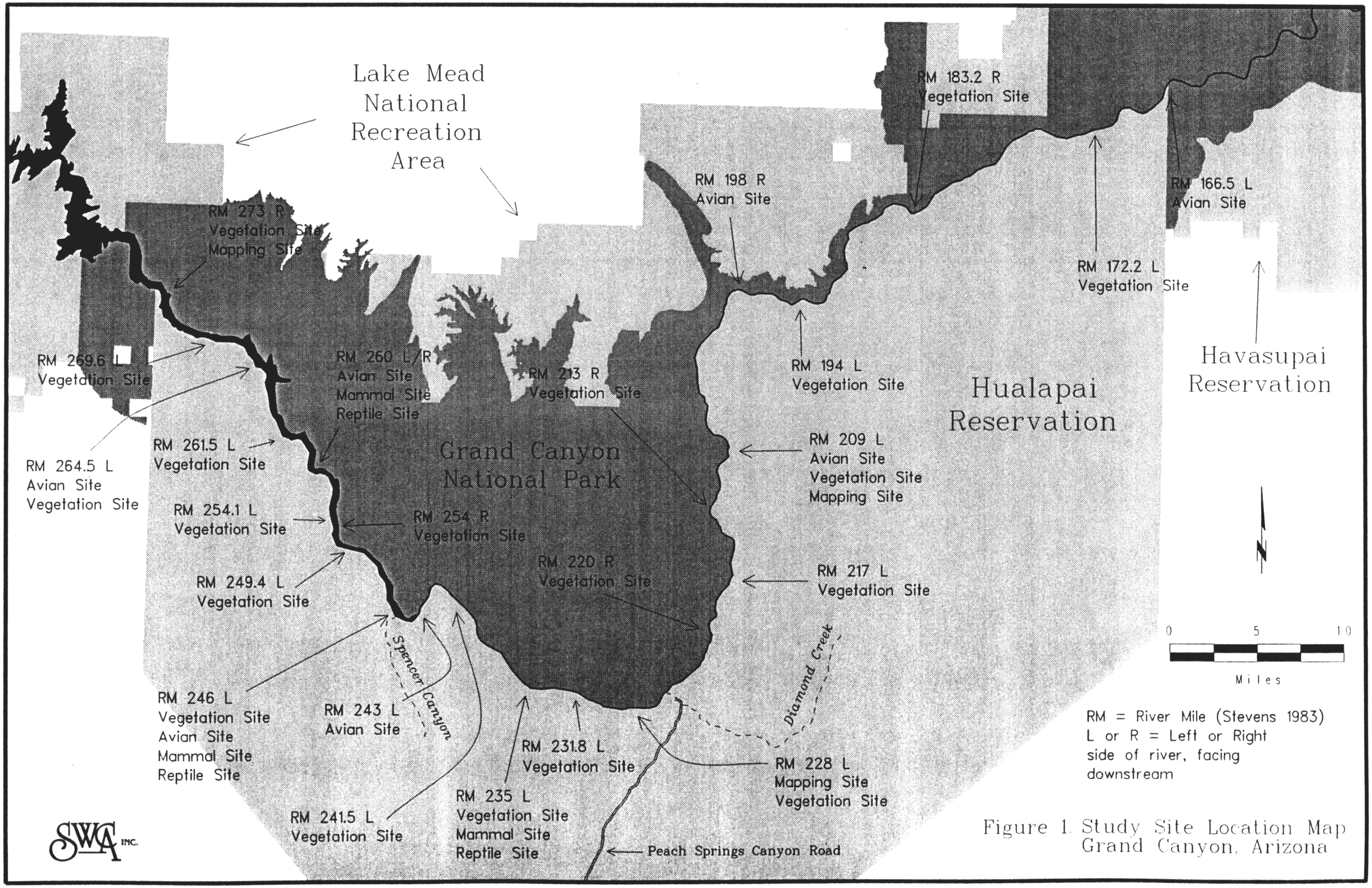


Figure 1. Study Site Location Map
Grand Canyon, Arizona

Mammal Studies

Small mammals were collected at four sites in 1992, and trapped at three sites in 1994. Five small mammal species were captured in 1992 and 1994. Capture rates in upland and riparian zones decreased between July and September sampling, while capture rates in the riparian/upland transition zone increased at two of the three sites in the same period, implying that small mammals may use the transition zone more in cooler periods.

Reptile Studies

Reptile populations were sampled at three sites in 1993 and 1994. Sample sizes were small for most surveys ($n<5$). Spencer Canyon was found to be the site exhibiting the highest density of reptiles, with almost twice as many reptile detections as the other two sites. Riparian and riparian/upland transition sightings were found to decrease between July and September censuses, while upland sightings increased.

Management Implications

River flows were apparently a factor in the erosion of 12 vegetation quadrat and marsh sites. No other direct flow effects were documented by these studies. The potential impacts of raising the level of Lake Mead were measured, and included the inundation of over 1,200 ha of vegetation, which may support between 12,000 and 19,000 individual breeding birds.

CHAPTER 1. INTRODUCTION

Purpose Statement

This study of riparian communities along 110 miles of the Colorado River through Grand Canyon was initiated as a result of concerns within GCES, the Hualapai Tribe, and other groups that the potential impacts of Glen Canyon Dam flows on lower Grand Canyon riparian communities were largely unknown. This study was developed to reach the following goal:

> Identify the impacts of river flows (as part of the interim flows regime and any exceptional events) and fluctuating Lake Mead levels on the riparian habitats and animal populations of lower Grand Canyon.

This two-part, three-year study included 1) determining appropriate methods and sites and collecting baseline data and 2) recensusing established sites during the remainder of the study period.

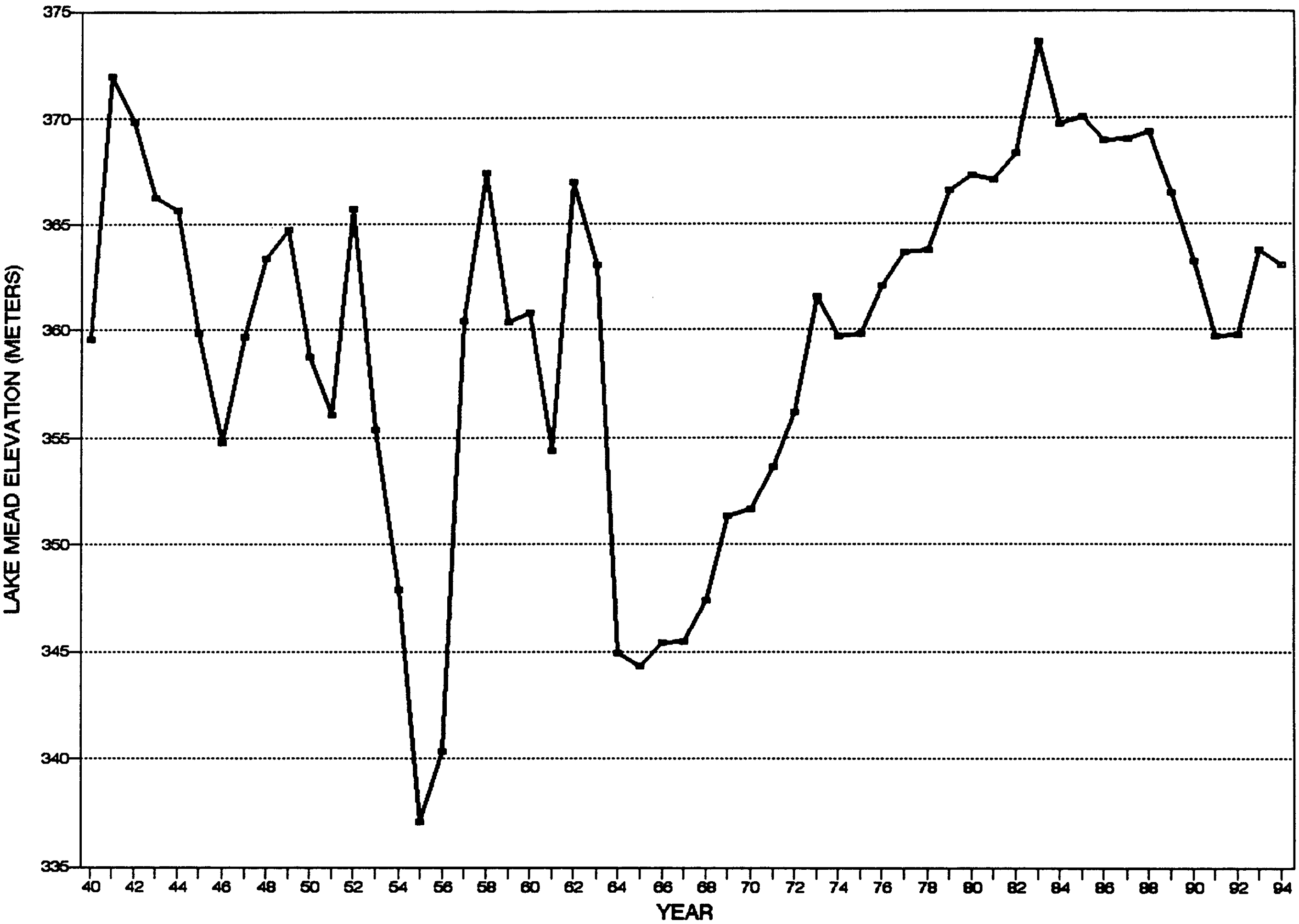
Background

The building of Hoover and Glen Canyon Dams on the Colorado River drastically changed the ecosystem of Grand Canyon. Prior to these dams, only a thin band of riparian vegetation existed next to the highly variable, sediment-laden river. After building of the dams a new, wider band of vegetation was able to grow next to a calmer, clearer river and, in lower Grand Canyon, next to Lake Mead.

In 1983, as the spillways at Glen Canyon Dam were opened and Grand Canyon was flooded, much of this riparian vegetation was scoured. Since the subsiding of the flood in 1984, riparian vegetation has re-established in Grand Canyon. In response to concerns by the U.S. Fish and Wildlife Service and other groups, and as part of the Glen Canyon Dam Environmental Impact Statement, a regime of relatively stable, low flows called interim flows was instituted in August 1991 and continued through 1994.

Lake Mead, backed up behind Hoover Dam, had a tremendous impact on vegetation in the lower 33 miles of Grand Canyon. Prior to 1966, Lake Mead was used for both flood prevention and water storage, resulting in annual lake level changes of up to 30m. During this period, the Colorado River brought nearly two billion tons of sediment into Lake Mead, creating silt terraces that were exposed when Lake Mead dropped and covered again when the lake rose. The highest terraces were created at the full pool level, while lower terraces were created at different lake elevations and river flows. With the completion of Glen Canyon Dam and subsequent use of Lake Mead as a water storage reservoir, the level of Lake Mead rose between 1966 and 1983 (Figure 2). Between 1983 and 1991, Lake Mead dropped, exposing large silt terraces. These terraces were rapidly invaded by exotic and native vegetation, which grew at extremely rapid rates.

Figure 2. Lake Mead Levels, 1940-1994
Annual Peak Levels



During the study period, the portion of Grand Canyon inundated by Lake Mead continued to be affected by Colorado River flows as the river cut new channels, brought in new sediment deposits, and rearranged existing deposits. Lake Mead rose approximately 3m and then fell approximately 2m during the study, resulting in inundation and subsequent exposing of several study sites.

Study Area

The study area included the Colorado River corridor from National Canyon (RM 166)[1] downstream to the Grand Wash Cliffs (RM 276). The lower portion of the study area (Separation Canyon at RM 240 to the Grand Wash Cliffs) was partially inundated by Lake Mead. The study area is also referred to in this report as lower Grand Canyon.

Significant overlap existed between the study area of this project and that used by Stevens and Ayers (1993). Stevens and Ayers conducted vegetation studies between Lees Ferry (RM 0) and Diamond Creek (RM 225). To avoid replication, the establishment and recensusing of vegetation sites in the overlap area (National Canyon to Diamond Creek) was divided between the two research groups, and census data were shared.

Overall Study Design

Studies of four interrelated ecological groups (vegetation, birds, mammals, and reptiles) in riparian and adjacent habitats were designed to analyze potential river and lake impacts. Vegetation cover, composition, and diversity were measured using rectangular quadrats, marsh plots, belt transects and total vegetation volume transects. Vegetation at specific sites and in the reach from Spencer Canyon (RM 246) to the Grand Wash Cliffs was mapped based upon aerial photography, overflights, and GIS analysis. Breeding bird populations, species, and nesting chronology were studied using a variation of the Emlen (1971) census technique called the absolute count method. Small mammals were trapped using standard trapline methodology (Carothers et al. 1985). Reptiles were counted using a visual transect method based upon the Emlen (1971) bird census technique.

The methods used were based to varying extent upon methods used by upper Grand Canyon researchers. Stevens and Ayers (1993) developed a rectangular quadrat plot technique and a marsh sampling method to identify vegetation composition, basal cover, and trends in separate habitat types within Grand Canyon. These methods were used as exactly as possible in this study. Belt transects designed by Kimberling (pers. comm. 1992) were used on Lake Mead silt terraces downstream of Separation Canyon. Kearsley (1993) created maps of vegetation at upper Grand Canyon sites using aerial photography, site visits, and GIS georeferencing; similar methods were used at lower Grand Canyon sites. Brown (1989) conducted absolute count surveys of breeding birds at sites in upper Grand Canyon; Brown conducted similar surveys at

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[1]River miles (RM) are place names after Stevens (1983).

previous and new sites for this study. Carothers (Carothers et al. 1976) trapped small mammals and identified reptile populations in upper and lower Grand Canyon; similar methods were used to study mammal and reptile populations for this study.

Analysis Techniques

The large amount of data collected during this study was condensed in this report to focus upon indicators of river or lake impacts, and upon major trends that could be informative for Grand Canyon managers. Vegetation data were analyzed to identify differences between habitat types as well as between river and lake-influenced reaches. The loss of many quadrats and marsh transects to erosion was related to river, lake and tributary flooding impacts. Exotic species prevalence was examined to show which habitat types and locations were more likely to support exotic vegetation. Avian census data were analyzed for differences between patch sizes and sampling periods. Mammal and reptile data were analyzed to determine habitat preferences and to characterize populations. Data summaries are provided in appendices for the use of readers and future researchers.

CHAPTER 2. VEGETATION STUDIES

Introduction

Vegetation studies for this project were conducted between National Canyon and the Grand Wash Cliffs. The reach from National Canyon to Diamond Creek was intensively studied prior to this project by National Park Service researchers. The reach from Diamond Creek to the Grand Wash Cliffs was little-studied prior to 1992.

Vegetation surveys were conducted in Grand Canyon by the Museum of Northern Arizona in the 1970s and 1980s, and by the National Park Service between 1987 and 1994 (Carothers and Aitchison 1976, Phillips et al. 1977, Carothers and Dolan 1982, Phillips et al. 1987, Carothers and Brown 1991, Ayers and Stevens 1993, Kearsley 1994). These surveys included the reach from Lees Ferry to Diamond Creek, and with few exceptions did not include the 51-mile reach from Diamond Creek to the Grand Wash Cliffs due to logistical and political considerations.

Carothers and Aitchison (1976) conducted an overview study that included lower Grand Canyon; Phillips et al. (1977) mapped vegetation in the Grand Canyon to the Grand Wash Cliffs; and Phillips (1987) produced an annotated checklist of vascular plants in all of Grand Canyon. In-depth vegetation surveys of lower Grand Canyon were not begun, however, until 1992, when the Hualapai Tribe became involved in Grand Canyon decision-making and began to support vegetation studies downstream of Diamond Creek.

Study Area

The study area, the river corridor from National Canyon to the Grand Wash Cliffs, was divided into three sections. The first, from National Canyon to Diamond Creek, could only be accessed by boat from Lees Ferry or by helicopter. This area was included in studies by National Park Service and other vegetation researchers. The second section, from Diamond Creek to Separation Canyon, included 15 miles of river corridor that were little-studied prior to this project. The third section, from Separation Canyon to the Grand Wash Cliffs, included the portion of Grand Canyon that was partially inundated by Lake Mead.

In this third section, riparian vegetation grew primarily on silt banks deposited when Lake Mead was higher. The highest of these banks was at 372m elevation (corresponding to a full pool), and the lowest varied in elevation throughout the study period as the lake level rose and dropped. In the 10 years prior to the study, the lake level dropped over 14m; during the study it rose over 3m (1992-93) and then dropped over 2m (1993-94). Accordingly, many areas were completely inundated in 1993, while other, higher areas benefited from a closer water table. As the water fell in 1994, newly deposited silt banks were exposed and became habitat for fast-growing riparian vegetation.

River current existed throughout this third section, although with much less force than upstream, and constantly reworked its channel through the silt banks. Generally, the current attenuated as it approached the Grand Wash Cliffs. River stage affected the water level downstream of Separation Canyon, causing the water level to rise and fall with rising and falling river flow, although to a lesser extent than upstream. The effect on water level also tended to attenuate further downstream.

Riparian zone substrates upstream of Separation Canyon were generally coarse, varying from sand to pebbles, cobbles, and boulders. However, when the river was muddy, silt was deposited at least as a veneer over coarser sediments at the fluctuating water line, and reached a depth of a meter or more in eddies. This silt could have been an important localized factor in moisture retention as shoreline was exposed with dropping water levels, and may have played a part in the origin of marshes. Riparian zone substrates downstream of Separation Canyon were generally fine silts.

Fifty-one vegetation plots and transects, located throughout these three sections, were established during and prior to 1992. Of these, 39 were suitable for use in long-term monitoring (Table 1). Twelve were eroded by river or tributary action by 1993.

Methodology

Five kinds of study were used to evaluate changes in riparian vegetation. These included 1) rectangular quadrats, 2) marsh transects, 3) silt terrace transects, 4) mapping, and 5) total vegetation volume measurements. An herbarium collection was also made throughout the study period. For each quadrat, marsh transect, and silt terrace transect, all individual plants were identified to species, counted, and basal diameter measured. Collection of total vegetation volume followed a separate protocol. Data were recorded in the field and then compiled on computer using a standard spreadsheet program.

<u>Rectangular Quadrats</u>

Rectangular quadrats, a study design developed by National Park Service researchers for use between Lees Ferry and Diamond Creek (Ayers and Stevens 1993), were established throughout the study area in and prior to 1992. Quadrats were used to sample four vegetation types on channel margin and eddy deposits: the riparian strip (RS) type at the 28,000 to 40,000 cubic feet per second (cfs) stage in channel margin vegetation patches; the general beach (GB) type, also at the 28,000 to 40,000 cfs stage, in eddy deposits with large, sandy dunes; the debris fan (DF) type, at the 28,000 to 40,000 cfs stage in tributary debris fans; and the old high water zone (OHWZ), at the 100,000 to 300,000 cfs stage in pre-dam vegetation patches. Within each vegetation zone, quadrat location was randomly determined, with the long axis aligned parallel to river flow. Each 5 x 10m quadrat was divided into eight subplots 2.5 x 2.5m to aid in species censusing, measurement of plant basal cover, and data analysis.

Table 1. Master List of Study Sites

River Mile	**Vegetation Studies**	**Avian Studies**	**Mammal Studies**	**Reptile Studies**
River Sites				
166.5L	Aerial Map	Transect		
172.2L	RS, GB, OHWZ, GIS			
183.2R	RS, GB, OHWZ, GIS			
194.0L	RS, GB, OHWZ, GIS			
198.0R	Aerial Map	Transect		
209.0L	RS, GB, OHWZ, Aerial Map	Transect		
213.0R	RS, GB, OHWZ, GIS			
217.4L	RS, GB, OHWZ, GIS			
220.0R	RS, GB, OHWZ, GIS			
228.8L	Marsh, GIS			
231.8L	RS, GB, OHWZ, GIS			
235.0L	GB, DF, OHWZ, GIS		Transects	Transects
Lake Sites				
241.5L	Marsh, GIS			
243.2L	Aerial Map	Transect		
246.0L	OHWZ, Aerial Map	Transect	Transects	Transects
246.0 to 276.0	Aerial Map			
249.4L	Marsh, GIS			
254.0R	GB1, GB2, GB3, GIS			
254.1L	Silt Terrace Transect			
260.2R	Aerial Map	Transect		
260.2L	Aerial Map	Transect	Transects	Transects
261.5L	Silt Terrace Transect			
264.5L	Silt Terrace Transect, Aerial Map	Transect		
269.6L	Silt Terrace Transect			
273.1R	Silt Terrace Transect			

Notes: RS=riparian strip; GB=general beach; OHW=old high water, GIS=electronically surveyed and included in the GCES Geographic Information Systems database. River miles (RM) are after Stevens (1983). L or R following river mile designates left or right side of river (facing downstream).

The rapid erosion of quadrats downstream of Separation Canyon, and the difficulty of using quadrats to sample large, zonated vegetation patches which did not readily correspond to vegetation types upstream of Separation Canyon, led to the abandonment of silt terrace quadrats that were eroded. Quadrats at one downstream site (RM 254R) were not eroded and were sampled throughout the study period. Silt terrace transects were the primary method used to sample sites downstream of Separation Canyon.

Marsh Transects

Five marsh transects were established downstream of Diamond Creek in 1992, in areas that supported dry or wet marsh vegetation[2]. A series of belt transects was used to sample each marsh. A baseline was laid out at the upper (talus) edge of marsh vegetation. At 3 to 5m intervals along the baseline, 1m wide belt transects were established from the baseline to the water's edge, perpendicular to river flow. Basal cover was measured; species identified; and individuals counted in each belt transect.

Two of the five marsh sites established downstream of Diamond Creek were eroded by river flooding in 1993, and due to a lack of other suitable sites were not replaced.

Silt Terrace Transects

Silt terrace transects were established downstream of Separation Canyon to sample the large, zonated vegetation patches that occurred on exposed silt banks. The silt banks were terraced as a result of sediment deposition at various lake levels and river stages, with as much as 12m elevation difference between low and high terraces. The lowest terraces were generally adjacent to the river, while the highest terraces were furthest from the river.

Silt terrace transects were sampled using a transect baseline and ten 1-sq-m random plots in each vegetation zone. Transect zones were 5 to 80m wide, and typically included a wide zone dominated by coyote willow (*Salix exigua*) adjacent to the water's edge, followed by a narrow band of large Goodding's willow (*Salix gooddingii*); a band of large tamarisk; and one or two zones of dead dry and wet marsh vegetation.

One transect was randomly placed within each of five 5-mile sub-reaches for a total of 5 transects. For each transect, a permanent endpoint (a painted or etched X) was established on the talus slope that marked the outer limit of the highest silt terrace. From this endpoint a transect baseline was established perpendicular to the flow of the river from the talus slope to the water's edge. Distinct vegetation zones were delineated and their width measured. Within each vegetation zone, in a belt 20 meters wide centered on the baseline, ten randomly placed 1-sq-m plots were censused and basal cover measured.

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[2]Dry marsh vegetation is defined by Cowardin et al. (1979) as patches of emergent annual or perennial vegetation in low-lying, periodically inundated habitats; wet marsh vegetation consists of patches of emergent annual or perennial vegetation in low-lying, regularly inundated habitats.

The majority of the transect at RM 273R and approximately half of the transect at RM 269L were inundated in 1993, preventing recensus of those areas for that year. By 1994, the lake had dropped and these areas were recensused.

Mapping

Four vegetation mapping projects were undertaken: 1) mapping of riparian vegetation types in the river corridor throughout the study area, using the GCES Map Image Processing System (MIPS); 2) mapping of the eight avian study sites (two of which overlapped with vegetation study sites); 3) mapping of areas between RM 273 and the Grand Wash Cliffs (GIS Site 13) that would be inundated during a rising lake event; and 4) mapping of riparian vegetation types in the river corridor from Spencer Canyon to the Grand Wash Cliffs, using aerial photography and aerial verification, and processing data using the GCES/Hualapai GIS.

The GCES MIPS was used to transform videotaped images (videography) of the river corridor into still images and maps of vegetation in the corridor. Printouts of MIPS images were used by researchers during a May 1993 research trip to map riparian vegetation types between National Canyon and the Grand Wash Cliffs. The ten dominant vegetation associations in this reach were identified and numbered for use in mapping. The data from the printouts were then entered into MIPS for analysis. MIPS was later found to be very inaccurate, with error margins of up to 200% (Arundel in litt.). These data were not useful for determining the vegetated area of distinct vegetation types, or of riparian vegetation overall.

The eight avian study sites were mapped by researchers and analyzed with GIS. Researchers used June 1994 aerial photographs to map vegetation types at National Canyon, Parashant Canyon, Granite Park, RM 243L, Spencer Canyon, Quartermaster Canyon, RM 260R, and RM 264L. One of these sites (Granite Park) is in a GCES GIS reach (Site 9). These data were then entered into GIS to determine the size of each site and proportion of each vegetation type. The five sites downstream of Separation Canyon were electronically surveyed in 1994 to provide more accurate area calculations.

The GIS was also used to model the effects of rising Lake Mead levels on the reach from RM 273 to the Grand Wash Cliffs (GIS Site 13). Topographic maps with 1m contours were available for this reach, allowing creation of a rough model of those areas that would be inundated were Lake Mead to rise.

Mapping of riparian vegetation in the corridor downstream from RM 247 to the Grand Wash Cliffs was completed in 1994. Researchers used June 1994 aerial photographs during a helicopter overflight to mark and verify vegetation types. As with the MIPS mapping, ten vegetation types were used. These data were then entered into GIS for analysis.

Total Vegetation Volume

Total vegetation volume (TVV, Mills et al. 1991), an index of vegetation volume, was measured for each rectangular quadrat, and the TVV of each silt terrace transect was sampled in each zone. All avian study sites were also intensively sampled to find the TVV of different vegetation types.

The presence (a "hit") or absence of vegetation within 0.1 m of a stationary height pole was recorded at 0.1 m intervals. Therefore, we sampled a series of cylinders 0.1 m tall and 0.1 m in radius. The number of hits in each meter layer above ground was from 0-10. Plant species associated with each hit were recorded; if 2 or more species were present in the same meter layer, the total number of hits in that layer were allotted between the species according to the relative dominance of each species within the layer. TVV was estimated from these measurements using the formula: $TVV = h/10p$, where h = total hits summed over all meter layers at all points measured, and p = number of points at which vegetation was measured. Resulting TVV estimates (units of m^3 of vegetation/m^2) provided indices of canopy height, percent cover, and volume by species.

At each rectangular quadrat, four 10m straight-line TVV transects were established lengthwise within the quadrat. Measurements were taken at 2m intervals along each transect, resulting in measurements from 5 points per transect and 20 points in each quadrat. TVV was also measured at 4-12 random plots located in homogeneous vegetation patches within each study site, with more plots in larger or more diverse study sites. A 20m straight-line TVV transect was established within each plot along a random bearing from the plot center; measurements were taken at 2m intervals along the initial TVV transect and a second, perpendicular TVV transect through the center of each plot, resulting in measurements from 20 points in each plot.

Herbarium Collection

An integral part of the project from its inception, plant collections were made during each trip on which a botanist was present. Specimens collected documented species present at study sites, and extensive collecting was done along the river corridor, up side canyons, on desert slopes, and in seeps and springs. The goal was to make as large a collection as possible and establish a reference herbarium at the Hualapai Natural Resource Department (HNRD). Specimens were pressed in standard plant presses as soon as possible after being collected (generally at lunch stops and evenings), and collection locations were documented. Specimens were identified using botanical manuals for the region, and verified at the Northern Arizona University Herbarium. HNRD technicians mounted specimens for accession into the herbarium collection.

Results

Interim Flow Effects

Ten quadrats and two marsh sites established in 1992 were eroded by river or tributary action by 1993 (Table 2). This erosion could be attributed to a combination of two factors: rains that in early 1993 caused high Colorado River flows and flash flooding in many tributaries, and clear interim flows throughout the year that caused appreciable erosion at many sites.

Table 2. Study Sites Established in 1992 and Eroded by 1994

River Mile	Vegetation Site	Erosion Cause
River Sites		
237.0L	GB	River Flow
Lake Sites		
234.9R	Marsh	River Flow
239.5R	Marsh	River Flow
240.0L	GB	River/Tributary Flow
240.0R	RS	River Flow
246.0L	GB	Tributary Flow
246.0R	RS, GB	River Flow
259.0L	RS, GB	River Flow
266.0R	GB	River Flow
274.0R	GB	River Flow

Notes: RS=riparian strip; GB=general beach. L or R following river mile designates left or right side of river (facing downstream).

Quadrats

General beach (GB) plots were typified by dominant arrowweed, growing on coarse, sandy substrates. These plots supported sparse populations of annual and perennial grasses and perennial shrubs, including jimmyweed (*Haplopappus acradenius*). No basal cover or species diversity trends were discernible between 1992 and 1994. The quadrat at RM 172 showed the most dramatic change over the study period, with a decrease in basal cover from 67.9 cm^2/m^2 in 1992 to 3.9 cm^2/m^2 in 1994. The primary source of this loss was in four species of dropseed, a perennial bunchgrass. These decreased from a combined basal area of over 3000 cm^2 in 1992 to 36.5 cm^2 in 1994. In addition, tamarisk basal area was approximately half its 1992 value in 1993 and 1994. It is not known if this decline was due to sampling irregularities or to a real decrease in vegetation in the plot; such dramatic changes were not noted elsewhere in upstream plots. Five of the GB plots established in 1992 were eroded by river action, and two others were eroded by tributary flows.

Riparian strip (RS) quadrats had generally finer substrates which apparently retained more moisture. These quadrats supported a wide variety of species, including *Baccharis* sp., arrowweed, tamarisk, horsetail (*Equisetum* sp.) and annual and perennial grasses. Exotic species increased markedly during the study period at two sites, RM 194L and RM 231L. The increase in exotics in both cases was due to a marked increase in Bermuda grass (*Cynodon dactylon*). This a rather ephemeral species which may have increased due to substrate stability associated with cessation of flooding with the onset of interim flows, or it may have increased due to short-term rainfall conditions. Three of the RS quadrats placed in 1992 were eroded by river flows.

Debris fan (DF) plots had varied substrates, including fine soils, coarse sands, cobbles, and boulders. Species diversity was highest in these plots, but many plots had very low total basal cover. These plots supported populations of annual grasses and other annual species, with few perennial species. No DF plots were eroded during the study period.

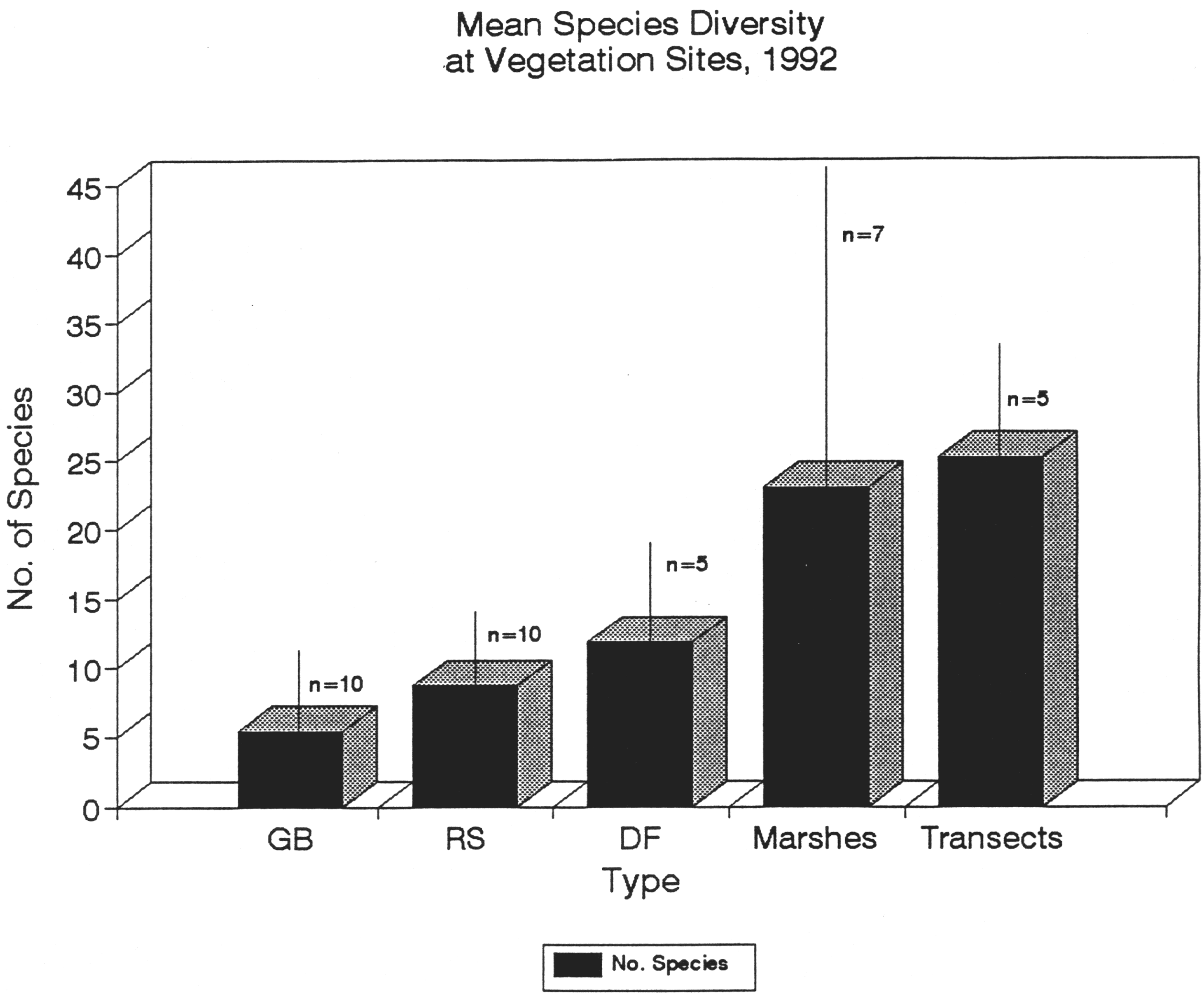


Figure 3. Mean species diversity at vegetation sites in 1992. GB=general beach, RS=riparian strip, DF=debris fan, Transects=silt terrace transects.

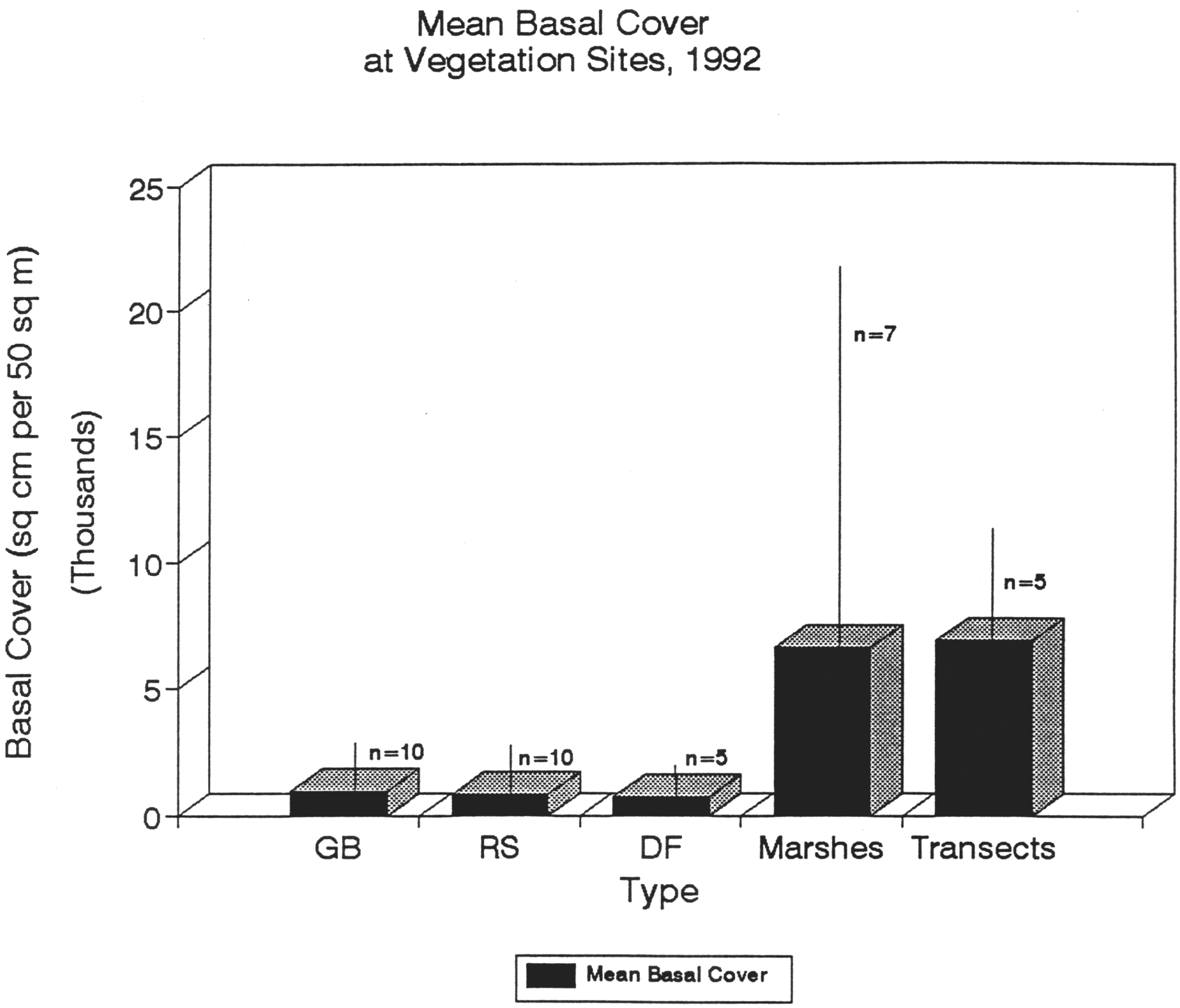


Figure 4. Mean basal cover at vegetation sites in 1992. GB=general beach, RS=riparian strip, DF=debris fan, Transects=silt terrace transects.

Marshes

Marsh sites included sites supporting entirely wet marsh vegetation and sites with dry marsh vegetation, and a fewer number of sites with both wet and dry marsh vegetation. Species diversity in several marshes was higher than in quadrats or silt terrace transects, but was not found to be significantly different between the three types.

Silt Terrace Transects

Silt terrace transects varied greatly in length, from approximately 20m to 300m. While zonation existed at all transects due to the terracing effect of silt deposition at separate Lake Mead levels, larger sites generally had a greater number of zones. Zone types, while similar between transects, did not reflect the differences in density and growth rates between study sites.

Statistical Analysis

The placement of quadrats, marshes and transects in areas stratified by vegetation type and river influences revealed dominant species which were distinct between plot types, but measurement of these plots did not show significant differences in species diversity, basal cover or exotic species dominance.

1) Basal Cover and Exotic Species Dominance

Using basal cover and species diversity of live perennials, we asked if vegetation zones were consistently different from each other from year to year. The results of a Friedman two-way analysis (using year to rank zone) was significant ($p=0.039$, $F=16.267$, $df=8$). However, when we tested for separation between zones within each year, a Kruskal-Wallis one-way analysis of variance was not significant for any of the three years. Using basal cover of exotic live vegetation, we asked if vegetation zones were consistently different from each other from year to year. The results of a Friedman two-way analysis of variance (using year to rank zone) was not significant ($p=0.457$, $F=2.60$, $df=3$). We also tested for separation between zones within each year, and a Kruskal-Wallis one-way analysis of variance was not significant for any of the three years ($p>0.1$). We were unable to use parametric methods of analysis because of the inability to transform these variables to homoscedastic groups.

2) Species Diversity (DECORANA)

Data from three years' census of vegetation transects, marsh transects, and vegetation quadrats were analyzed using a repeated measures analysis of variance. The variables used in the repeated measures design were canonical variables generated by detrended correspondence analysis of the perennial plant species assemblages sampled. The general approach corresponded to that used in other GCES vegetation analyses.

Overall, there was no detectable effect of time on the plant assemblages. This lack of discernable change seems to arise from several sources. First, annual species are deleted from all analyses, removing the most malleable species from analyses. Second, within marshes, all plots were combined, so that potential changes in one part of the marsh could have been masked by others occurring elsewhere (plots close to the river behave differently than those higher up and drier). Third, sites are a powerful blocking factor, and lumping plots removed the ability to analyze for changes within them. Also, analyses were apparently confounded by the effects of having plots both above and below the lake level. Finally, many plots, including quadrats, marshes, and transects were not recensused in all years, reducing the total number of observations and the power of the tests.

In the absence of a single indicator species or *a priori* species ratio, the first step in the analysis was the reduction of all species variables within each year for each plot to a single canonical variable. For this, detrended correspondence analysis (DCA) was selected, owing to its suitability to plant data. Its chief advantage is that it is insensitive to the confounding effects of environmental gradients on second and higher order axes. Even though the plot values from only a single axis was used in this analysis, it was deemed appropriate for the sake of consistency because it is in general use in GCES vegetation analysis.

For each plot, changes in its DCA axis 1 score in each year were analyzed using the repeated measures option of the SAS Proc GLM (general linear models) procedure. In this multivariate procedure, the three Y values (DCA axis 1 score for 1992, 1993, and 1994) were related to a single predictor. In the case of the marsh data, this was mile (site). For quadrat and transect data, this was tried for both mile (site) and zone (or plot type). The test statistic was an F value associated with Wilkes' Lambda.

a) Marshes

No repeated measures analysis was possible for the marsh data given the structure of the data set. Given that the repeated measures analysis is estimating values of each year's overall mean, in addition to the site parameter (the "x" in this case), the fact that there were only 5 marsh sites with three years worth of data meant that there were no degrees of freedom remaining for the error term. To salvage some analysis, a 3 x 5 Chi-square contingency table was constructed (3 years by 5 marshes with complete data). The test showed significant deviation from the null hypothesis of no differences among the behavior of the 5 marshes in the three years (X^2_8 = 83.86, $p <<< 0.05$). This can also be seen in the graph of the marsh scores which shows all possible behaviors: monotonic increases (194), monotinic decreases (241, 249), a rise and fall (172), and a fall and rise (228 mile). As stated in the introduction, this would seem to be the effects of lumping all plots within the marsh into a single measurement and measuring marshes both above and below the beginning of the lake.

b) Long Term Plots (LTP)

The LTP (quadrat) data from all three years were analyzed first as a function of plot type and second as a function of river mile. In neither case was a significant effect of time found (years vs plot: Wilks' Lambda = .9630, $F_{(2,12)}$ = .230, n.s. year vs mile/site: Wilks' Lambda = .6144, $F_{(2,7)}$ = 2.196, n.s.). In both cases, variation within the blocking factors swamped out the variation between years. Subsequently, a two-factor analysis of variance was run using plot and mile as factors (ignoring years) which showed both mile and plot had significant effects (plots differ significantly within and among sites), as did the plot*site interaction (plots behaved differently at different sites). The outputs from all these analyses are attached, as are graphs of the behavior of each type of plot. In plain language, the results indicate that exactly where you are (mile and plot) tells you more about the surrounding vegetation than what year it is.

c) Transects

As with LTP data, the transect data were subjected to the repeated measures analysis first by mile (site) and second by zone. And, as with the LTP data, neither of these analyses showed a significant effect of time on the vegetation data (years vs zone: Wilks' Lambda = .6800, $F_{(2,9)}$ = 2.117, n.s. years vs mile: Wilks' Lambda = .6089, $F_{(2,10)}$ = 3.2122, n.s.). A 2-way analysis of variance was run using mile and zone as factors. The results showed significant effects of both mile and zone, as well as the mile*zone interaction. Subsequently, a one-way analyses of variance relating scores (regardless of year) to sites within each zone showed significant effects of site for all zones. This means that there were significant differences among zone 1 transects from all the sites, and that the same applied to all other zones. The plain-language translation of all these tests is that there was no consistent effect of year on the vegetation, but that vegetation between sites, and within sites (between zones), differed strongly. Again, knowing exactly where you were told you more about the vegetation around you than knowing what year it was.

Vegetation Mapping

Four vegetation mapping projects were undertaken. The first of these, using MIPS to analyze videography, was abandoned after error margins were found to be unacceptable. The results of the other three are presented below.

1) Mapping of Eight Avian Study Sites

Vegetation types were mapped at the eight avian study sites to determine the proportion of areas covered by distinct vegetation types (Table 3). Maps of each site are provided in Chapter 3.

Table 3. Area in hectares of vegetation at eight avian sites.

Vegetation Type	Avian Study Site 1	2	3	4	5	6	7	8
1. Wet marsh	-	-	-	-	-	0.89	-	-
2. Dry marsh	-	0.08	-	-	-	-	-	-
3. Goodding's willow	-	-	-	-	-	-	-	4.69
4. Arrowweed	-	0.22	0.62	-	-	-	-	-
5. Tamarisk	7.62	0.65	2.55	2.51	2.42	2.72	2.35	22.30
6. Grasslands	-	-	-	-	-	-	-	3.97
7. Seep willow	-	-	-	-	-	-	-	0.08
8. Coyote willow	-	-	-	-	0.07	0.46	-	3.67
9. Acacia/mesquite	4.3	1.58	3.48	-	0.13	0.11	-	-
10. Hackberry	-	0.01	-	-	-	-	-	-

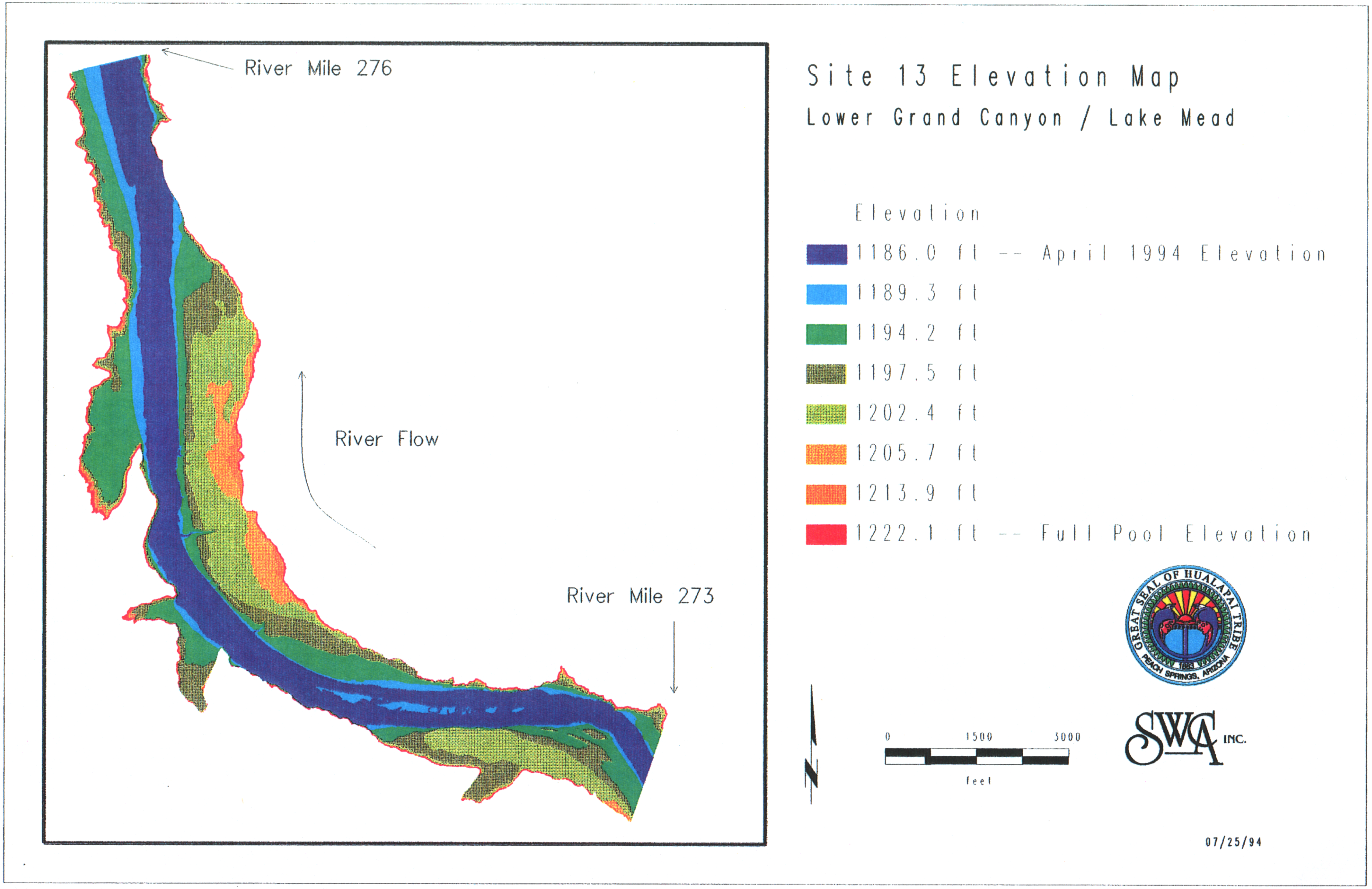
2) Mapping of Potential Inundation Areas

Elevation data for GIS Reach 13 (RM 273 to the Grand Wash Cliffs) detailed enough to create topographic maps with 1m contours were provided for this project by GCES. These data were analyzed by a GIS system to create a map of areas in that reach that would be inundated were Lake Mead to rise. It was found that, in this reach, a rise of 2m would cause flooding of over 80% of the exposed silt terraces (Figures 5 and 6).

3) Mapping of Vegetation from Spencer Canyon to the Grand Wash Cliffs

Presented in Table 4 is a summary of aerial mapping from Spencer Canyon to the Grand Wash Cliffs data. Tamarisk had the greatest areal extent of vegetation types, covering over 644 hectares. Coyote willow and Goodding's willow were also highly abundant. Maps of this reach are provided in Appendix A.

Figure 5. Elevation map for GIS Site 13 (RM 273 to the Grand Wash Cliffs).



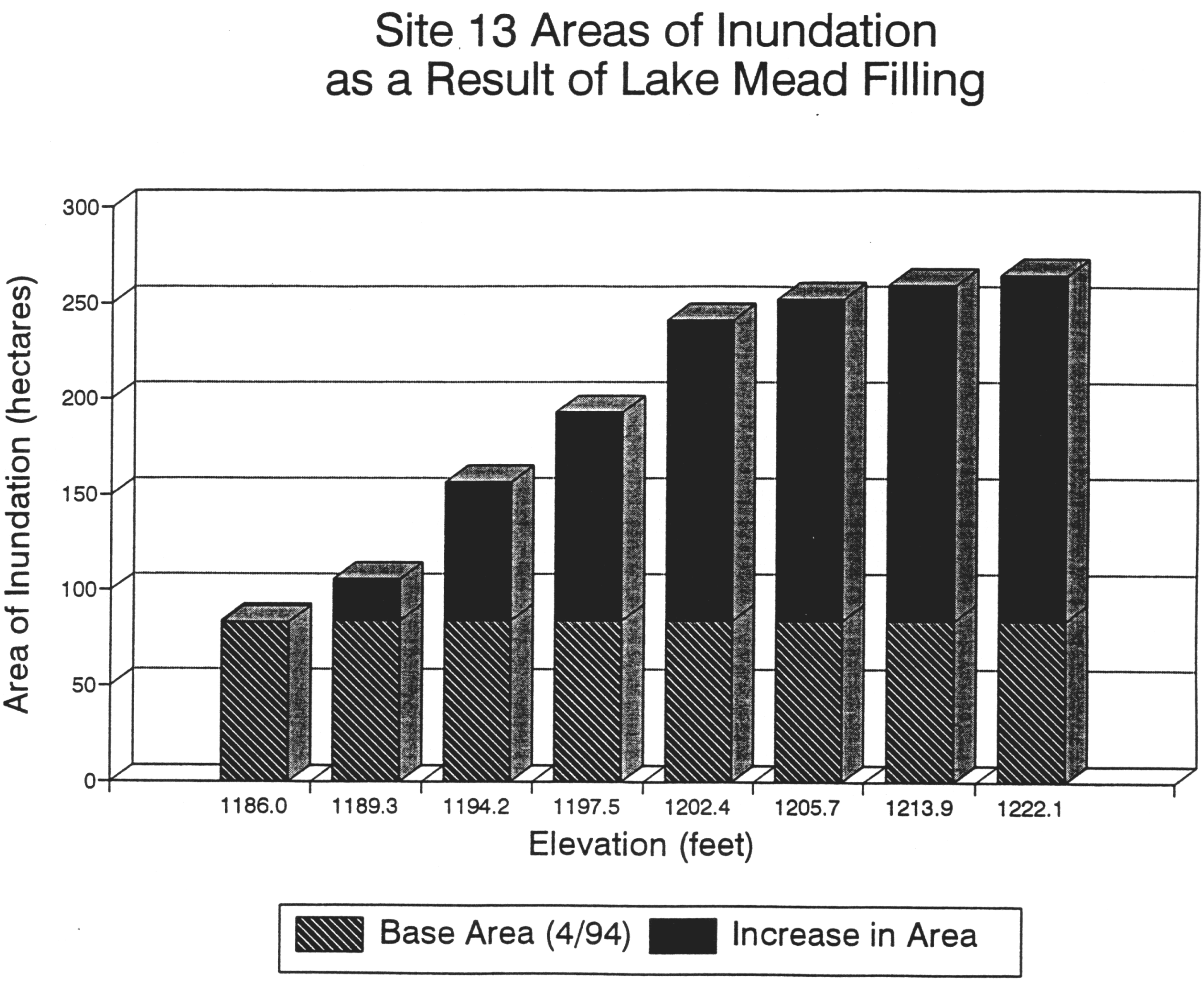


Figure 6. Areas of inundation for GIS Site 13 (RM 273 to the Grand Wash Cliffs) at differential lake levels.

Table 4. Area of vegetation on silt terraces from Spencer Canyon to the Grand Wash Cliffs, based upon aerial mapping.

Vegetation Type	Area (Hectares)
1. Wet marsh	65.91
2. Dry marsh	32.80
3. Goodding's willow	226.87
4. Arrowweed	0.57
5. Tamarisk	644.06
6. Grasslands	14.72
7. Seep willow	14.46
8. Coyote willow	238.72
Total	1238.11

Total Vegetation Volume

Figure 7 graphs mean vegetation volume by species at the eight avian study sites. While aerial mapping described the areal extent of vegetation patches, vegetation volume showed the quantity of vegetation in those patches. As the graph shows, tamarisk was present at all of the sites, and had the highest vegetation volume at most of the sites. At National Canyon (Site 1), seep willow (*Baccharis salicifolia*) and OHWZ species made up the majority of the vegetation volume. Parashant (Site 2), had high volumes of mesquite (*Prosopis glandulosa*), seep willow, and other species as well as tamarisk. Spencer Canyon (Site 5), had a large volume of tamarisk, but also had significant volumes of Goodding's willow, coyote willow, seep willow, and other species. Waterfall Rapids (Site 6), a small site entirely on a silt terrace, had low volumes of tamarisk but high volumes of coyote willow and seep willow. Quartermaster Canyon (Site 7), a large, diverse site with a large marsh, had high volumes of cattail (*Typha* sp.), seep willow, coyote willow, and tamarisk. Tincanebitts Canyon (Site 8), a large, tamarisk-dominated site on a silt terrace, also had a notable volume of seep willow, coyote willow and Goodding's willow.

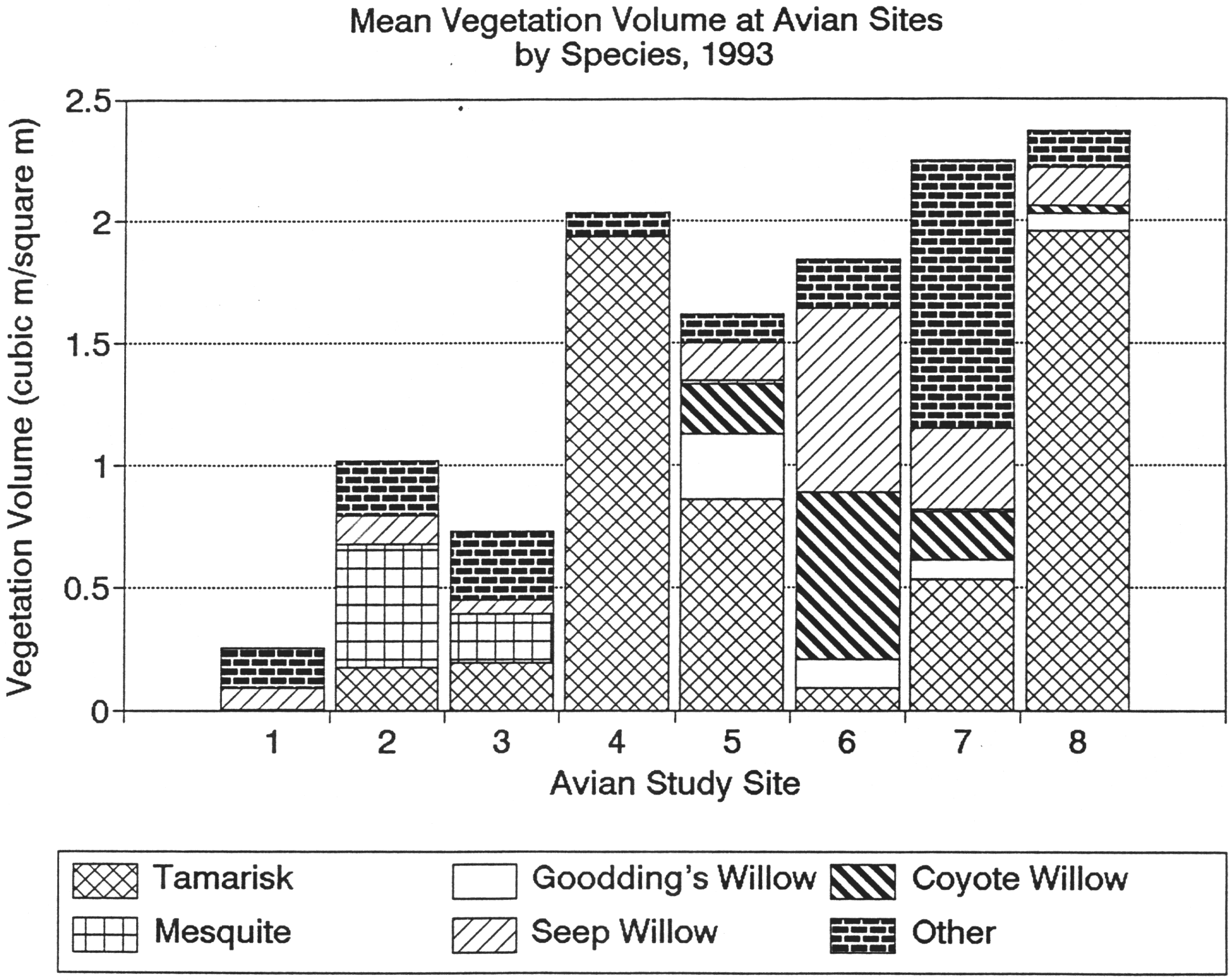


Figure 7. Mean vegetation volume at eight avian sites, 1993.

Herbarium Collection

Approximately 300 separate collection numbers were assigned during the three field seasons of the project, representing some 250 different species. Approximately half of the specimens were delivered to HNRD on February 2, 1995, and the remainder await final processing and mounting before being transferred to Peach Springs. The herbarium will be a permanent research resource for HNRD personnel and projects. A list of all plants collected for the herbarium is provided in Appendix G. Duplicate specimens are deposited at the NAU Deaver Herbarium.

During the course of this project, new localities for three sensitive plant species were found on Hualapai lands in lower Grand Canyon.

1) *Arctomecon californica* (California bear poppy), a U.S. Fish and Wildlife Service (USFWS) Category 2 candidate species, was located on Hualapai lands for the first time in April 1994, in two side canyons high above Lake Mead at the western end of Grand Canyon, during the spring plant collecting trip for this project. It was previously known from similar habitats west of Hualapai lands in Grand Canyon National Park.

   The plants were first located in Ash Seep Canyon, RM 272L, the first side canyon on Hualapai Reservation lands upstream from the boundary with Grand Canyon National Park. The plants were on shelves along the east wall of the canyon, above the east fork, on benches in the first unit below the Redwall, elevation approximately 2000-2200 feet, about 1/2 mile from Lake Mead. The plants appeared to be inaccessible; the extent of the habitat or number of individuals was not determined. On the July 1994 helicopter mapping trip, possible access to the site from the west fork of the canyon was noted. This represents a range extension of about 2 river miles from Cave Canyon (Columbine Falls).

   California bear poppy was also found in Evans Heaven, the next major canyon upstream, at RM 270.5L. *Arctomecon* was at the top of a high talus slope on the east side of the canyon about 1/2 mile from Lake Mead, growing on narrow benches. Herbarium specimens were collected at this site (Phillips 94-13); this is the first collection on Hualapai lands and a further range extension. There were 20-25 plants at this site, and a few more large plants were seen on the next shelf up and to the south.

   Searches were not carried out further upstream; potential exists for additional localities on Hualapai lands. The localities in lower Grand Canyon are high above Lake Mead in areas that are *de facto* wilderness, in rugged, inaccessible terrain that is seldom if ever visited by recreationists and other visitors to the area.

2) *Camissonia speculicola* subsp. *hesperia* (Evening primrose; no specific English common name), a USFWS Category 2 Candidate species, was tentatively identified from collections made at Bridge Canyon (RM 235L, Phillips 94-67) and one mile up Spencer Canyon (RM 246 L, Phillips 94-56) on two trips in September 1994. It had previously been reported from Separation Canyon to Spencer Canyon. This taxon is difficult to distinguish from other

closely related taxa, and additional specimens will be collected on the spring trip in 1995 and sent to experts in the particular group if necessary to verify identification. It grows on coarse gravels and sandy areas in side canyons and debris fans, and could potentially be quite common in the area as such habitat is abundant. Additional surveys will be required to determine the distribution and abundance of this species.

3) *Flaveria mcdougallii* (McDougall's flaveria), a USFWS Category 3C species endemic to lower Grand Canyon from Matkatamiba Canyon (RM 148L) to above Lava Falls, was found in a side canyon just upstream from Vulcan's Anvil by A. Phillips during a Paiute ethnobotanical survey river trip in May 1993. This is believed to be a downstream record for the species and the second or third site verified on Hualapai lands. About 50 plants were noted in a seep at the upper end of a steep drainage that passes through the river camp at RM 177.8L. The plants grow in an area about 100 feet long on the west wall of the amphitheater at the head of the drainage about 1/4 mile from the river at an elevation of about 2200 feet. The plants were also present at the top of a waterfall on the east side of the amphitheater; this site was inaccessible. This seep appears to be permanently flowing as associated species (redbud, cattails, maidenhair fern, cardinal monkeyflower) require permanent water. This species was first discovered at Cove Canyon (RM 174R) in 1975; the only place in the world it occurs is in seeps and moist side canyons in this 30-mile stretch of Grand Canyon. It was dropped from consideration for listing as threatened because there are no discernible threats despite its rarity.

CHAPTER 3. AVIAN STUDIES

Introduction

Little information exists on the birds of the Hualapai Reservation in general and the Colorado River through the Hualapai Reservation in particular (Brown et al. 1987). Although historic studies have provided valuable baseline information on the birds of the river corridor through all or part of this area (Carothers and Aitchison 1976), bird density, diversity, and ecology need to be documented using quantitative techniques that will provide contemporary information for river and dam management.

Periodic fluctuations in the level of Lake Mead since the 1930s have strongly influenced the substrate and vegetation of the river corridor from Separation Canyon to the Grand Wash Cliffs (Carothers and Brown 1991) and are suspected to have caused several cycles of episodic change in its riparian birds. A single cycle of change would have likely involved two phases: 1) avian colonization of emergent riparian vegetation as lake levels receded, followed by 2) displacement of the resulting nesting bird community as lake levels increased. At present, the nesting bird community of the river corridor from Separation Canyon to the Grand Wash Cliffs is approximately 9-10 years into the first phase of a new cycle of change. The probability is high that changing lake levels will continue to cause future episodic changes in nesting bird use of the river corridor on this portion of the Hualapai Reservation.

The purposes of this study were twofold: 1) to identify the status and estimate the abundance and species richness of birds nesting in the riparian zone of the Colorado River through the Hualapai Reservation; and 2) to assess, where possible, the influence of interim flows from Glen Canyon Dam on these nesting birds.

Study Area

The study area was the riparian corridor of the Colorado River between National Canyon and the Grand Wash Cliffs. For the purposes of analyzing avian use, the riparian vegetation of the study area can be divided into three associations based upon river and lake influences: (1) the old high-water zone (OHWZ), (2) the new high-water zone (NHWZ), and (3) the fluctuating lake-level zone (FLLZ). The OHWZ is located at and above the pre-dam average high-water mark (ca. 100,000 cfs) and is dominated by mesquite, catclaw acacia, and netleaf hackberry (*Celtis reticulata*). Little if any riparian vegetation existed in the scour zone adjacent to the river's edge below the average high-water mark prior to the construction of Glen Canyon Dam. Glen Canyon Dam eliminated the annual floods which scoured away developing riparian vegetation below the pre-dam high-water-mark, allowing development of the NHWZ. The NHWZ, which exists side-by-side with the relict community of the OHWZ between National and Separation Canyons, is dominated by tamarisk, coyote willow, *Baccharis* sp., and arrowweed.

The FLLZ was located on silt banks deposited by the Colorado River downriver of Separation Canyon in the zone of influence of upper Lake Mead. Riparian vegetation in the FLLZ was also dominated by tamarisk, willow, *Baccharis* sp., and arrowweed, the same four species prevalent in the NHWZ upstream of Separation Canyon. The term NHWZ as used in this report is synonymous with the term FLLZ, unless a specific distinction is made.

Methodology

Surveys for nesting birds were conducted at eight sites (Table 5) in the study area from April 20 to June 6, 1993 and April 8 to June 11, 1994 using the absolute count method, in which an attempt was made to count all birds in a specified area (Kendeigh 1944, Emlen 1971). This was the method used in baseline studies of nesting riparian birds along the river corridor in the 1980s (Brown and Johnson 1987, Brown 1987a, Brown 1987b, Brown 1988, Brown 1989). The small size and linear nature of the study sites, the relative homogeneity of vegetation, and sample size considerations imposed by the limits of time and field work scheduling made the use of this method preferable to techniques such as the variable circular plot method, fixed or variable-strip census, or the spot-map method (Ralph and Scott 1981). Each study site was surveyed four to eight times in 1993 and six to eight times in 1994, based upon research trip length and timing as well as weather conditions. In 1993, study sites upstream of Diamond Creek were surveyed four times on one research trip from May 1-7, and study sites downstream of Diamond Creek were surveyed five to eight times on four research trips spanning the entire annual study period. In 1994, study sites upstream of Diamond Creek were surveyed six to eight times on two research trips from April 8-14 and May 19-25, while study sites downstream of Diamond Creek were surveyed seven to eight times on four research trips spanning the entire annual study period.

Table 5. Location of bird study sites along the Colorado River between National Canyon and Pearce Ferry. Sites 1 through 3 were located on the Colorado River upstream of the influence of Lake Mead; all other sites were in the zone of influence of Lake Mead. River Miles are after Stevens (1983).

Site Number	Location	River Mile	Elevation (m)
1	National Canyon	166.1-167.0L	532
2	Parashant Canyon	198.0-198.1R	465
3	Granite Park	208.4-209.0L	442
4	Above Spencer Canyon	243.2-243.4L	372
5	Spencer Canyon	246.0L	372
6	Quartermaster Canyon	260.1-260.3L	372
7	Waterfall Rapids	260.1-260.3R	372
8	Tincanebits Canyon	263.8-265.1L	372

Bird Surveys

A single observer conducted bird surveys between 05:00 and 09:30 hours by walking slowly through the small, discrete study sites. The survey objective was to detect and record singing males for those species that were primarily monogamous and exhibited type-A territories, and to detect and record all individuals for those species that were either polygamous, did not exhibit type-A territories, or did not exhibit vocal or visual sexual dimorphism.

A type-A territory is an all-purpose area, used for nesting and feeding by the pair, that is vocally advertised, physically defended, and from which all other individuals of the same species are assumed to be excluded. Therefore, monogamous type-A species were most easily censused by recording detections of singing males (Mayfield 1981), with the assumption that each male represented a nesting pair and that all singing males were detected during the survey periods. For a discussion of avian territoriality, see Perrins and Birkhead (1983). Species that were either primarily monogamous or maintained type-A territories included: Western Screech-Owl, Ladder-backed Woodpecker, kingbird, Bewick's Wren, Marsh Wren, Blue-gray Gnatcatcher, Phainopepla,

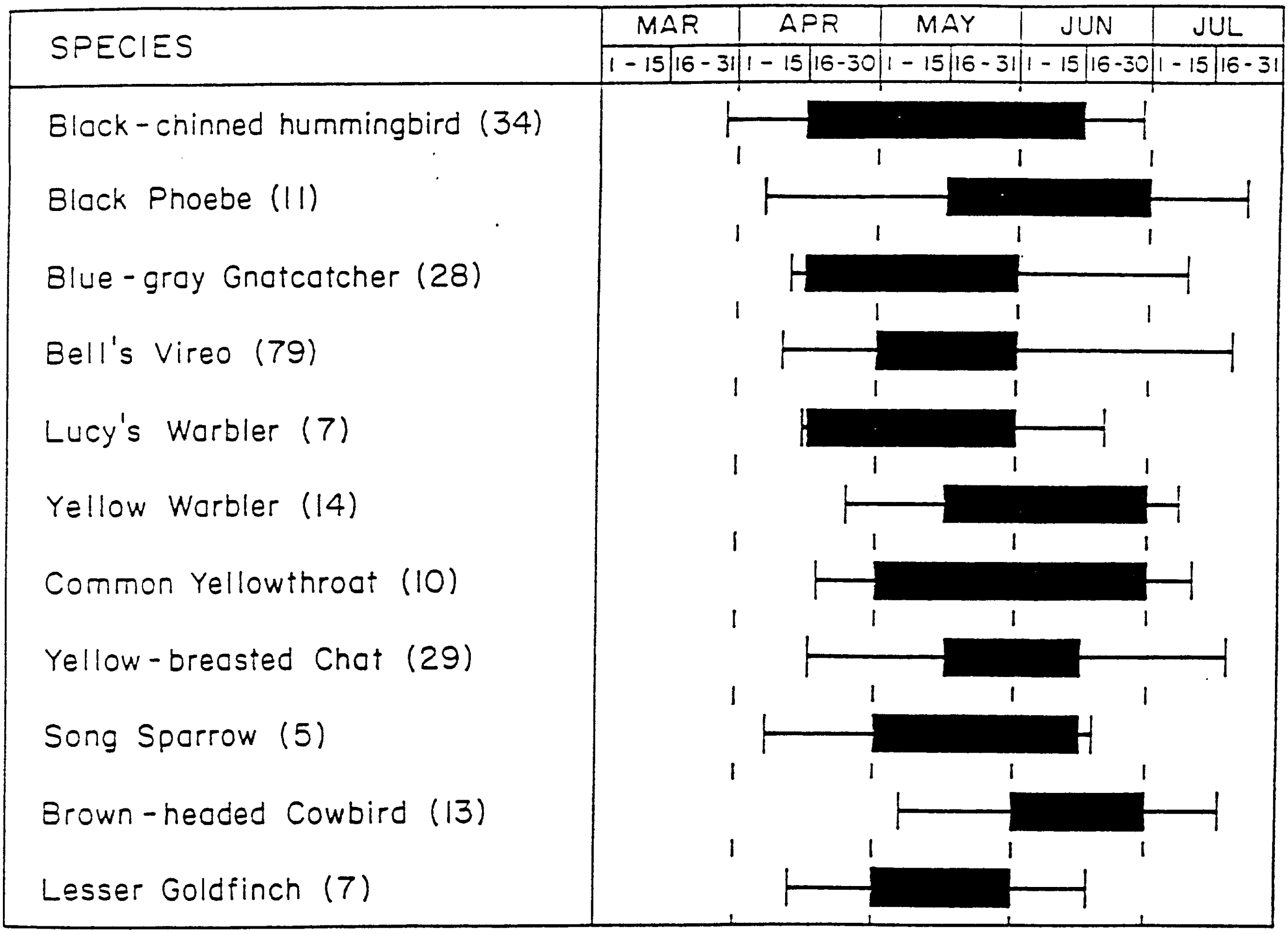


Figure 8. Nesting chronology of selected bird species detected nesting along the Colorado River corridor from National Canyon to Tincanebits Canyon (RM 166-265), 1982-1987 and 1993-1994 combined. Only species for which ≥ 5 nests were found containing eggs or young are included. Sample sizes in parentheses follow species names. Brackets indicate the period when each species was calculated to have eggs or young in active nests; bold lines indicate the peak of nesting when ≥ 50% of the sample nests of each species was calculated to contain eggs or young.

Northern Mockingbird, Crissal Thrasher, Bell's Vireo, Lucy's Warbler, Yellow Warbler, Common Yellowthroat, Yellow-breasted Chat, Summer Tanager, Blue Grosbeak, Lazuli Bunting, Indigo Bunting, Song Sparrow, and Hooded Oriole.

Species that did not maintain type-A territories included: Gambel's Quail, Mourning Dove, Black-chinned Hummingbird, Costa's Hummingbird, Great-tailed Grackle, Brown-headed Cowbird, House Finch, and Lesser Goldfinch. Ash-throated Flycatchers maintained type-A territories but did not exhibit visual or vocal sexual dimorphism, so that detections could not be assigned to a male or female. For this reason, Ash-throated Flycatcher detections were recorded as individuals.

Species that were detected during surveys but were either known not to nest at the eight study sites or were assumed to be wanderers from nearby nesting areas were not reported in the survey results. These species included: herons, ducks, swifts, Black Phoebe, Say's Phoebe, swallows, Canyon Wren, Rock Wren, and Red-winged Blackbird.

This conservative technique likely underestimated actual bird density, and other techniques may provide a more accurate density estimate for some species, particularly hummingbirds (Brown 1992). Nest searches were conducted before and after most surveys to provide supplemental information on bird densities and to identify species-specific nesting chronology.

Nest Searches

Nest searches were conducted from April to June during the study period by up to six trained observers. Data recorded on nests and nest contents included: nest substrate plant, nest height above ground (nearest 10cm), habitat (NHWZ or OHWZ), species, date, number of eggs or young present, age of young (if applicable), and presence of cowbird eggs or young.

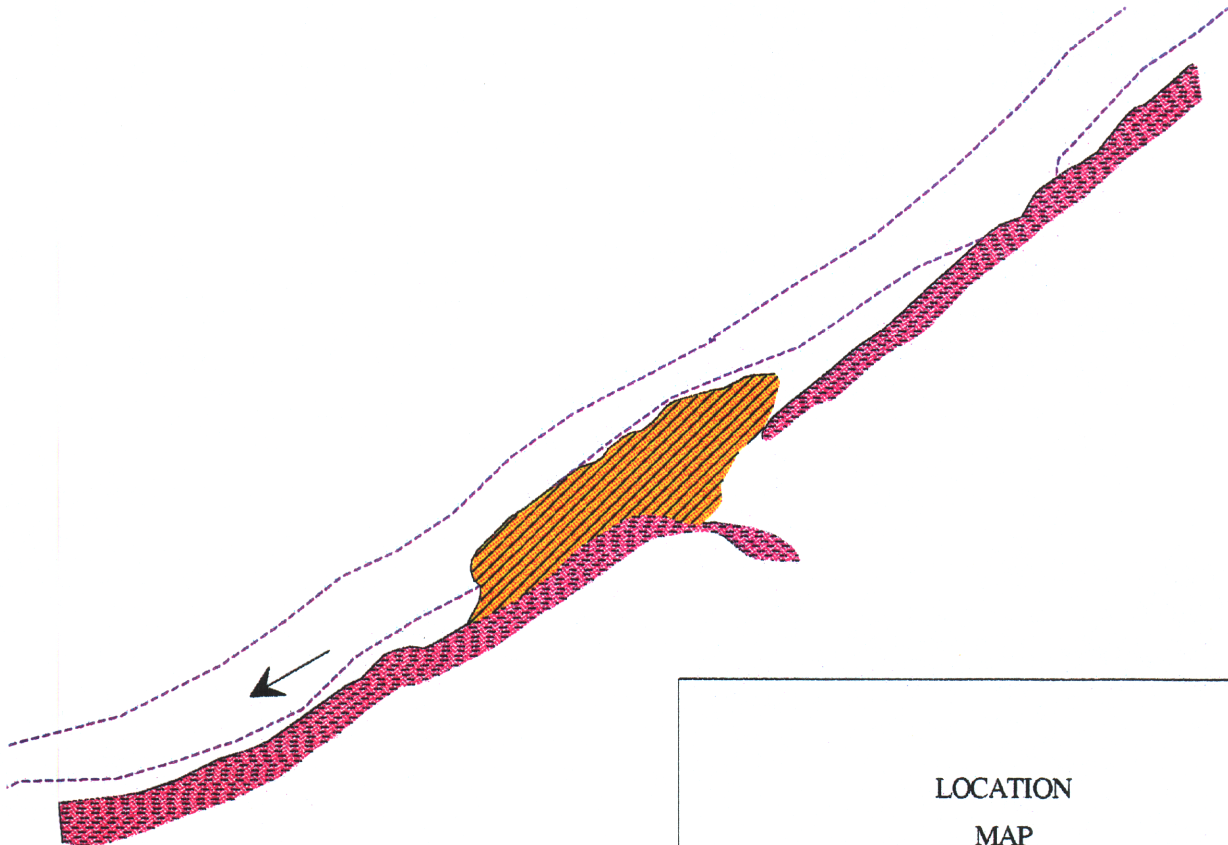
Observations on nest contents made during nest searches were combined with similar data collected in the study area during 1982-87 studies (Brown 1992, Brown 1994) to create the nesting chronology summary in Figure 8. Nest contents data were collected at active nests during one to four visits per season, with most nests visited once. For this reason, the chronology of each nest was reconstructed from the average number of days reported in the literature for the egg-laying, incubation, and nestling periods of each species (Table 6, Figure 8). Nests containing fewer eggs than expected for a completed clutch were assumed to be at the corresponding day of the egg-laying period. Nests containing a completed clutch were assumed to be at the mid-point of the incubation period. Further details and assumptions of nest chronology reconstruction based on nest contents, especially for hummingbirds and cowbirds, are presented in Brown (1992 and 1994).

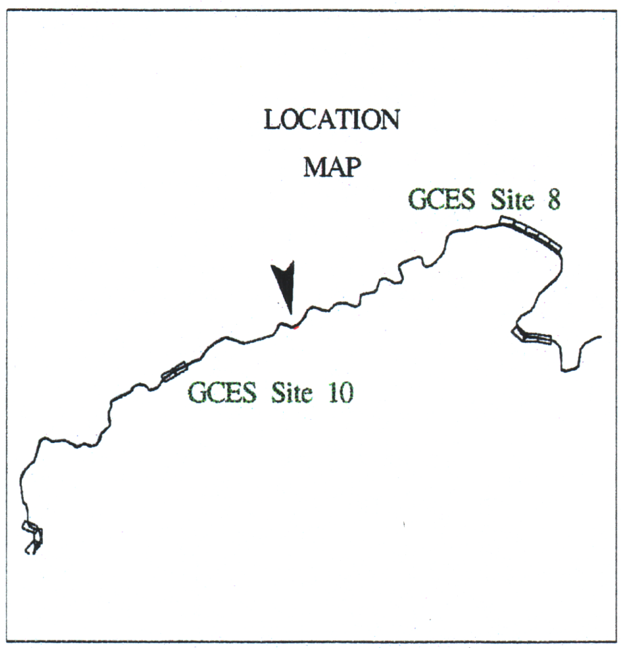
The egg-laying period was the number of days required to lay a completed clutch, as a single egg was assumed laid each day at dawn (Pettingill 1970). The incubation period was the number of days from laying of the last egg to hatching of the last egg, and the nestling period was the number of days from hatching of the first egg to fledging of the last young. The average number of days for hummingbird and cowbird egg-laying periods was assumed to be 1 day, even though more eggs may be laid, especially by cowbirds. Nesting chronology information on Lucy's Warbler was unavailable, but was assumed to be similar to that of Nashville Warbler. It was assumed that no delay occurred between termination of egg-laying and initiation of incubation.

Vegetation Mapping and Measurement

Vegetation at each of the eight study sites was mapped by researchers using 1993 aerial photos, and these data were analyzed with GIS to show the proportions of vegetation types (Figures 9-15). Total vegetation volume (TVV) measurements were also taken at each site. Data on vegetation types and volume are presented in Chapter 2. The size of each study site was measured with a compensating polar planimeter from 1:4800 scale aerial photographs taken on 31 May 1993.

Avian Habitat Study:Site 1





Symbols

- Acacia (4.3 ha)
- Lush Tamarisk and Arrowweed (7.62 ha)
- New High Water Zone
- Old High Water Zone
- Colorado River Channel

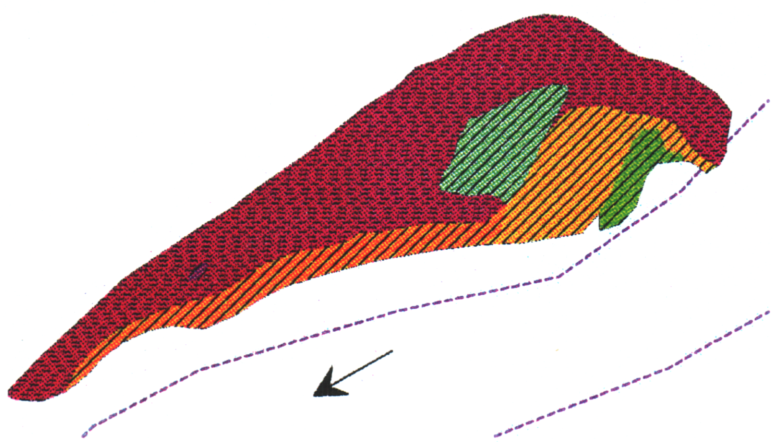
This study was conducted in cooperation with GCES, Hualapai Tribe and SWCA, Inc. Particular vegetation types and sizes have been found to be closely related to bird habitats. Endangered bird species in particular are studied for suitable habitat types.

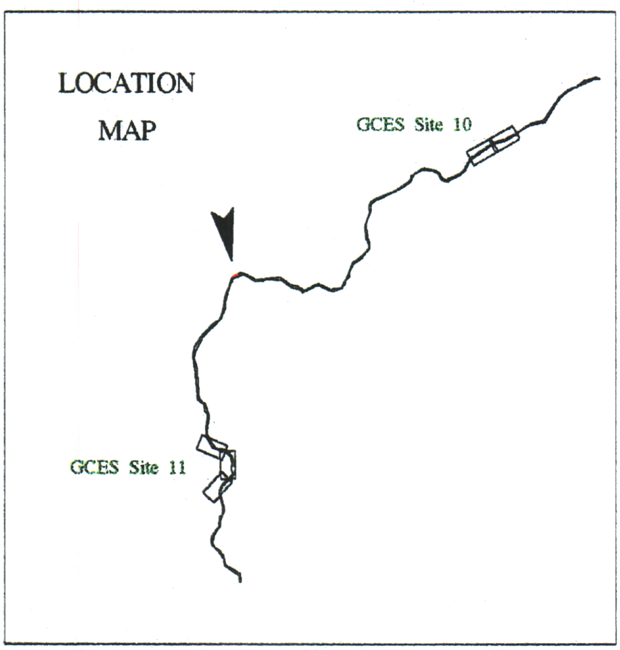
1:8000

0 100 200 m

Hualapai GIS

Avian Habitat Study:Site 2





Symbols

- Dry Marsh (.08 ha)
- Arrowweed (.22 ha)
- Lush Tamarisk and Arrowweed (.36 ha)
- Mature Tamarisk (.29 ha)
- Mesquite (1.58 ha)
- Hackberry (.01 ha)
- New High Water Zone
- Old High Water Zone
- Colorado River Channel

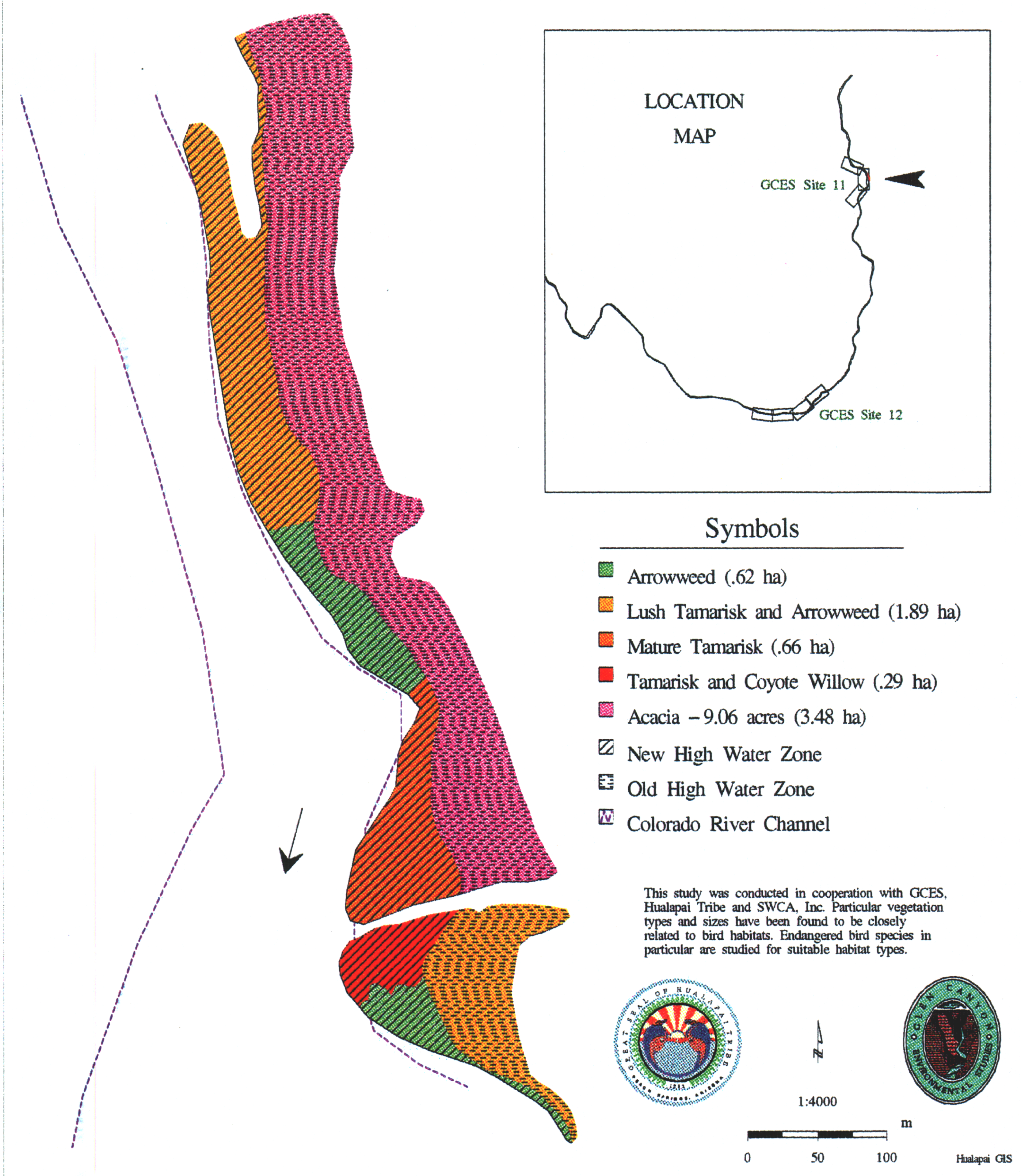
This study was conducted in cooperation with GCES, Hualapai Tribe and SWCA, Inc. Particular vegetation types and sizes have been found to be closely related to bird habitats. Endangered bird species in particular are studied for suitable habitat types.

1:4000

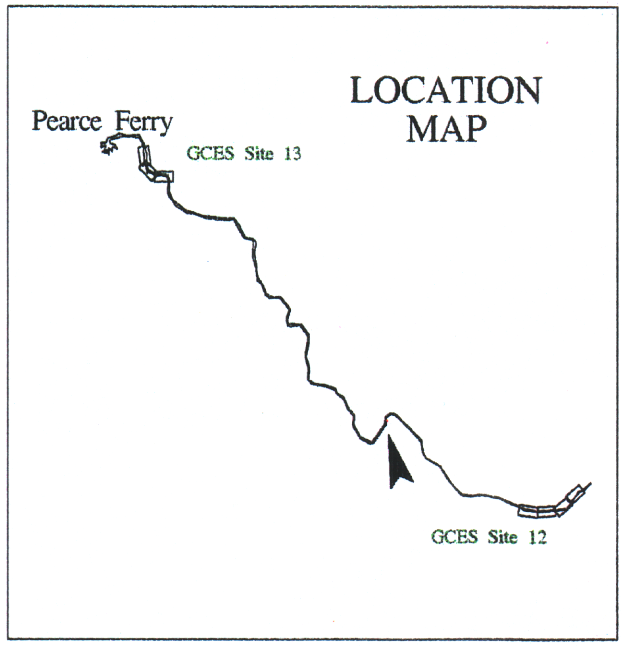
0 50 100 m

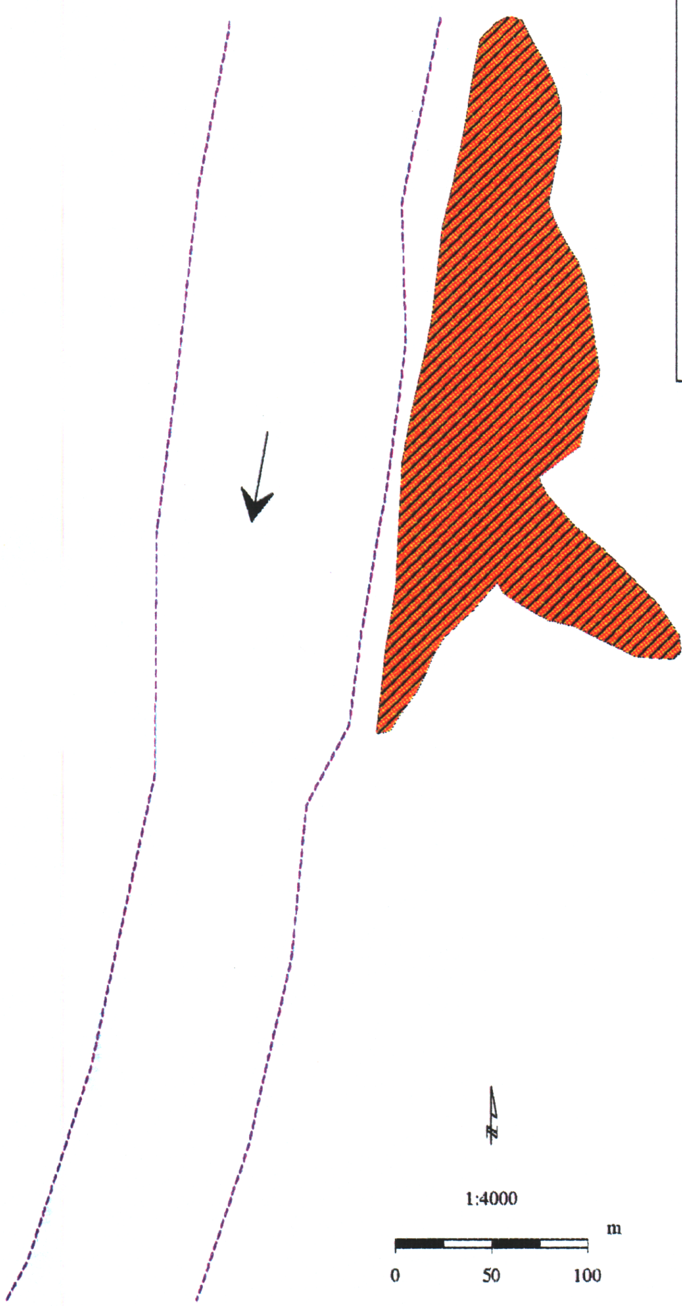
Hualapai GIS

Avian Habitat Study:Site 3



Avian Habitat Study:Site 4





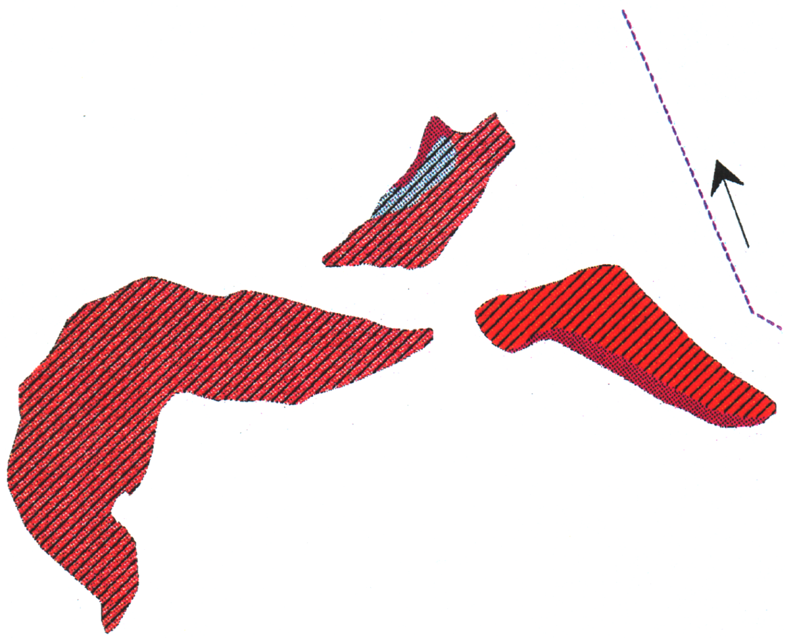
Symbols

- Mature Tamarisk (2.51 ha)
- New High Water Zone
- Colorado River Channel

This study was conducted in cooperation with GCES, Hualapai Tribe and SWCA, Inc. Particular vegetation types and sizes have been found to be closely related to bird habitats. Endangered bird species in particular are studied for suitable habitat types.

Hualapai GIS

Avian Habitat Study:Site 5

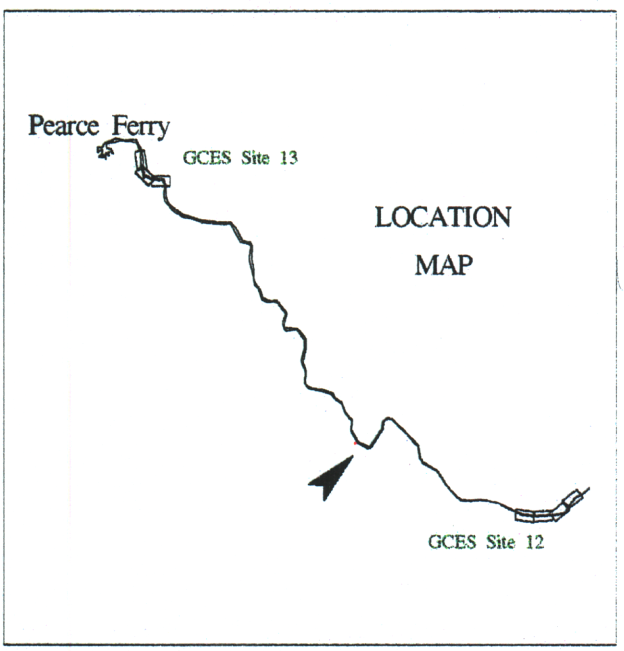


Symbols

- Coyote Willow (.07 ha)
- Tamarisk and Goodding's Willow (1.98 ha)
- Tamarisk and Coyote Willow (.44 ha)
- Mesquite (.13 ha)
- New High Water Zone
- Colorado River Channel

1:4000

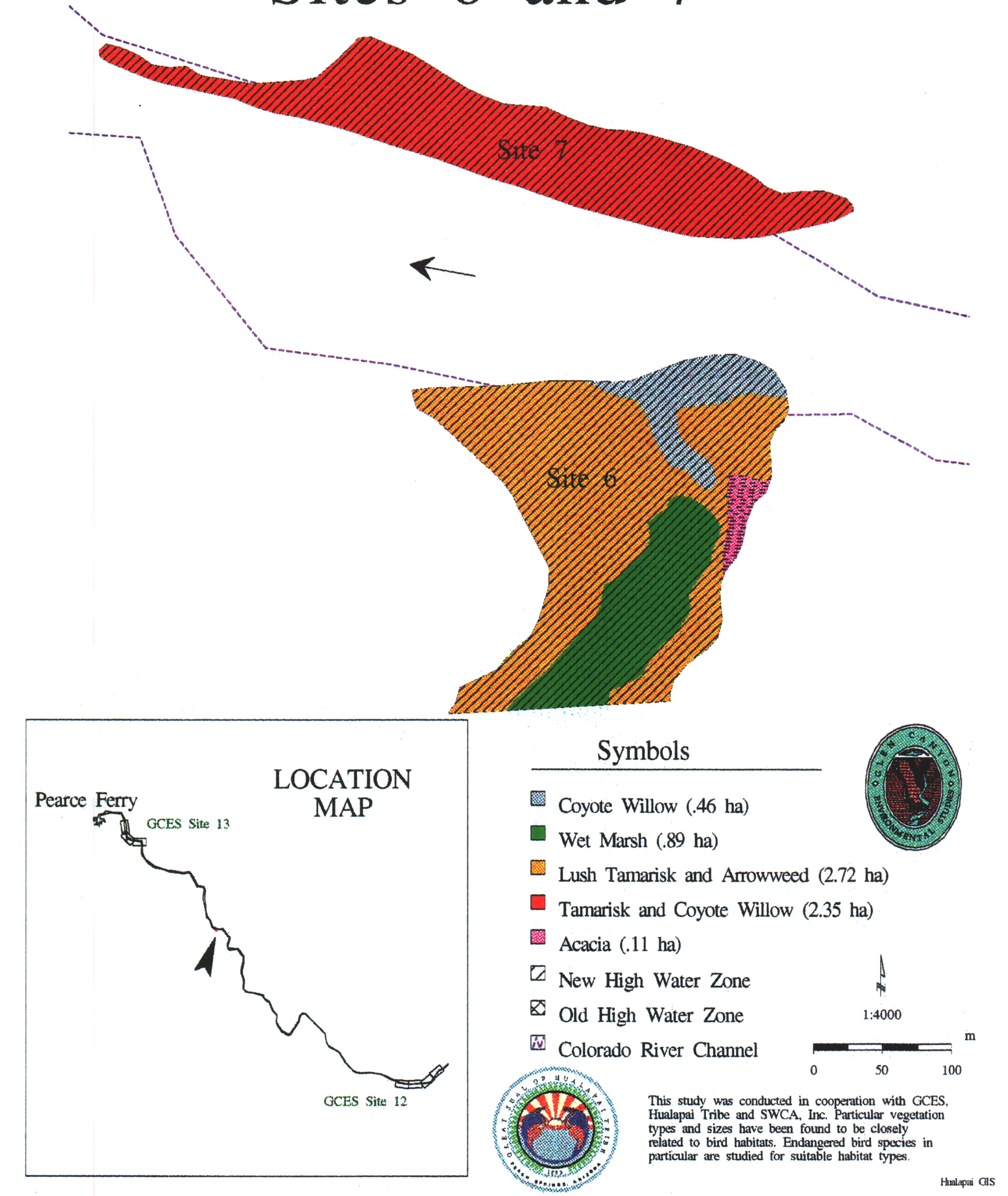
0 50 100 m



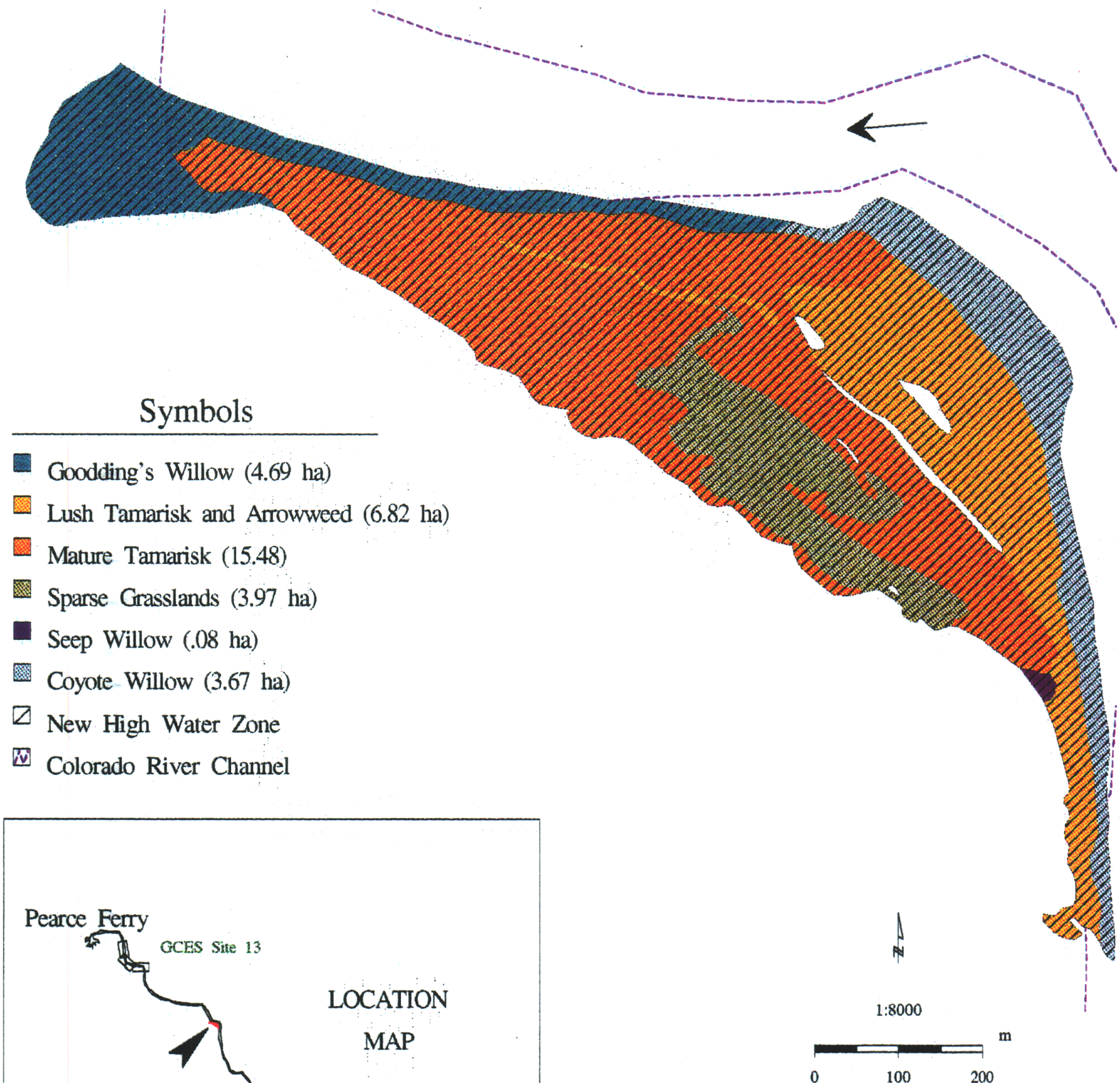
This study was conducted in cooperation with GCES, Hualapai Tribe and SWCA, Inc. Particular vegetation types and sizes have been found to be closely related to bird habitats. Endangered bird species in particular are studied for suitable habitat types.

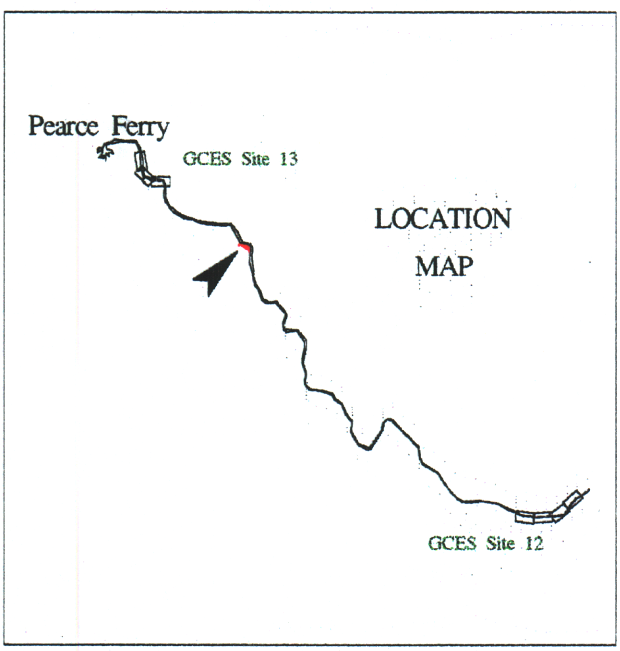
Hualapai GIS

Avian Habitat Study: Sites 6 and 7



Avian Habitat Study:Site 8





This study was conducted in cooperation with GCES, Hualapai Tribe and SWCA, Inc. Particular vegetation types and sizes have been found to be closely related to bird habitats. Endangered bird species in particular are studied for suitable habitat types.

Hualapai GIS

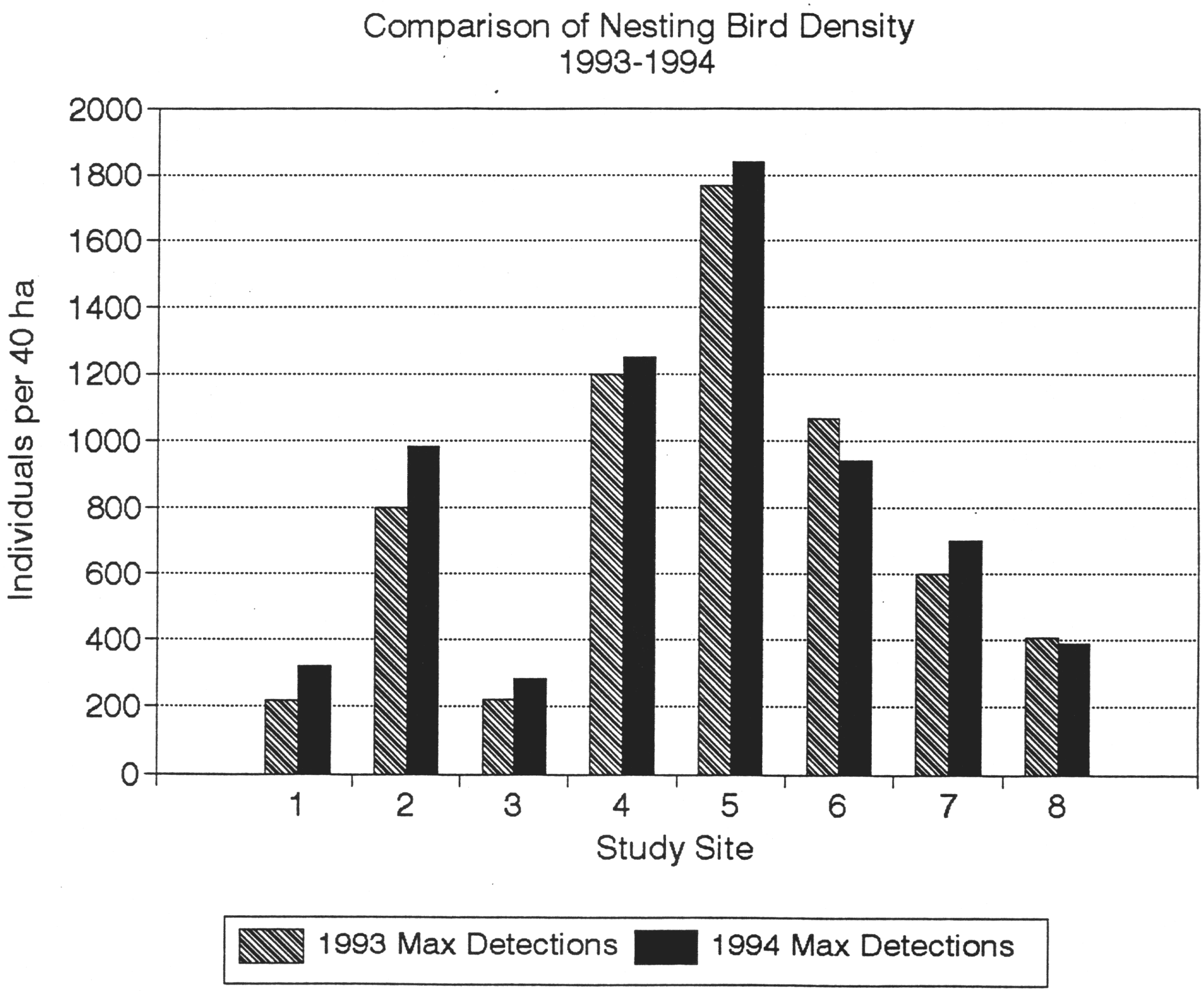


Figure 16. Comparison of nesting bird density at eight study sites from 1993 to 1994, using maximum detections technique.

Results

Survey results are presented in two ways. In the first, the maximum detections technique, the maximum number of singing males detected for each type-A territorial species at a study site was multiplied by two (as we assumed each singing male was paired), combined with the mean number of individuals detected of those species not maintaining type-A territories, and then reported as an estimate of the number of nesting individuals for that site. In the second, the mean detections technique, the mean number of singing males detected for each type-A territorial species at a study site was multiplied by two, combined with the mean number of individuals of those species not maintaining type-A territories detected at each site, and then reported as an alternative estimate of the number of nesting individuals. The number of singing males was multiplied by two to arrive at the number of individuals to account for the assumption of a 1:1 male:female sex ratio for territorial type-A species.

Because the detectability of each species appeared to vary throughout the study period and because the maximum detectability of each species was likely just prior to or during its time of peak nesting (Best 1981), estimates based on maximum detections are considered to be more accurate. Densities based on mean detections likely underestimated actual densities. For species that did not arrive until mid-season, such as Yellow-breasted Chat and Brown-headed Cowbird, mean detections were calculated by using only those surveys made after the species had first been detected.

Twenty-nine bird species known or suspected to nest were detected in riparian vegetation at the eight study sites. The number of species detected at study sites ranged from 8 to 21 in 1993 and 12 to 21 in 1994. A brief description of each species' occurrence in the study area along with its habitat use, nesting behavior, and other information is presented in Appendix B.

In 1993, bird density estimates derived from the maximum detections technique ranged from 217 to 1,764 individuals/40 ha; density estimates derived from the mean detections technique ranged from 154 $\pm$ 12 to 1,098 $\pm$ 121 individuals/40 ha (Table 7). In 1994, bird density estimates derived from the maximum detections technique ranged from 283 to 1,840 individuals/40 ha (Figure 11); density estimates derived from the mean detections technique ranged from 177 $\pm$ 75 to 1,238 $\pm$ 200 individuals/40 ha in 1994 (Table 8). The raw data from which these densities were calculated are presented in Appendix I. Based upon these results and measurements of vegetated area in the reach from Spencer Canyon to the Grand Wash Cliffs, we estimate that between 12,000 and 19,000 individual breeding birds may occupy the over 1,200 ha of habitat in lower Grand Canyon each year.

Table 6. Length of nesting period for species with $\geq$ 5 nests containing eggs or young found in the Colorado River corridor from National Canyon to Tincanebits Canyon (River Miles 166-265), 1982-87 and 1993-1994.

	Average number of days/period			
Species	Egg-laying	Incubation	Nestling	Literature Source
Black-chinned Hummingbird	1	16	22	Bent 1940, Demaree 1970
Black Phoebe	4	16	17	Bent 1963
Blue-gray Gnatcatcher	4	14	12	Bent 1949
Bell's Vireo	4	14	11	Barlow 1962, Brown 1993
Lucy's Warbler	4	12	11	Estimated from Bent 1953
Yellow Warbler	4	11	10	Bent 1953
Common Yellowthroat	4	12	10	Stewart 1953, Bent 1953
Yellow-breasted Chat	4	15	11	Petrides 1938, Bent 1953
Song Sparrow	5	12	12	Bent 1968
Brown-headed Cowbird	1	11	10	Bent 1958, Scott 1979
House Finch	4	13	15	Evenden 1957, Bent 1968
Lesser Goldfinch	4	12	12	Linsdale 1957, Bent 1968

Table 7. Study site size, sample size of bird surveys/site (N), and estimated densities of nesting birds extrapolated by study site and method, Colorado River between National Canyon and Pearce Ferry, 1993. Raw data summaries are presented in Appendix I.

Study site number	Size (ha)	N	Number of individuals detected per unit area: Maximum detections /5 ha	Maximum detections /40 ha	Mean detections /5 ha	Mean detections /40 ha
1	4.6	4	27.2	217.6	20.7±0.9	165.6±7.2
2	3.0	4	100.0	800.0	66.3±4.8	530.4±38.4
3	11.6	4	27.6	220.8	19.3±1.6	154.4±12.8
4	2.3	8	150.0	1200.0	77.8±17.6	622.4±140.8
5	2.2	5	220.5	1764.0	137.3±15.2	1098.4±121.6
6	7.1	5	133.1	1064.8	80.1±11.2	640.8±89.6
7	3.4	6	75.0	600.0	40.9±7.2	327.2±57.6
8	47.1	6	51.2	409.6	37.5±2.0	300.0±16.0
Totals	81.3	42	-	-	-	-

Table 8. Study site size, sample size of bird surveys/site (N), and estimated densities of nesting birds extrapolated by study site and method, Colorado River between National Canyon and Pearce Ferry, 1994. Raw data summaries are presented in Appendix I.

			Number of individuals detected per unit area			
Study site number	Size (ha)	N	Maximum detections /5 ha	Maximum detections /40 ha	Mean detections /5 ha	Mean detections /40 ha
1	4.6	6	40.2	321.7	22.1±9.3	176.5±74.8
2	3.0	8	122.8	982.7	69.2±6.0	553.3±48.0
3	11.6	6	35.4	283.1	22.6±4.6	181.0±36.6
4	2.3	8	156.1	1248.7	101.1±21.5	808.7±172.2
5	2.2	8	230.0	1840.0	154.8±25.0	1238.2±200.0
6	7.1	8	117.6	940.8	82.8±7.0	662.5±56.3
7	3.4	8	87.5	700.0	42.1±12.1	336.5±96.5
8	47.1	7	49.1	392.9	37.8±3.2	302.6±25.7
Totals	81.3	59	-	-	-	-

CHAPTER 4. MAMMAL STUDIES

Introduction

Mammal studies were initiated in lower Grand Canyon in order to identify the impacts, if any, of interim flows from Glen Canyon Dam on small mammal populations and to increase the biological knowledge base of this little-studied area. As with vegetation and avian studies, research was conducted to gather baseline species diversity and capture rate data, and monitoring provided comparative data. Prior to these studies, only informal mammal research was conducted in the portion of Grand Canyon below Diamond Creek (Carothers et al. 1985, Carothers and Aitchison 1976, Ruffner et al. 1978). Because small mammals in this area used riparian vegetation patches, but also made use of upland areas, this study was designed to examine differential use of riparian and adjacent xeric upland areas.

Small mammals constitute an ideal experimental focus for mammal studies because of the relative ease with which they could be trapped and because of their relatively large numbers. Small mammal communities are known to be dependent upon riparian vegetation for food sources, nesting material, cover sites, and breeding areas. A strong relationship potentially exists between small mammal population dynamics and vegetation volume, type, and area of riparian vegetation patches. Small mammal populations may be directly affected by differing flow regimes and changing lake levels, as these can affect the type and quantity of primary small mammal habitats.

Monitoring at small mammal research sites was initiated in 1992, with trapping conducted during July vegetation studies research trip. The 1993 outbreak of the hantavirus, a deadly disease carried by small mammals of several species, caused the postponement of 1993 research. Two research trips were conducted in 1994.

Study Area

The study area consisted of the Colorado River corridor between Diamond Creek and the Grand Wash Cliffs. Three study sites were chosen in this reach: Bridge Canyon (RM 235L), Spencer Canyon (RM 246L), and Quartermaster Canyon (RM 260L, Table 9). The Bridge Canyon site was primarily river-influenced, while the Spencer and Quartermaster Canyon sites were influenced by both river action and Lake Mead water level fluctuations. The Spencer and Quartermaster Canyon areas at the mouth of each canyon were last completely inundated by Lake Mead in 1983, and were partially inundated through 1993. The majority of vegetation in these areas became established since 1983. Perennial streams flowed through each site, and some riparian vegetation at each site was found to pre-date the 1983 inundation.

Each of the three study sites supported three distinct habitat zones: riparian areas, adjacent to the river or perennial stream; xeric upland areas; and the transition zone between riparian and upland areas. Riparian areas were dominated by coyote willow, tamarisk, and arrowweed; upland areas were generally dominated by brittlebrush. The transition zone was populated primarily by depauperate riparian vegetation.

Table 9. Location of mammal study sites between Diamond Creek and the Grand Wash Cliffs. River miles are after Stevens (1983).

Site Number	Location	River Mile
1	Bridge Canyon	235.0L
2	Spencer Canyon	246.0L
3	Quartermaster Canyon	260.2L

Methodology

Research trips were conducted from July 10-16 and September 28-October 6, 1992 as well as July 11-17 and September 10-15, 1994. Research trips in 1992 focused upon collection of small mammals, determination of appropriate trapping methodology, and selection of monitoring sites. Trapping was conducted at Travertine Falls (RM 229L) and RM 241L, but the small site size and lack of accessible upland habitat led to the choice of other sites for further research. Research trips in 1994 focused upon sampling riparian, upland, and transition areas through live trapping. Three trap-nights were spent at the Bridge Canyon site in 1994, and five trap-nights were spent each at Spencer and Quartermaster Canyons. On each trap-night, in each of the three habitat zones, fifty Sherman live traps were armed and baited with wet oats. A total of 150 traps were set each evening. These traps were checked the next morning and the types and numbers of species captured in each habitat zone were recorded. After all pertinent information was collected, the mammals were released near the point of capture except where the mammal was kept as a museum specimen (Duncan 1990). After the traps were checked they were de-armed and left in place until later that evening when the process was re-initiated.

Results

Four small mammal species were trapped in 1992, including rock pocket mouse (*Perognathus intermedius*), cactus mouse (*Peromyscus eremicus*), canyon mouse (*Peromyscus crinitis*) and desert woodrat (*Neotoma lepida*). Three small mammal species were trapped in 1994, including rock pocket mouse, cactus mouse, and desert woodrat. Figure 17 depicts capture rates for each of the three study sites during July and September. Capture rates in upland and riparian zones decreased markedly in September. During the same period, capture rates in the transition zone at Bridge and Quartermaster Canyons increased, implying that small mammals were using the transition zone at these sites more heavily in September. However, captures in the transition zone at Spencer Canyon in September dropped.

All three species were found at Spencer and Quartermaster Canyons, but desert woodrat was not found at Bridge Canyon. Rock pocket mouse was the species most commonly captured.

Study sites at Bridge Canyon and Quartermaster Canyon were stable in size and vegetation composition throughout the study period, which can be attributed to the interim flow regime and Lake Mead levels that varied less than 3m over the study period. Spencer Canyon experienced the destruction of several riparian areas during a February 1993 tributary flood; during this time period, high Colorado River flows deposited new sediments near the mouth of the canyon. Small mammal populations were not documented at this site until 1994, so the effects of tributary and river flooding on small mammals could not be measured.

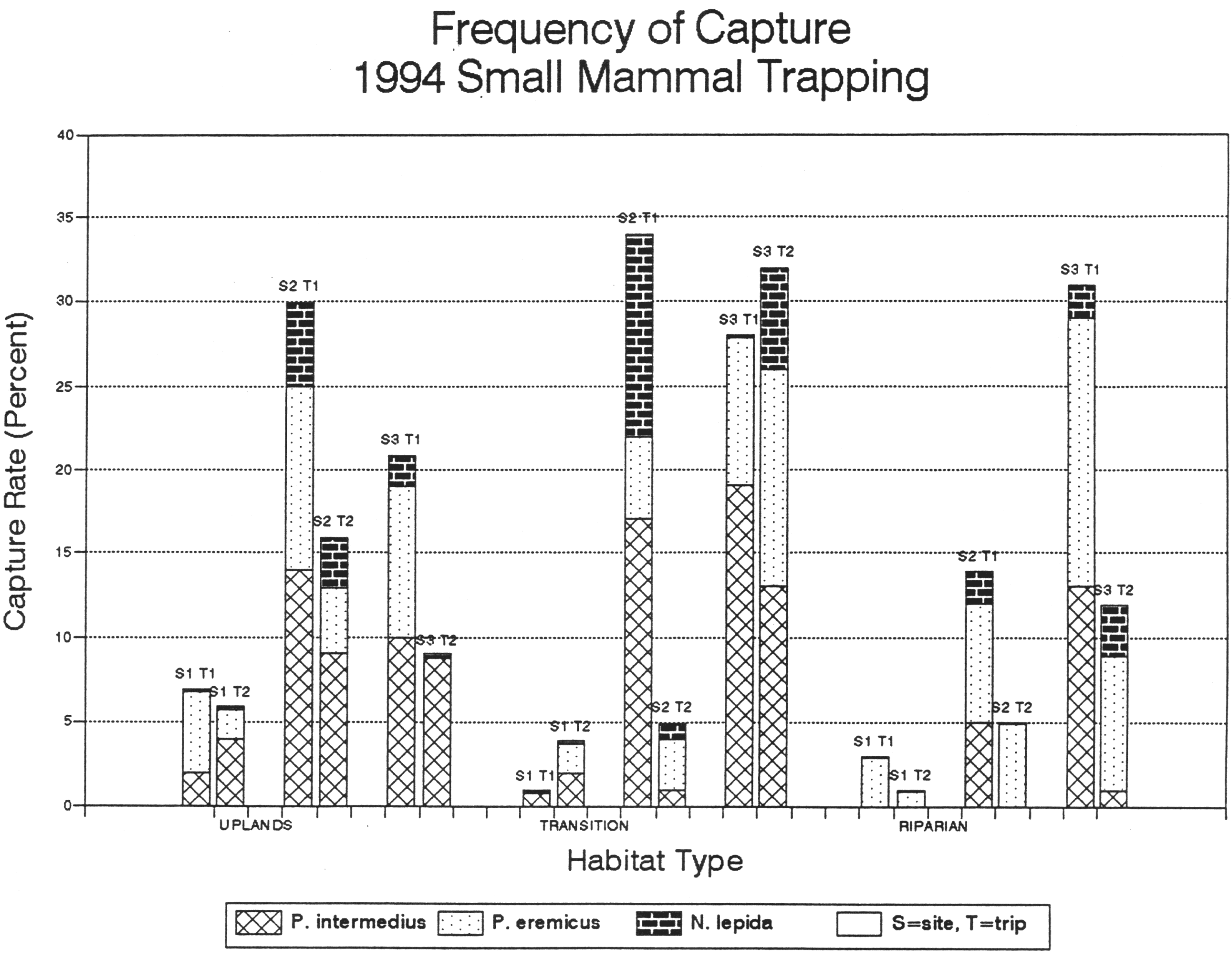


Figure 17. Frequency of capture, 1994 small mammal trapping. S denotes site number (S1=Bridge Canyon, S2=Spencer Canyon, S3=Quartermaster Canyon). T shows trip number (T1=July, T2=September).

CHAPTER 5. REPTILE STUDIES

Introduction

The objective of reptile studies in lower Grand Canyon was to identify any correlation between interim flows and reptile population and species diversity. A baseline research and subsequent monitoring program identified reptile community parameters. Only informal reptile studies have been conducted below Diamond Creek (Carothers et al. 1985, Carothers and Aitchison 1976). Previous studies in upper Grand Canyon (Warren and Schwalbe 1986) focused upon shoreline, new high water, and old high water vegetation zones. In much of lower Grand Canyon, these zones have been replaced by newly vegetated depositional silt bars in the area influenced by Lake Mead. Our studies used the methods of upper Grand Canyon researchers where possible, and adapted these techniques as necessary for the special conditions of lower Grand Canyon.

Terrestrial reptiles were surveyed to assess both species diversity and species abundance. Reptiles are primarily dependent upon riparian habitats for food sources: insects, vegetation and small mammals. Because reptiles are ectothermic, their habitat lies equally in the rocky uplands and in the transition zones between upland and riparian areas. Reptiles depend on uplands where darkly colored volcanic rocks and soil substrates provide optimum habitat for body temperature regulation.

Study Area

The three study sites used for reptile censusing were identical to those used for mammal trapping: Bridge Canyon, Spencer Canyon, and Quartermaster Canyon. Each study site contained three sampling zones: riparian areas, uplands, and the transition zone that separates riparian from upland areas. Bridge Canyon was the smallest of the three sites, and riparian areas there were primarily affected by present and historic river activity. Spencer and Quartermaster Canyons supported extensive riparian areas upon silt banks deposited by Lake Mead.

Methodology

Research trips were conducted from September 13-20, 1993 and July 11-17 and September 10-15, 1994. During the 1993 trip, the main focus of which was vegetation recensus, sample transects at Spencer Canyon and Quartermaster Canyon were censused to identify the most suitable survey and analysis techniques. Visual belt transects, modified from the Emlen (1971) bird census technique, were used in 1994 to census common diurnal lizard species and crepuscular amphibian species (Lowe and Johnson 1977). This method involved walking transects through dominant vegetation types and recording all reptile individuals observed within a 1 to 4 meter wide belt, based upon the density of vegetation. Transect length varied with size of the habitat patch. Transect routes were selected to identify variation between riparian habitats and adjacent non-riparian desertscrub.

Results

Quartermaster Canyon exhibited the smallest density of reptiles among sites, with fewer reptiles detected in all three zones on both research trips. Reptile populations at Quartermaster Canyon varied little between vegetation zones and separate surveys, but due to a small sample size no clear analysis could be made (Figure 18).

Bridge Canyon, a site with very little riparian vegetation, had more reptiles in the upland zone than in any other. More reptiles were sighted on the second research trip in the upland and riparian zones, but fewer in the transition zone.

Spencer Canyon showed the highest density of reptiles among sites, with almost twice as many reptile detections as at other sites. Many more reptiles were detected at this site during the first research trip, an indication that reptiles may have been less active during September and thus less readily counted. This is also shown by an increase in upland sightings and a decrease in transition and riparian sightings between July and August research trips.

Western rattlesnake (*Crotalus viridis)* was found only in transition and riparian areas, and desert spiny lizard (*Sceloporus magister)* was found primarily in riparian areas. Coachwhip (*Masticophis flagellum)* was found only in upland areas. Other species found included tree lizard (*Urosaurus ornatus*), western whiptail lizard (*Cnemidophorus tigris*), and side-blotched lizard (*Uta stansburiana*).

As with mammal studies, the majority of reptile census data were collected after the flooding events which altered the quantity and configuration of vegetation at the Spencer Canyon site, so the effects of this event on reptile populations could not be assessed. The reworking of the Spencer Canyon site was not attributable to interim flows, and the stability of the Bridge Canyon and Quartermaster Canyon sites is more indicative of stabilizing interim flow effects.

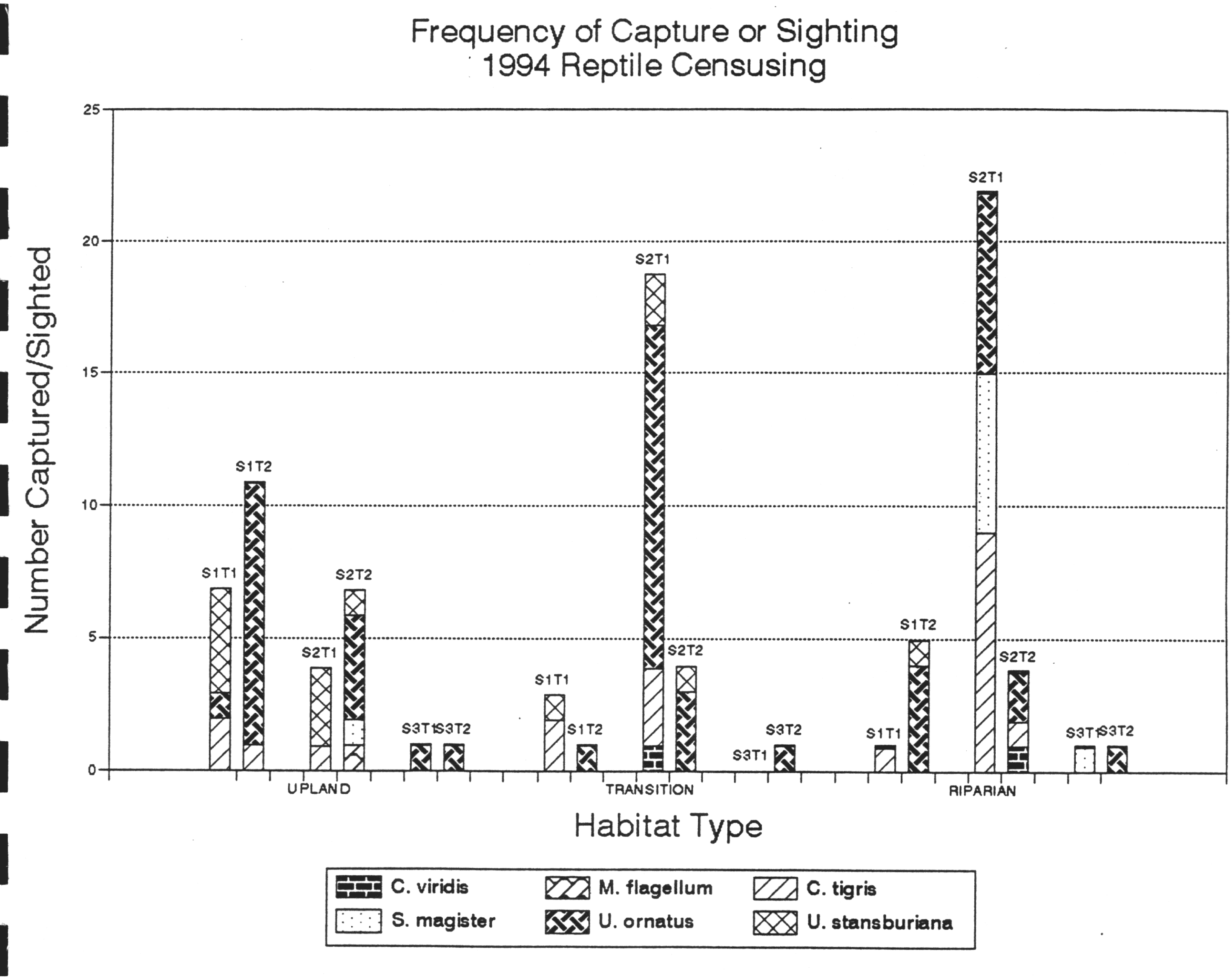


Figure 18. Frequency of capture or sighting, 1994 reptile censusing. S denotes site number (S1=Bridge Canyon, S2=Spencer Canyon, S3=Quartermaster Canyon). T shows trip number (T1=July, T2=September).

CHAPTER 6. DISCUSSION AND RECOMMENDATIONS

Studies for this project provided in-depth information on several facets of the riparian community in lower Grand Canyon. The NHWZ and OHWZ areas upstream of Separation Canyon were found to contain diverse vegetation communities which, in turn, supported diverse avian communities. Study sites and avian populations were stable: the size of study sites did not vary measurably between 1992 and 1994, vegetation at those sites did not vary significantly overall, and bird populations did not change significantly between 1993 and 1994.

Downstream of Separation Canyon, silt bars supported productive vegetation communities, that in turn supported large bird, mammal and reptile communities. These silt bars and animal communities were also quite stable during this study, but the dynamism of this area was apparent. The loss of vegetation quadrats, cutting of banks, deposition of new silt bars, and flooding of many areas when lake levels rose, showed that river flows and changing lake levels can have significant impacts on riparian areas. The effects of river and lake management decisions are rapidly felt in lower Grand Canyon, and hasty reservoir level or river flow decisions could inadvertently affect resources that managers are trying to protect. We recommend that streamlined studies of lower Grand Canyon be continued to provide managers with the data they need to make fully informed decisions.

Vegetation Studies

In the study area upstream of Separation Canyon, interim flows appear to have introduced stability in debris fan sites, with few dramatic changes occurring in riparian zones. In some cases, there appears to have been a shift in favor of exotic species, usually Bermuda grass and tamarisk. Marshes appear to have senesced in places where they lie above current maximum flow levels, deprived of periodic water and nutrient recharge from the river. No quadrats or marshes were eroded in this reach.

In the transition area where both the effects of the river and water levels in Lake mead influence shoreline communities, one marsh has shown a large increase in riparian (rather than marsh) vegetation due to the establishment of a mainly riparian community on a newly stabilized silt bar at the shoreline, while another marsh has shrunk due to bank erosion. Spencer Canyon, the last downstream side canyon not choked by Lake Mead silt terraces, was scoured by a severe flash flood in early 1993, causing nearly all of its vegetation to be removed, depositing a new cobble delta at its mouth, and eroding a silt bar across the Colorado River from which a study plot was lost. A large coarse silt bar at RM 254R which was devoid of vegetation when the study began was rapidly invaded by riparian species and by 1994 supported dense native trees. The largest gains in vegetation associated with the interaction of interim flows and varying lake levels appear to have occurred in the transition zone. Four quadrats and two marshes were eroded between 1992 and 1993 in the reach from Separation Canyon to RM 254, primarily as a result of river flows.

In the downstream portion where wide lake silt terraces choke the mouths of side canyons, habitat is lost as the banks erode into the lake where terraces are high. Lake levels, which fluctuate more than Colorado River levels, alternately expose and cover new habitat which is quickly invaded by riparian species, only to be flooded or eroded in most places before plants become well established. Four quadrats were eroded between 1992 and 1993 in this reach as a result of river flows and lake fluctuations.

Lake Mead Sites

The vegetation of the silt bars in the lower part of the Canyon has undergone a profound change in the past 15 or 20 years, and much of the change may be due to a single event, the flood of 1983. Prior to that time the silt bars, from talus slopes to lakeshore, were consistently a monoculture of dense exotic tamarisk. The flood of 1983 carried downstream a silt load of sediments coarser than any that had been deposited in many years, along with high water and fast current all the way to the Grand Wash Cliffs. The tremendous inflow caused a high lake level that flooded most of the canyon silt terraces from wall to wall. Along with these sediments and high water, branches and seeds of coyote willow, seep willow, and Goodding's willow may also have arrived in large quantities, debris from upstream beaches and riparian areas that were scoured out by the flood waters. When the floods receded and new silt bars emerged, the three native species were apparently ready to invade the habitat created, along with the old standby tamarisk. This may have signaled the most important change in lower Grand Canyon vegetation since the construction of Hoover Dam.

The three downstream quadrats at RM 254L showed the dynamic growth of native and exotic plant species typical of exposed Lake Mead silt terraces. GB1 was established in 1992 on a large patch of unvegetated coarse sand, which by 1994 was densely vegetated. Basal cover grew most dramatically between 1992 and 1993, as seedlings (dominated by coyote willow and tamarisk) sprouted throughout the quadrat. Basal cover then dropped between 1993 and 1994, as thinning occurred with numerous sapling coyote willow growing at the expense of other seedlings. GB2 was established in 1992 at approximately the same elevation as GB1, in a back beach area that supported a dense population of native and exotic seedlings. Basal cover in this quadrat dropped between 1992 and 1993, following the same thinning pattern as GB1. Basal cover then rose rapidly, and the percentage of exotic species fell, between 1993 and 1994 as native saplings grew. GB3 was established in 1992 on a back beach terrace approximately one meter higher in elevation than the terrace on which GB1 and GB2 were placed. This terrace was dominated by healthy sapling seep willow in 1992, with little understory. As lake levels dropped in 1993, the seep willow began to die. Tamarisk began to invade the plot in 1993, and by 1994 sapling tamarisk dominated the quadrat.

In all of the plots at RM 254R, tamarisk was present at all readings, including the upper plot that had dense seep willow in 1992. Tamarisk and seep willow may have germinated at the same time, but the faster-growing seep willow shaded out the tamarisk early on and the tamarisk remained as very slowly growing small plants. Or, tamarisk seeds might have arrived some time after the seep willow was established, perhaps the last time the bar was flooded. In either event, small tamarisk were already there when the seep willow became senescent or drought stressed and started to die out, then took advantage of the opportunity for rapid growth as seep willow died. The tamarisk has to germinate on wet sand persisting long enough for it to get a good root established, so its invasion and establishment must have occurred prior to the last time the terrace dried out.

The rapidity with which riparian species can invade newly exposed silt bars in the Lake Mead part of the study area was notable, and following the invasion, the competitive interaction of exotic tamarisk and native coyote willow, Goodding's willow, and seep willow and the rate at which they grow is truly remarkable. In most of the cases we noted, tamarisk was soon outstripped by natives in what was clearly no contest: coyote willow can grow two meters in three months, leaving tamarisk in its shade barely 10 cm high. However, the adaptive tamarisk survives as an understory, probably with a taproot disproportionately long in comparison to its stem, and as the stand of senescent or drought-stricken seep willow in the back beach at RM 254R showed, the tamarisk shoots are there ready for a spurt of growth when their overstory dies off.

Today, native species generally are dominant on outer portions of the silt terraces, while old tamarisk, probably pre-dating 1983, remains a dominant on inner portions of the terraces. The width of each zone varies from place to place, but on the widest terraces in the lower canyon the recently established natives occupy a thin ribbon along the lake shore compared with the wide expanse of old tamarisk. High banks erode back at low lake levels, and habitat along the shore is continuously lost, taking coyote willows and in places large Goodding's willows with it. An understory of small tamarisk is generally present in the willow thickets, perhaps ready for a surge of growth similar to that observed at the upper plot at RM 254R.

Fluvial Marshes

Opposing trends were noted at the two lower marshes, RM 241L and RM 249L. At RM 241L, erosion of the outer edge of the shore by wave action resulted in the loss of some of the outer bank, the creation of a steep, unstable slope dropping in to the river, and exposing of roots of tamarisk and other woody species. This site has lost both stability and some of its bank, especially between 1993 and 1994. This may be an example of a case where steady interim flows have resulted in erosion by steadily impacting on a particular level along the shoreline.

At RM 249L, the outer portion of the beach has seen a dramatic increase since 1992. When the study site was established, marsh vegetation was in a fairly narrow strip at this site, ending at a pronounced low but apparently stabilized bank at the base of which was a wide wet sand terrace at the shoreline. This apparently recently exposed habitat had a dense growth of seedlings, mainly of riparian species rather than marsh species. By 1994 the seedlings on this outer silt bar had grown rapidly, forming a thicket of riparian species, dominated by seep willow. Interim flows, stabilizing near-shore habitat by keeping it moist while reducing erosion and flooding, have allowed a dense riparian growth to develop at this site in an area that would have been much more subject to erosion and deposition, as well as alternate flooding and exposure, under more variable flow regimes. The marsh, which remains intact behind the new riparian zone, has not been adversely affected by bank stabilization; however, it probably receives less moisture from the river under interim flows than it did under other regimes, so it may ultimately senesce from reduced water availability. It should also be noted that this site is at the lower end of the transitional reach between river and lake, and an increase lake level would probably be as likely to flood the site as a larger variation in river levels.

Exotic Species

Frequently noted in the RS zone, as well as elsewhere such as in marshes, was Bermuda grass, a short-lived exotic perennial grass species. This species spreads rapidly by horizontal prostrate stems which root at the nodes, sending up digitate inflorescences during warm seasons. it is a very difficult species to measure using basal area; investigators were taught to take a handful of stems, measure the diameter, and extrapolate to the entire subplot. This is a difficult maneuver for the most experienced technician, and consistency from person to person, site to site, and year to year is very difficult to attain. The same sampling technique was used with all perennial grasses; it is more accurate with bunch grass species. Basal area figures for grasses, especially Bermuda grass, must be considered as indicative only of the most general trends, and differences should not be interpreted with much conciseness. A better method of quantifying such species, such as measuring cover, should be implemented at future readings.

The rise in exotic species in silt terrace transects was due almost entirely to large increases in basal area of tamarisk measured in some zones. It is unlikely that this was due to a growth spurt by tamarisk; most of the individuals were found in the back portion of the wide silt bars, away from the lake and in areas that have not been flooded or subject to the effects of the lake for some years. The tamarisk thickets in these areas are generally dense, mature, and slow to change. Using the sampling method used for these transects, random sampling of ten 1-sq-m plots in each terrace zone, the same place was not necessarily measured each year. It is likely that while a plot size of 1-sq-m is sufficient for herbaceous species and woody seedlings, a considerably larger plot or many more than ten sampling points per zone would have been more appropriate for the trees found in most of the zones along the silt terrace transects. Thus the methodology used for these transects probably resulted in sampling inaccuracies in a mature vegetation type which changes very slowly, especially at the back of silt terraces where rainfall is the primary source of moisture.

Recommendations

An understanding of the dynamics of flooding, erosion, deposition and rapid regrowth in lower Grand Canyon will be essential for Lake Mead and Grand Canyon managers, since management actions can have a large impact on vegetation communities in this area. The establishment patterns of native and exotic species are still not well understood, but varying river flows and lake levels could affect whether native species dominate newly exposed silt bars.

Large-scale vegetation trends in both river and lake-influenced areas can best be measured by mapping riparian areas with the use of aerial photos and GIS. As areas are electronically surveyed, they can be precisely compared year to year to determine changes in area and species composition. Vegetation parameters can be sampled by hand to verify mapping and to add other information such as vegetation volume.

Avian Studies

The estimated density of nesting birds at most study sites was generally comparable to southwestern riparian habitats exhibiting similar vegetative composition and structure. The 388 pairs/40 ha (ca. 776 individuals/40 ha) estimated by Szaro and Jakle (1982) in tamarisk habitat along the Gila River drainage of southern Arizona was generally equivalent to estimated densities at most tamarisk-dominated sites in this study (Parashant Canyon, Above Spencer Canyon, Quartermaster Canyon, and Waterfall Rapids). In contrast, estimated density at Spencer Canyon, where tamarisk was co-dominant with mature, native willows and other native vegetation, was extremely high (1,764 and 1,840 individuals/40 ha in 1993 and 1994, respectively). This was comparable to the highest densities ever reported for non-colonial nesting birds, such as the 847 pairs/40 ha (ca. 1,694 individuals/40 ha) estimated in riparian cottonwood forests along the Verde River of central Arizona (Carothers et al. 1974). The lowest estimates of bird density in the study area (National Canyon and Granite Park) were at sites exhibiting primarily low-density, open mesquite and acacia.

Bird density estimates from this study were compared to those reported in the 1980s (Brown and Johnson 1987, Brown 1987a, Brown 1988, Brown 1989) at the three study sites upriver of Diamond Creek (Table 10). Direct comparison of 1980s findings to those of the present study were not possible due to changes in site size, differences in vegetation structure, and different proportions of each site composed of NHWZ and OHWZ habitat from the 1980s to the present, but generalized comparisons can be made. Density estimates from the National Canyon site from 1993-94 were within the range of density estimates made during the 1980s in spite of changes in site size, but estimated density at Parashant Canyon and Granite Park from 1993-1994 were generally less than that reported in the 1980s. The reason for the apparent decrease in estimated density at the two latter sites is unknown. However, the apparent decrease at the Parashant Canyon site is likely related to the loss through erosion of well-developed NHWZ habitat at the water's edge since the 1980s and the 1993-94 inclusion of a large patch of poorly-developed NHWZ habitat that had developed since the 1980s. The apparent decrease at the Granite Park site is likely related to the inclusion of a large patch of poorly-developed NHWZ habitat that had developed since the 1980s.

Species Richness

Species richness at the Parashant Canyon and Granite Park sites from 1993-94 was within the range estimated for those sites in the 1980s, but richness at the National Canyon site from 1993-94 was much greater than that estimated during the 1980s. The reason for this apparent increase in richness is unknown. Taking all three study sites upriver of Diamond Creek together, 22 species known or suspected to nest were found from 1984-1987; 21 were found from 1993-94. The only species found from 1993-94 but not in the 1980s were Gambel's Quail and Song Sparrow at the Parashant site. The local distribution of quail in the study area is patchy and occurrence is sporadic, so the appearance of potentially-nesting quail at the Parashant site is not surprising. However, the detection of a singing male Song Sparrow at the Parashant site does suggest the possibility that this species has begun to colonize the river corridor upstream of Diamond Creek, where it was absent in the 1980s. Species found in the 1980s but apparently absent from 1993-94 included Crissal Thrasher, Lazuli Bunting, and Hooded Oriole. These three species were rare to uncommon in the study area and were not always found at each study site each year in the 1980s; Crissal Thrasher was only found in one of four survey years. Therefore, their apparent absence from 1993-94 probably did not represent any real change in the breeding bird community, but most likely represented sample error or random fluctuations in local patterns of site-occupancy.

Table 10. Comparison of site size, species richness, and estimated bird density at three study sites upriver of Diamond Creek surveyed for nesting birds in the 1980s and 1990s (Brown 1987a, Brown 1988, Brown 1989).

Study site	Size of study site (ha)		Estimated bird density (individuals/40 ha)			Species richness (number of species)		
	1993-94	1984-87	1993	1994	1984-87	1993	1994	1984-87
National Canyon	4.6	2.6	217	322	215-492	8	12	4-5
Parashant Canyon	3.0	1.9	800	983	1010-2084	14	19	12-19
Granite Park	11.6	6.6	220	283	272-752	14	17	11-16

Marsh Wren, a regularly-nesting species in the adjacent Lake Mead National Recreation Area (Blake 1978), was only detected downriver of Diamond Creek in riparian vegetation developing on the silt banks of Upper Lake Mead. Song Sparrow was detected only once upriver of Diamond Creek, but it was common downriver of Diamond Creek where it has rapidly colonized new habitat created by dropping levels of Lake Mead and has increased in numbers to become one of the two most abundant riparian-nesting species (the other being Bell's Vireo; see Appendix II). Riparian habitat upriver of Diamond Creek appeared suitable for nesting by both species, but the lower Granite Gorge from RM 217 to the head of Lake Mead (approximately Separation

Canyon, RM 240), an area largely devoid of riparian vegetation, may present a barrier to upstream colonization by these two species.

Timing of Survey Work

Bird density at all three study sites upstream from Diamond Creek was probably underestimated in 1993 due to the timing of survey work. Each study site upstream from Diamond Creek was surveyed four times during a single field trip from May 1-7, which was late in the season to survey some species and early in the season for others. Song frequency, detectability, and perhaps even the abundance of common species such as Lucy's Warbler, Lesser Goldfinch, and Costa's Hummingbird apparently had declined by early May. Likewise, the song frequency, detectability, and perhaps even the abundance of late arrival species such as Yellow-breasted Chat, Blue Grosbeak, and Brown-headed Cowbird were likely lower than they would have been later in the season. Two bird survey trips upriver of Diamond Creek were conducted in the 1994 nesting season to obtain more accurate bird density information. Regardless of the timing of future survey work, bird densities will likely continue to be underestimated because of the difficulty of accurately determining the true density of species that do not maintain type-A territories such as Black-chinned Hummingbird (Brown 1992).

The duration of the study periods for both years, which ended before mid-June, may have prevented the detection of Yellow-billed Cuckoos. The peak of spring migration through Arizona for cuckoos appears to be mid-June, and the species probably does not begin nesting until late June. No cuckoos were detected in the study area during the study period, but several cuckoo sightings were reported from the study area in mid-summer 1992 (Timothy Tibbitts, U.S. Fish and Wildlife Service, pers. comm.).

Effects of Interim Flows

The overall trend showed by these studies was of stability; bird densities as well as study site size and composition did not change significantly between the two study years. Two trends affecting the quality and size of study sites were noted by researchers: 1) channel margin deposits created during the 1983-84 floods had eroded significantly by 1992; and 2) where channel margin deposits were not eroded, vegetation growth was generally rapid and provided high-quality bird habitat. Erosion of channel margin deposits was especially notable at Parashant Canyon (Site 2), where the study site was estimated to have shrunk by over 20% between 1985 and 1994. Erosion may have occurred at other sites, but could not be measured. It is unknown whether interim flows caused the erosion of channel margin deposits, or whether the erosion occurred prior to 1991.

Recommendations

Based upon mapping of vegetation between Separation Canyon and the Grand Wash Cliffs, and the densities of birds at study sites, the over 1,200 ha of dense riparian vegetation in lower Grand

Canyon may support between 12,000 and 19,000 individual breeding birds. The potential for flooding of areas influenced by Lake Mead, with a subsequent loss of huge numbers of breeding birds, require that management options for lake-influenced areas be carefully weighed. The presence of special-interest species in lower Grand Canyon, including Bell's Vireo, Peregrine Falcon and potentially Southwest Willow Flycatcher, and the fragility of this habitat, make continued study of avian populations in this area a critical element of any ongoing management program.

Mammal and Reptile Studies

Mammal and reptile studies for this project represent baseline data for the area from Diamond Creek to the Grand Wash Cliffs. Survey results confirmed those of other researchers, indicating diverse, dynamic communities of small mammals and reptiles that use but may not be dependent upon riparian vegetation. Because these communities respond to many environmental influences not directly associated with river flows, it would be difficult to measure interim flow effects on these populations with any but the most elaborate and intensive study. We recommend that if mammal and reptile studies are continued, they focus upon determining the amount and type of use of riparian areas.

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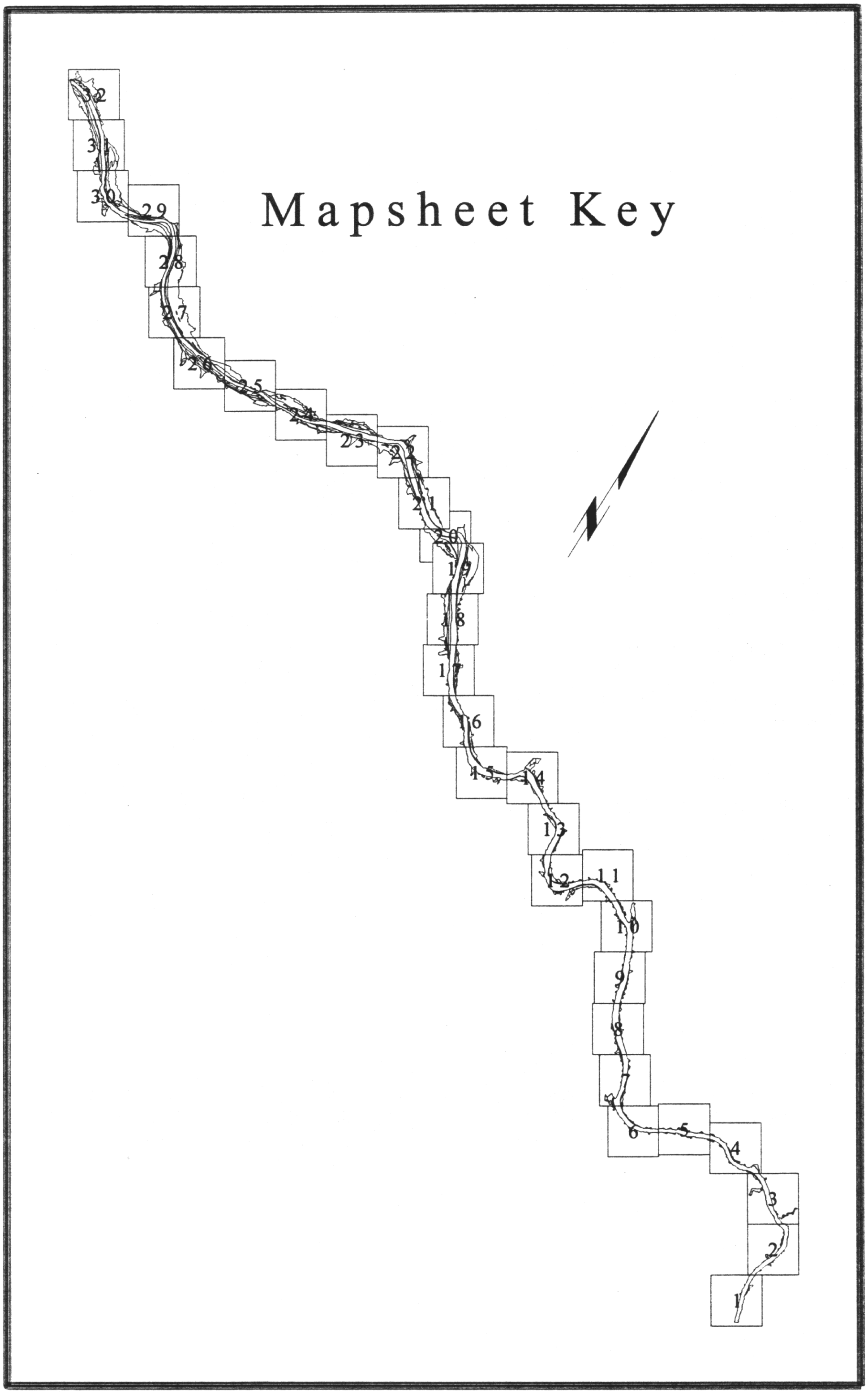
APPENDIX A. VEGETATION MAPS
SPENCER CANYON TO THE GRAND WASH CLIFFS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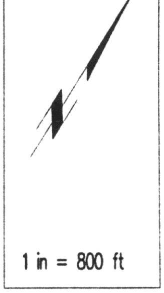
Vegetation Map

Sheet 1 of 32

Lush Tamarisk & Arrowweed



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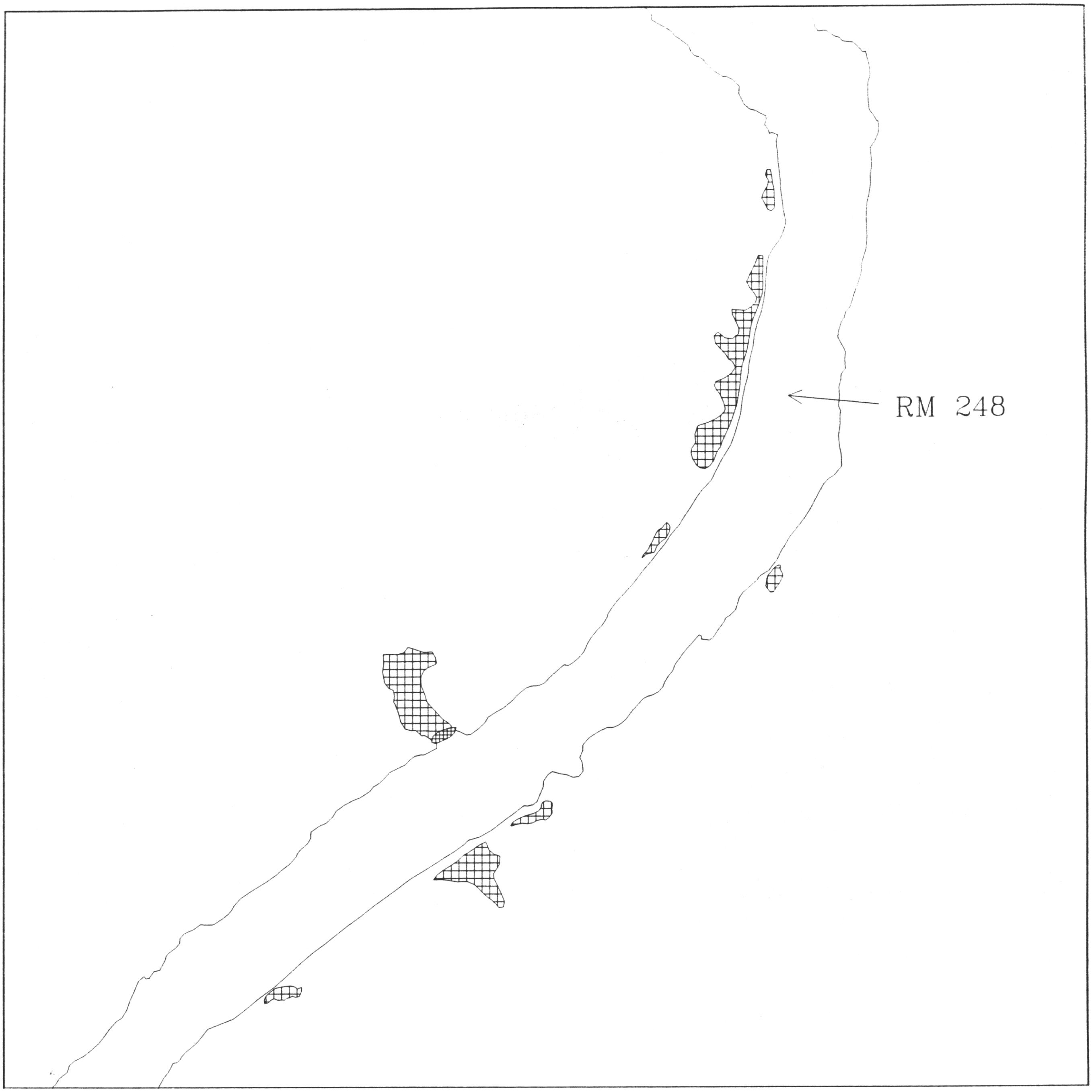
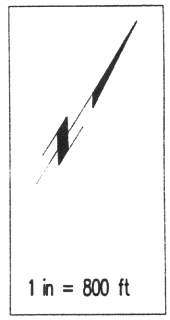


Vegetation Map

Sheet 2 of 32

Lush Tamarisk & Arrowweed

Sparse Grasslands



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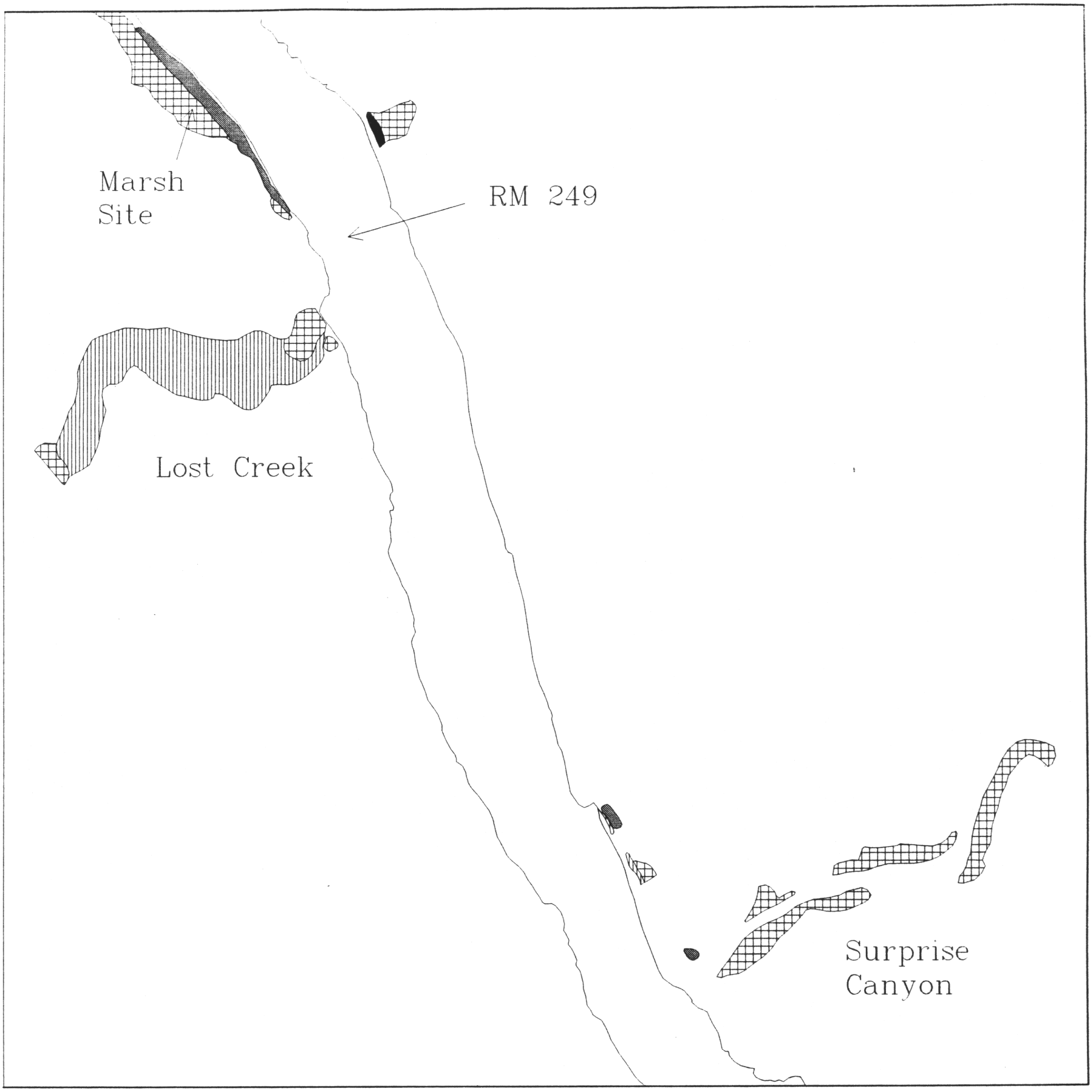
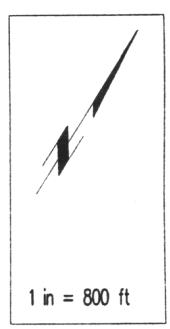


Vegetation Map

Sheet 3 of 32

- Wet Marsh
- Dry Marsh
- Arrowweed
- Lush Tamarisk & Arrowweed



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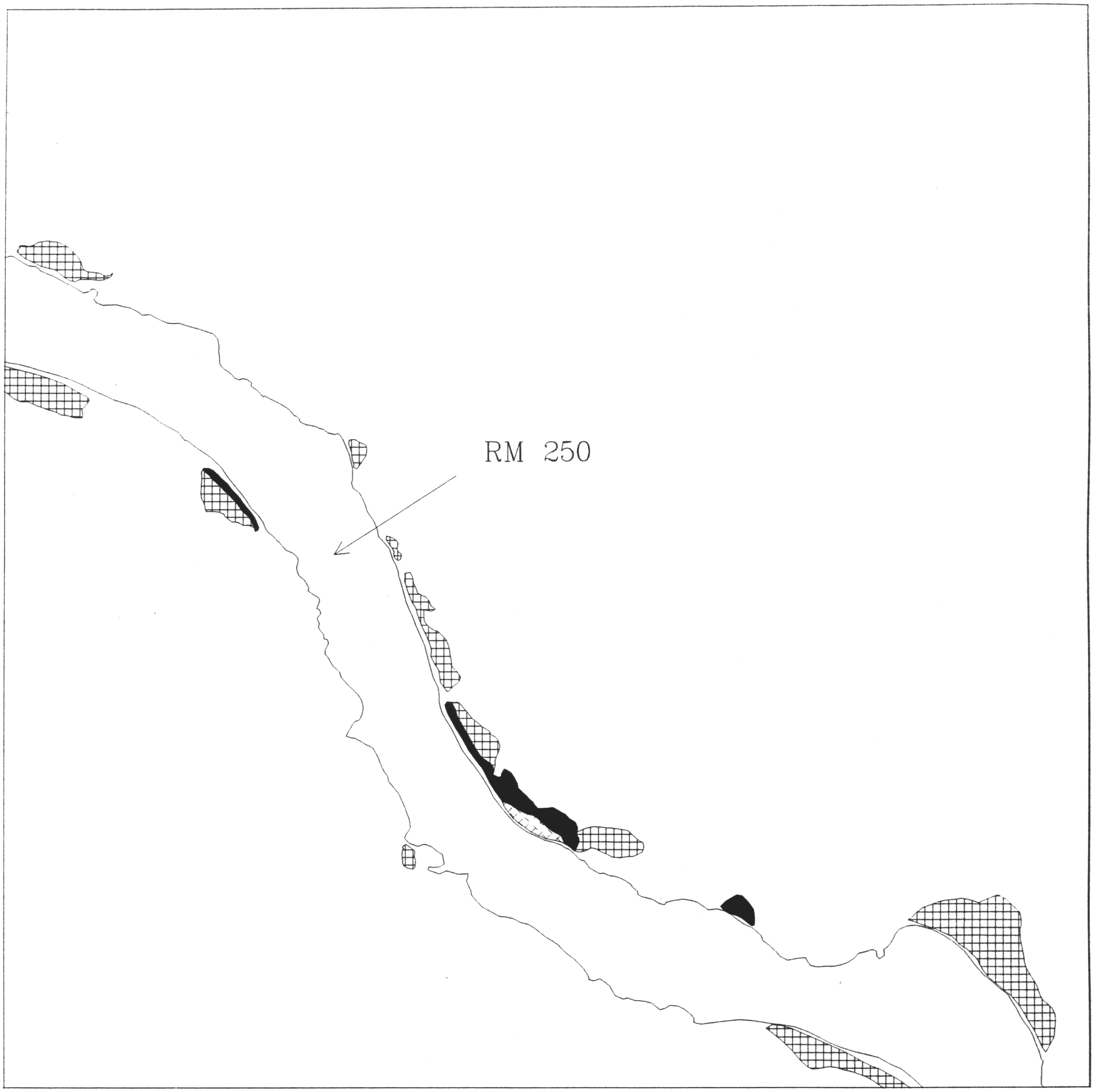
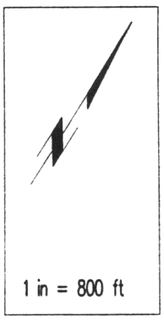


Vegetation Map

Sheet 4 of 32

Goodding's Willow
Arrowweed
Lush Tamarisk & Arrowweed
Seep Willow



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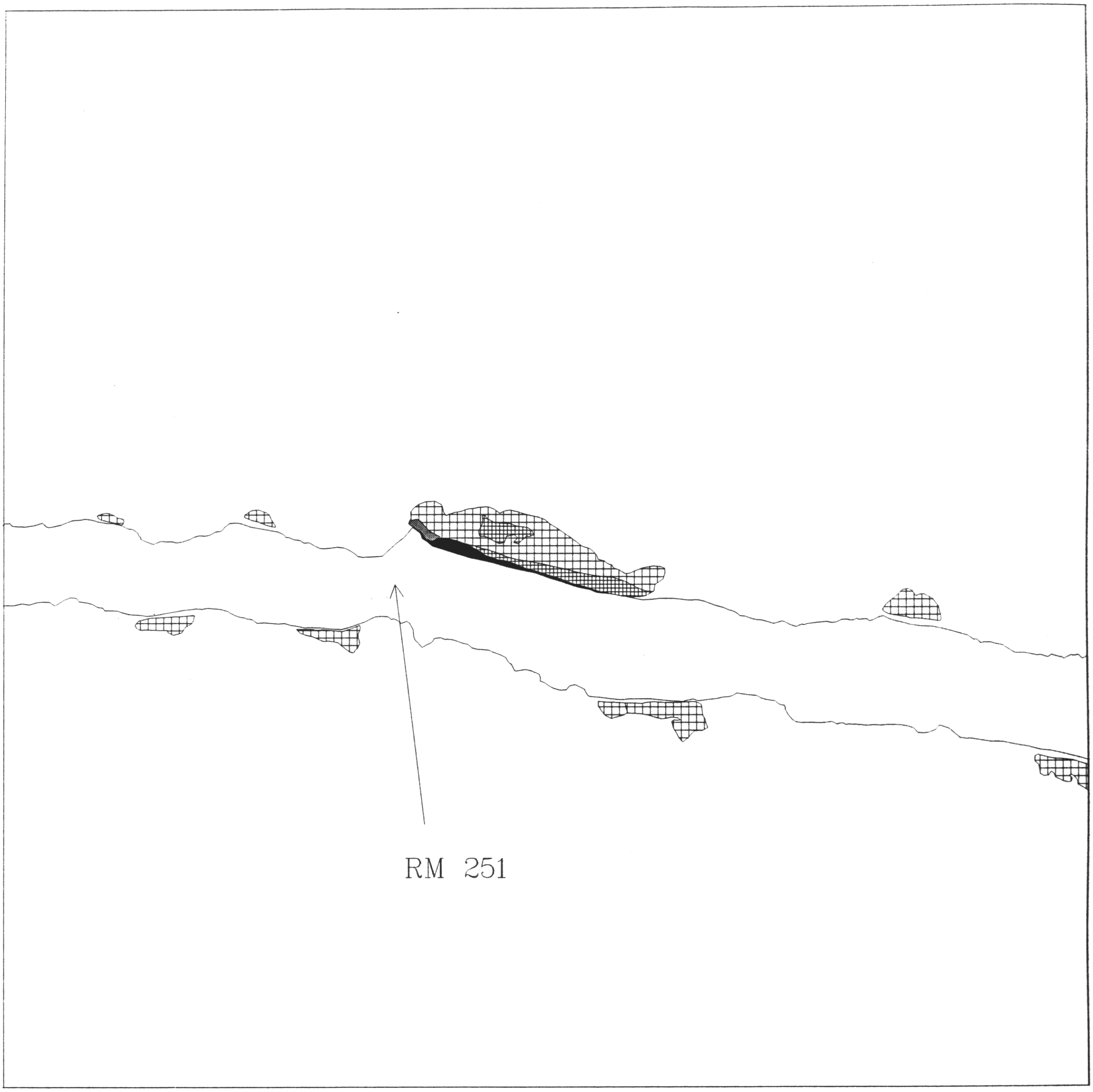
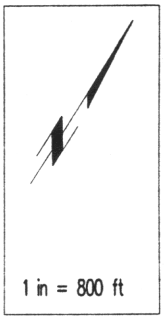


Vegetation Map

Sheet 5 of 32

Dry Marsh
Arrowweed
Lush Tamarisk & Arrowweed
Sparse Grasslands



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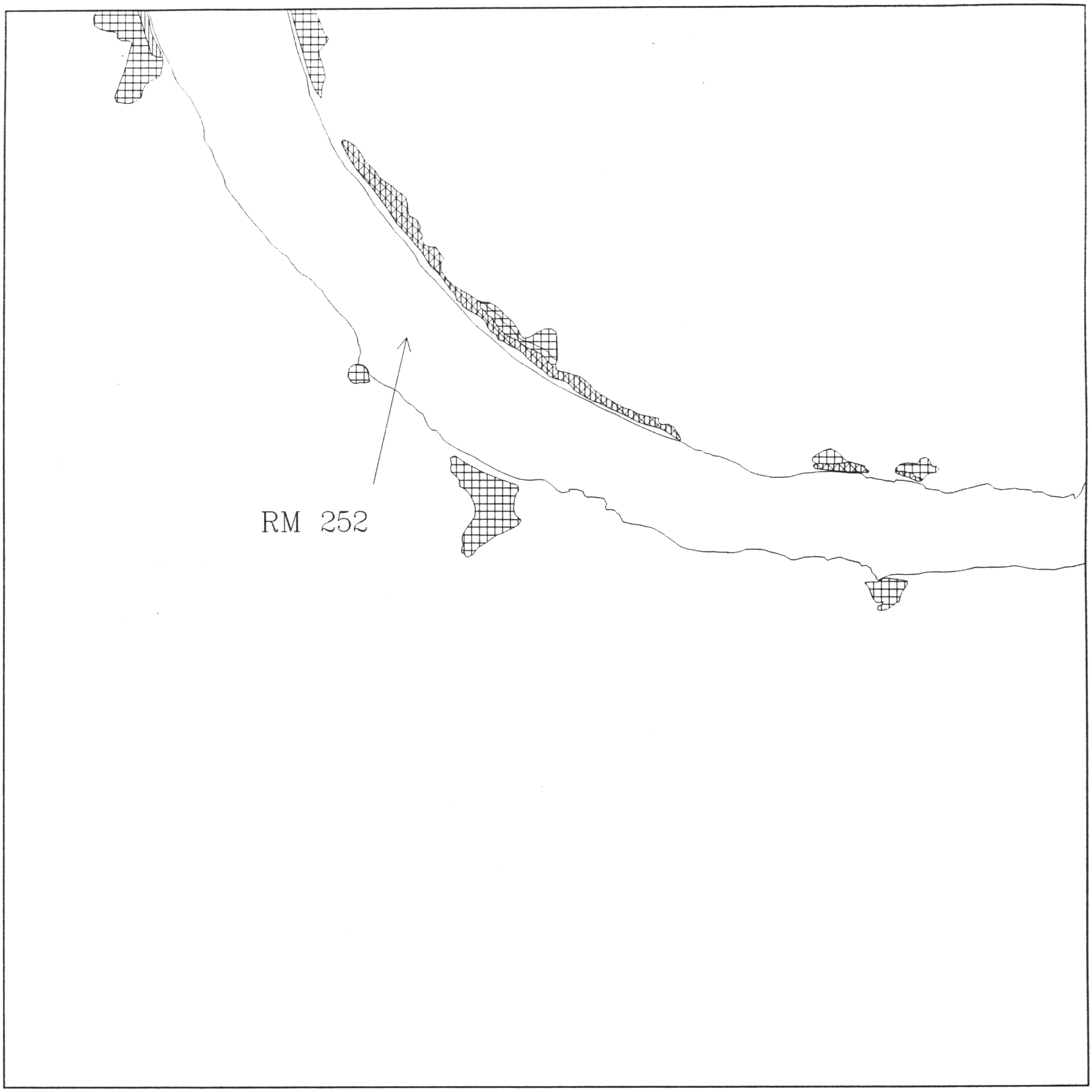
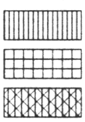
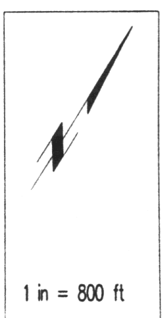


Vegetation Map

Sheet 6 of 32





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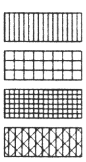
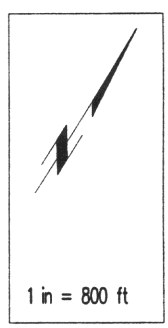
Vegetation Map

Sheet 7 of 32





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Vegetation Map

Sheet 8 of 32

Lush Tamarisk & Arrowweed
Coyote Willow

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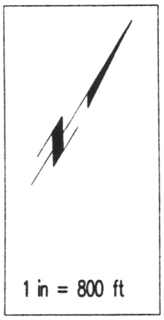
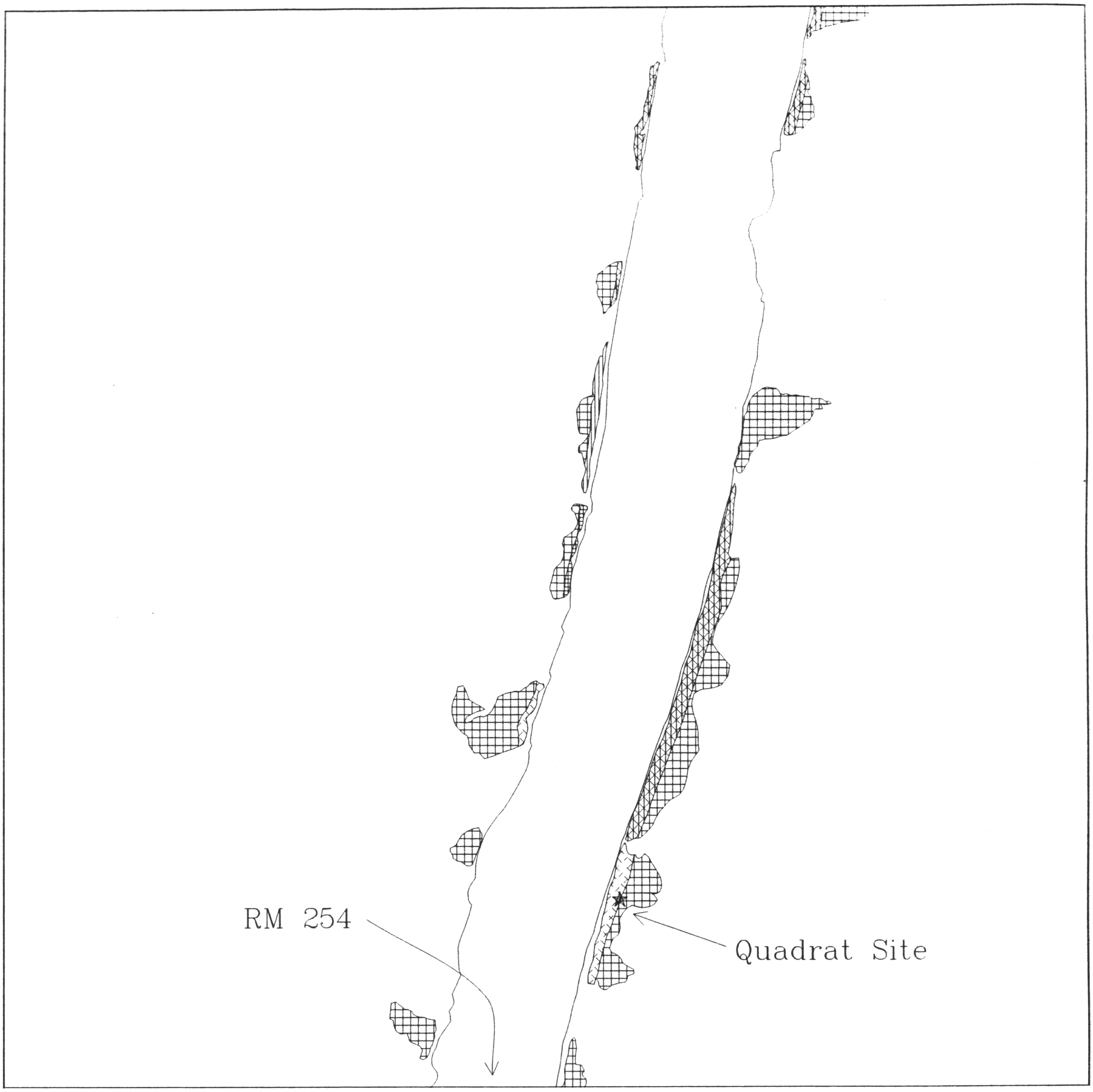
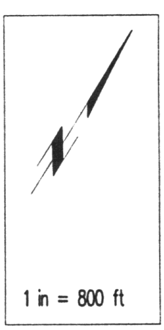




Vegetation Map

Sheet 9 of 32



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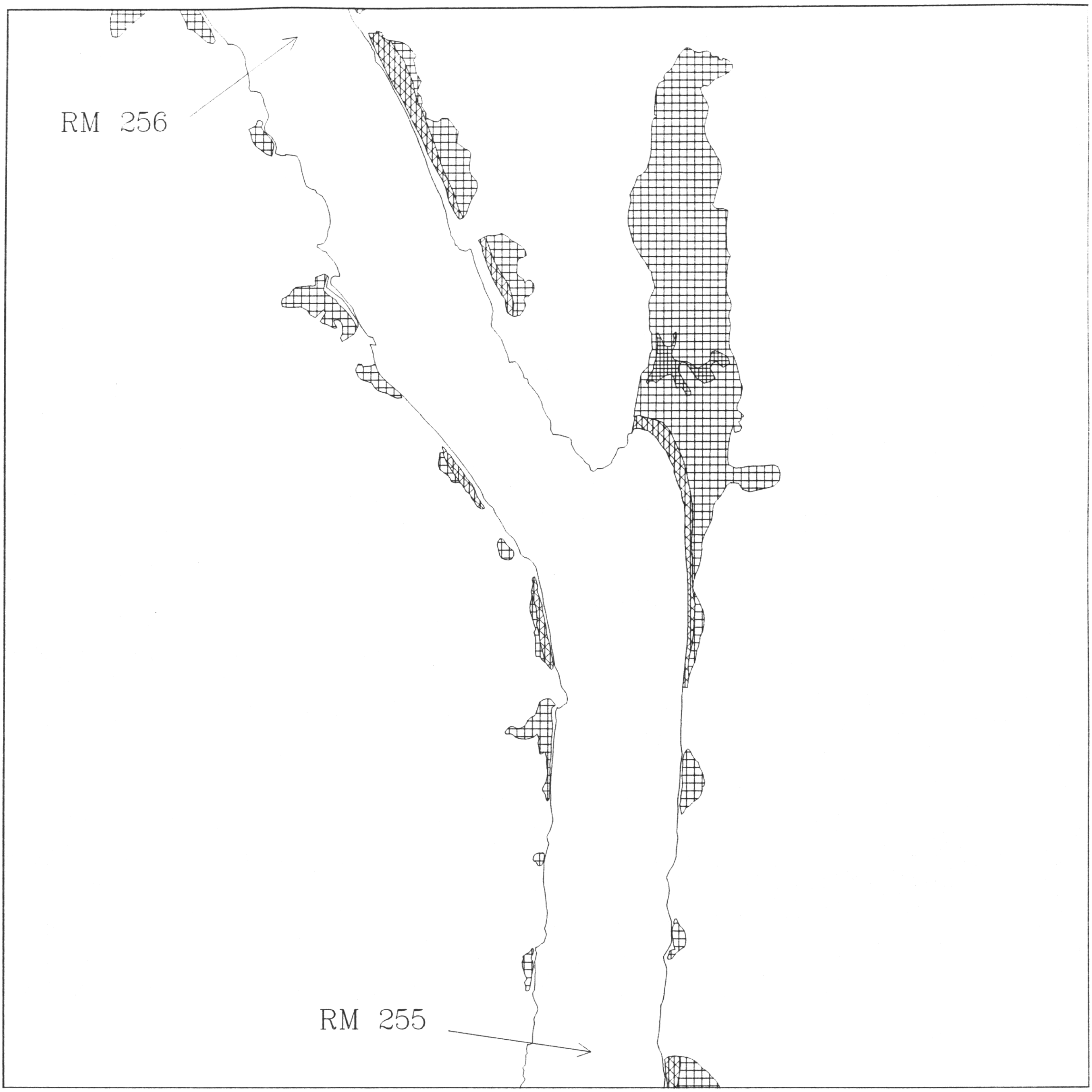
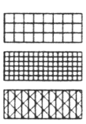
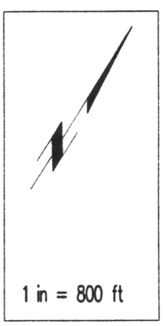


Vegetation Map

Sheet 10 of 32





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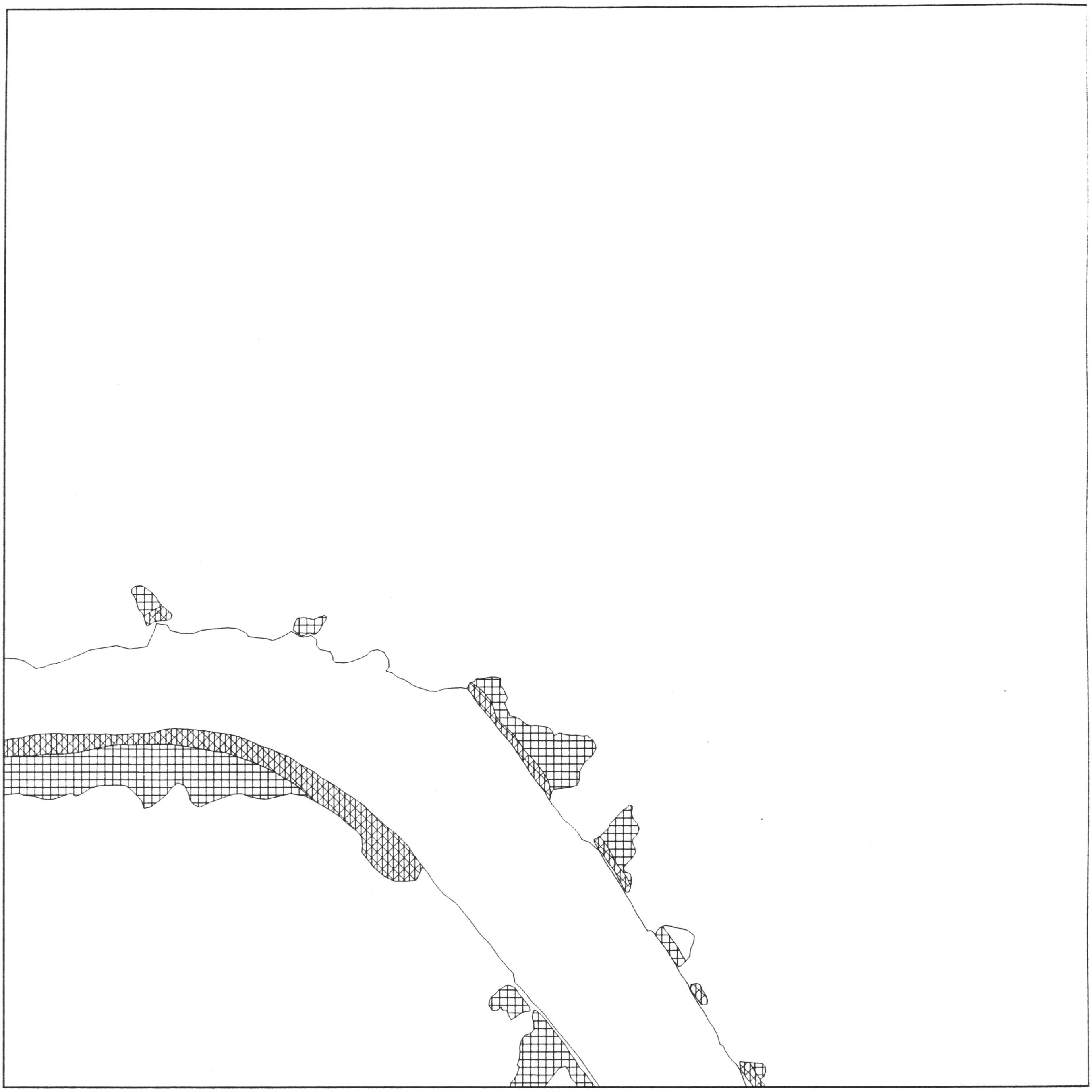
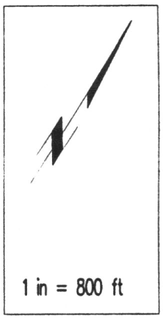


Vegetation Map

Sheet 11 of 32



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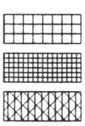
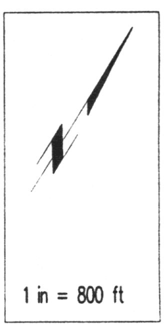
Vegetation Map

Sheet 12 of 32





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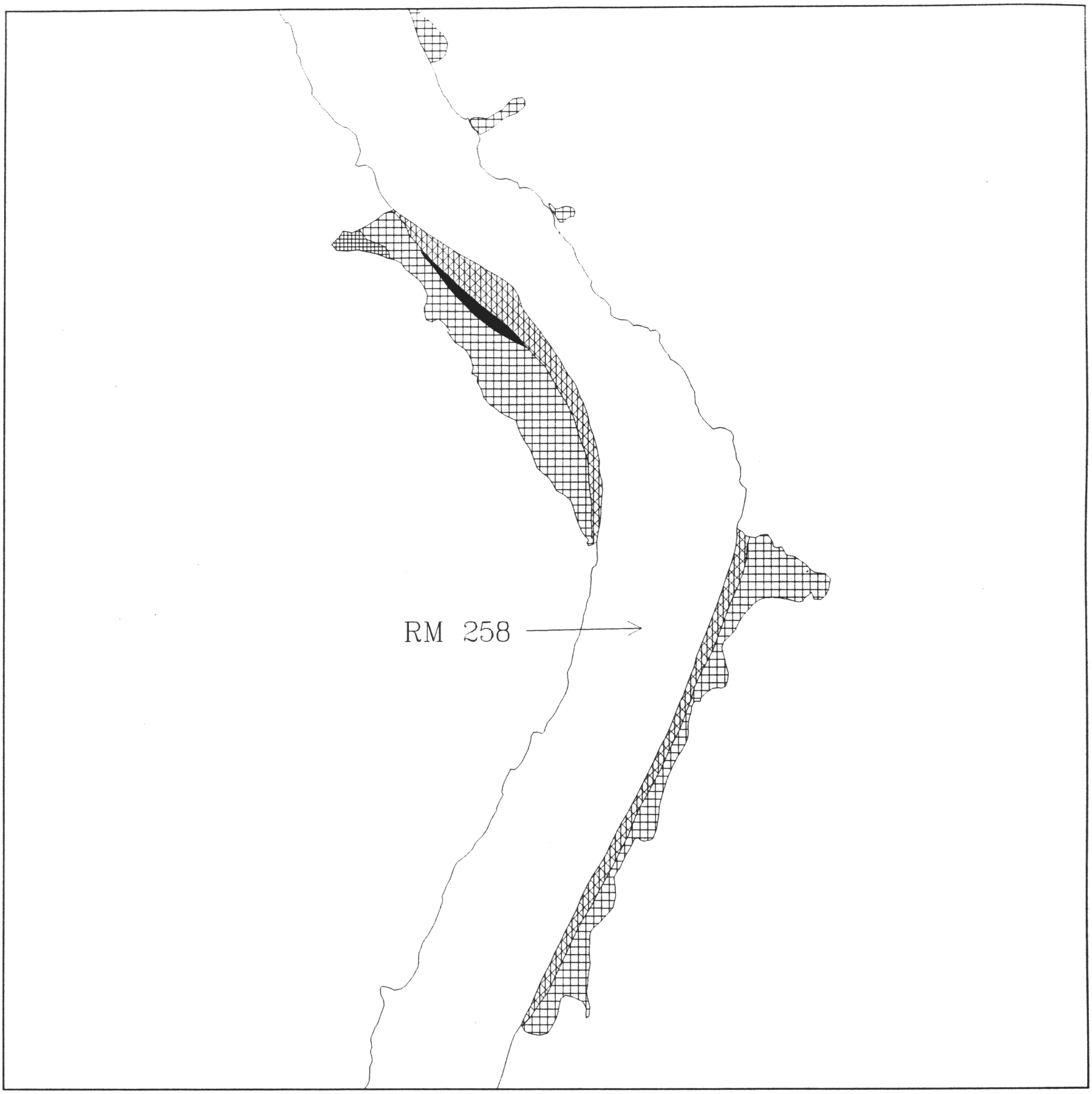
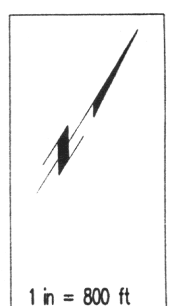


Vegetation Map

Sheet 13 of 32

Goodding's Willow
Lush Tamarisk & Arrowweed
Sparse Grasslands
Coyote Willow



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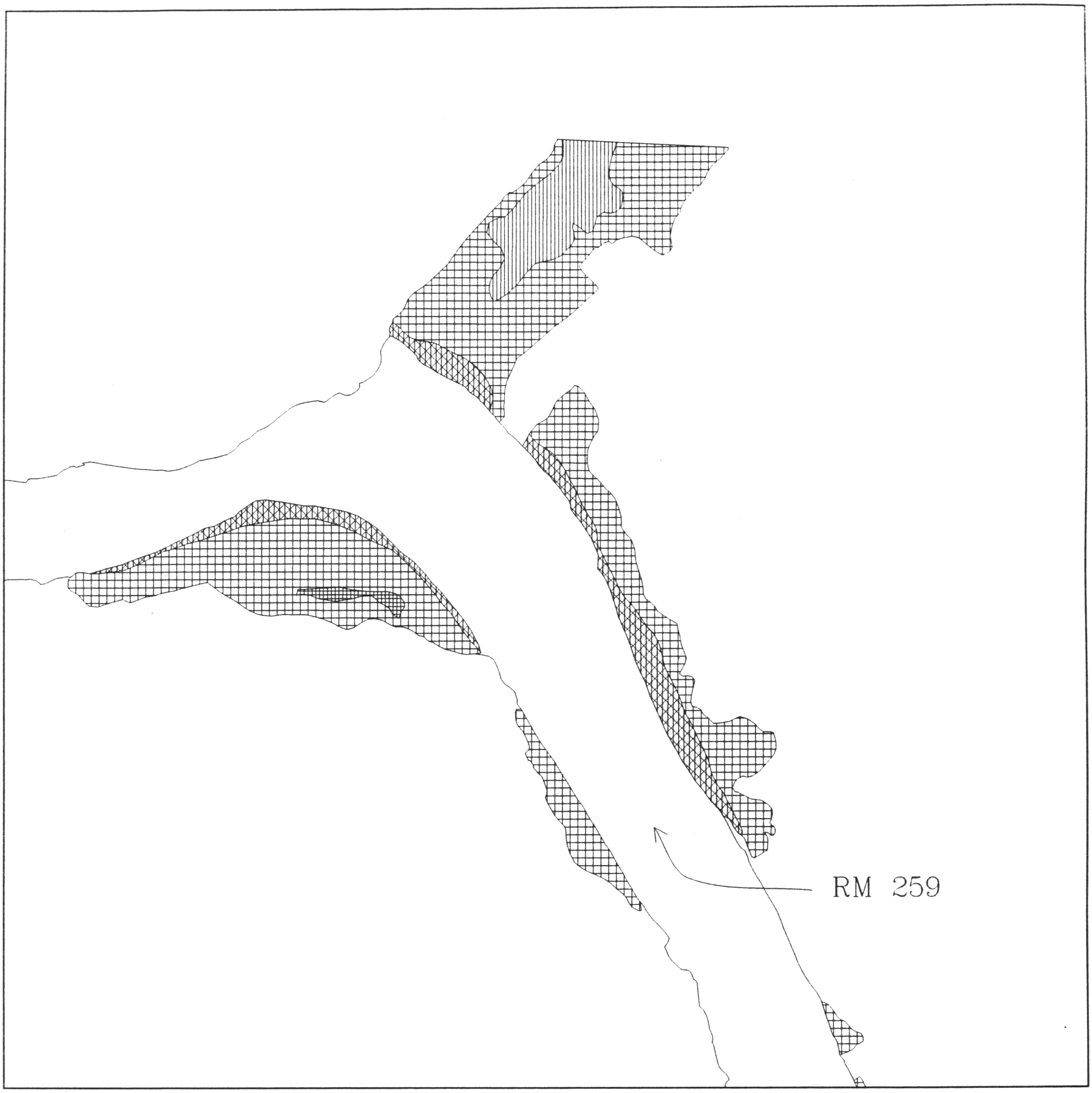

Vegetation Map

Sheet 14 of 32

- Wet Marsh
- Lush Tamarisk & Arrowweed
- Sparse Grasslands
- Coyote Willow

1 in = 800 ft

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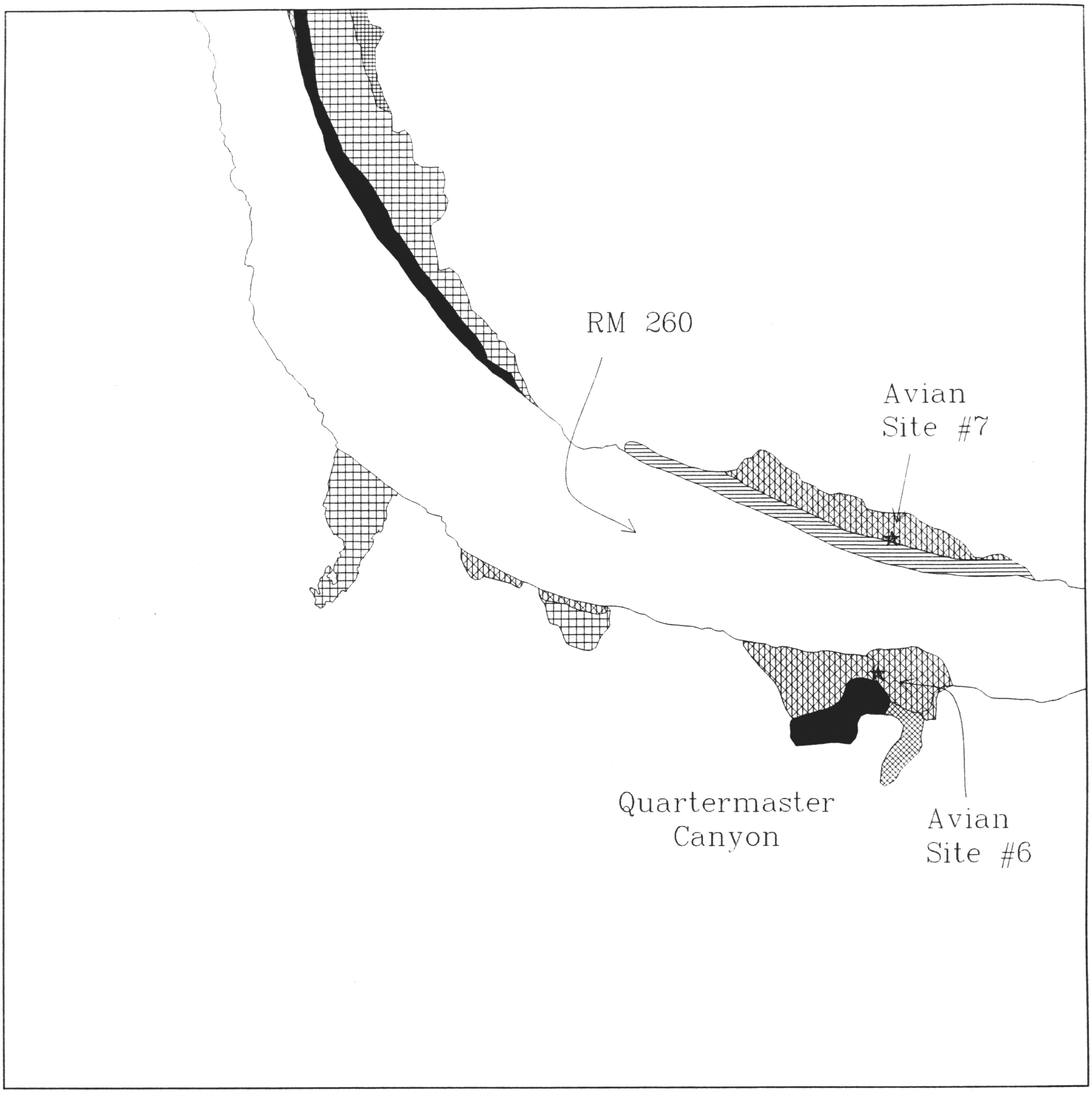
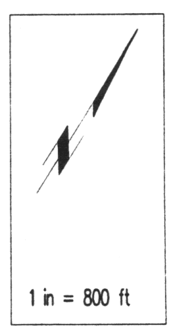


Vegetation Map

Sheet 15 of 32

- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Mature Tamarisk (>4M height)
- Sparse Grasslands
- Coyote Willow
- Acacia



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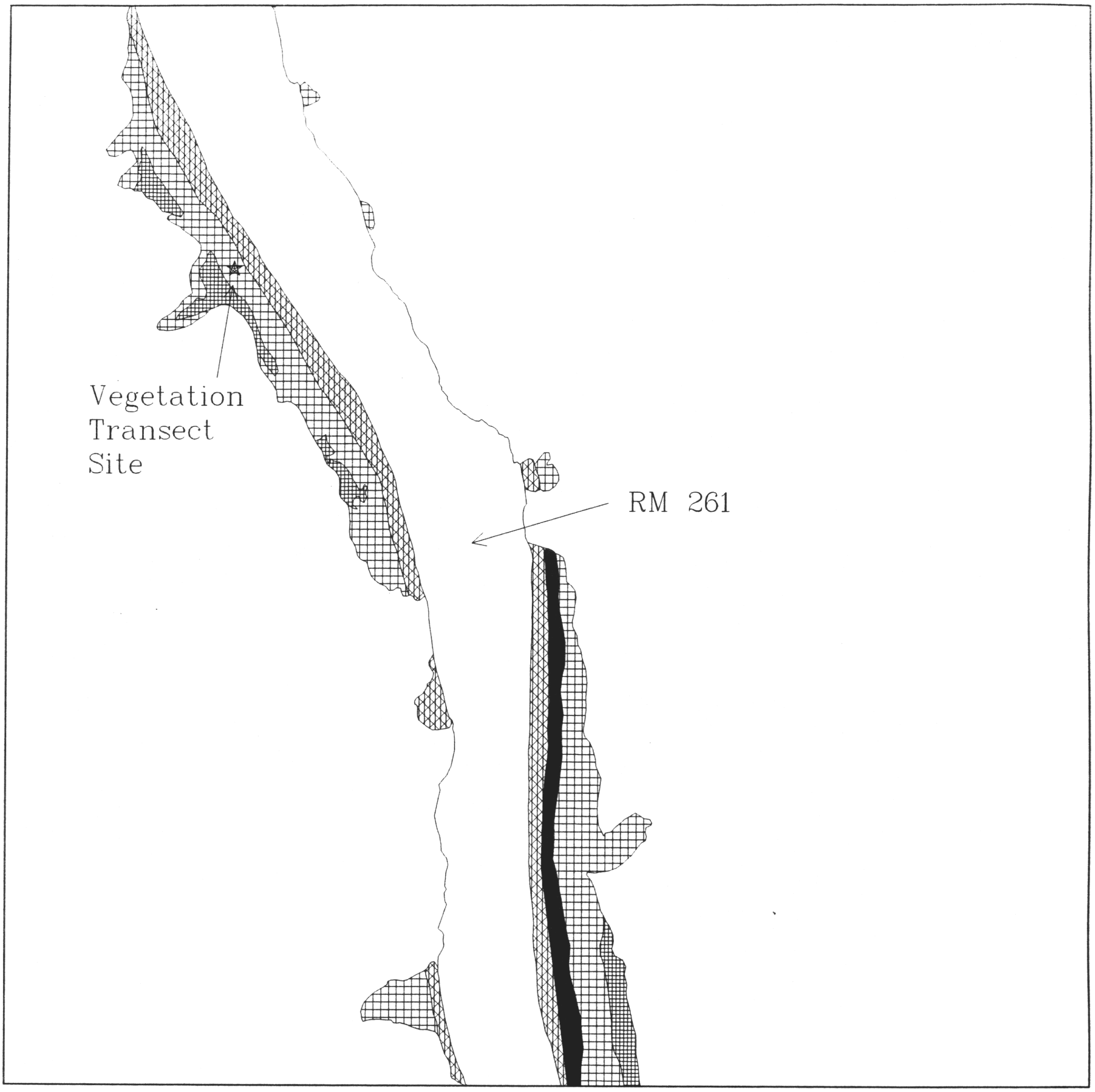
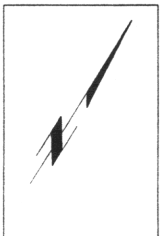


Vegetation Map

Sheet 16 of 32

Goodding's Willow
Lush Tamarisk & Arrowweed
Sparse Grasslands
Coyote Willow



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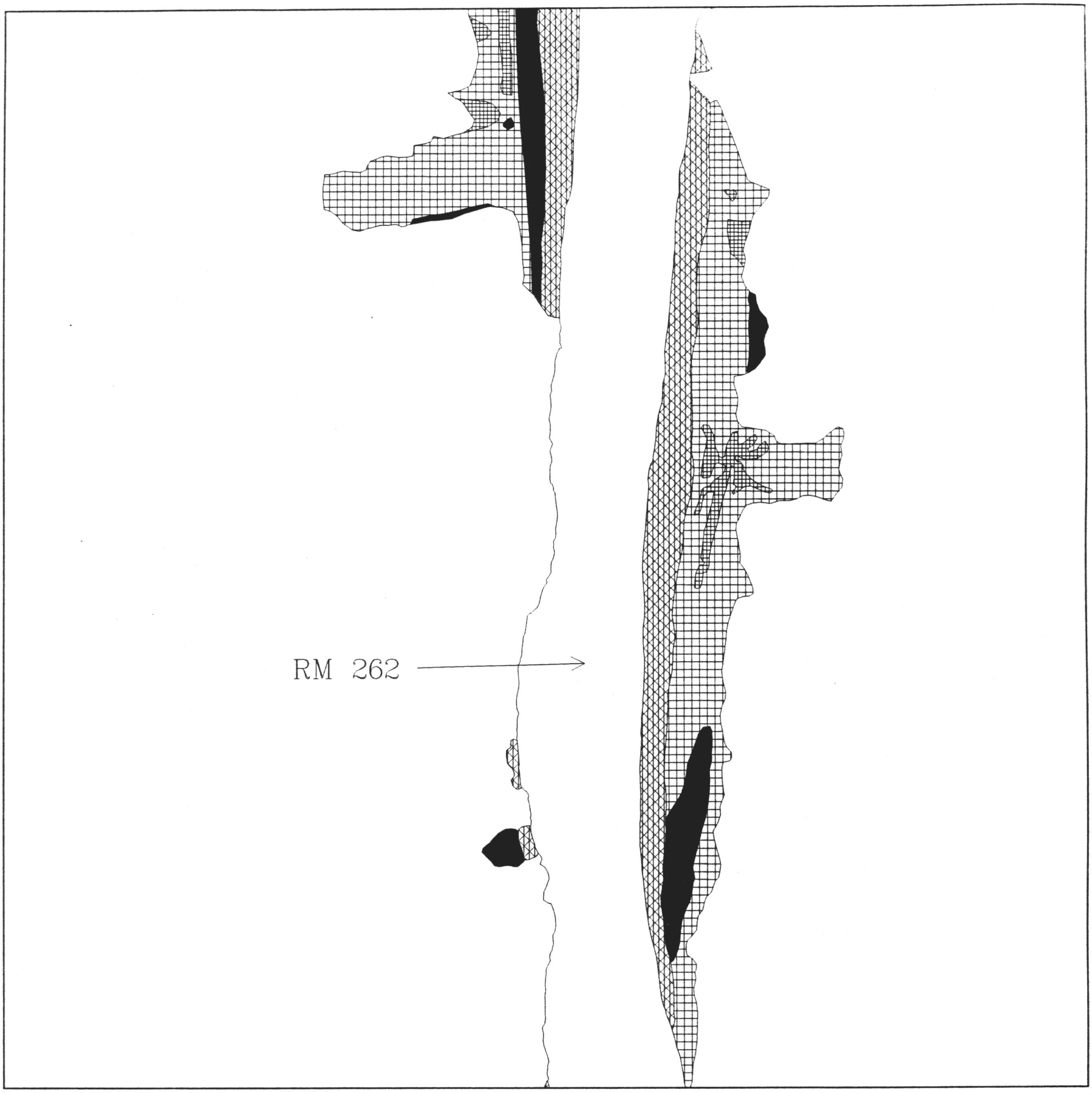
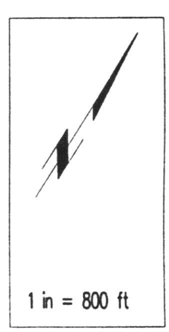


Vegetation Map

Sheet 17 of 32

- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Sparse Grasslands
- Coyote Willow



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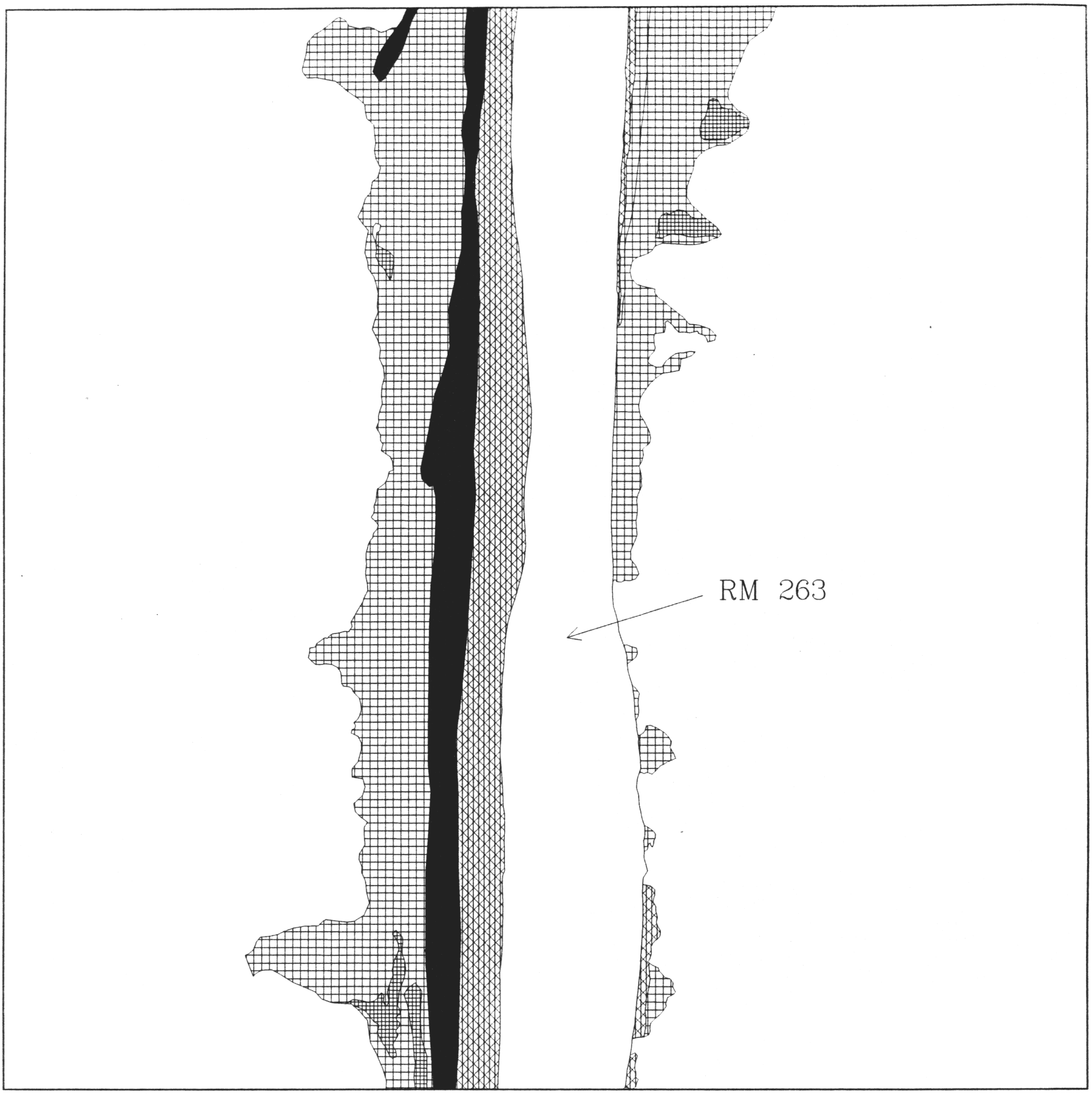
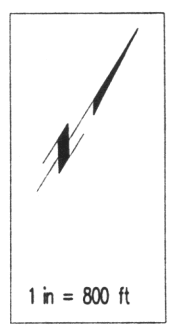


Vegetation Map

Sheet 18 of 32

Goodding's Willow
Lush Tamarisk & Arrowweed
Sparse Grasslands
Coyote Willow



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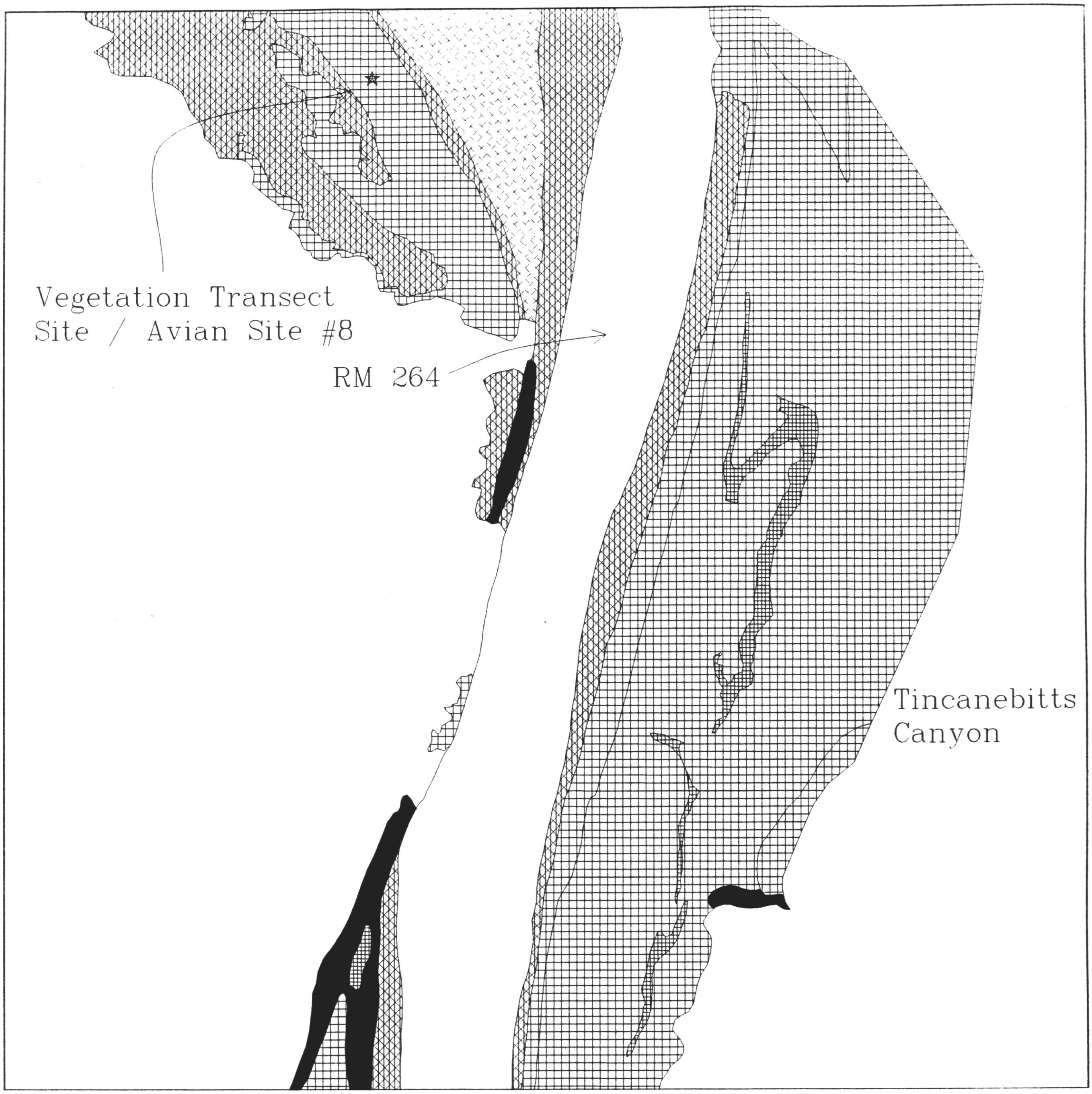
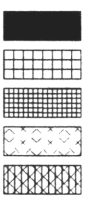
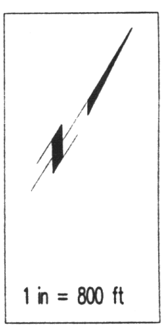


Vegetation Map

Sheet 19 of 32





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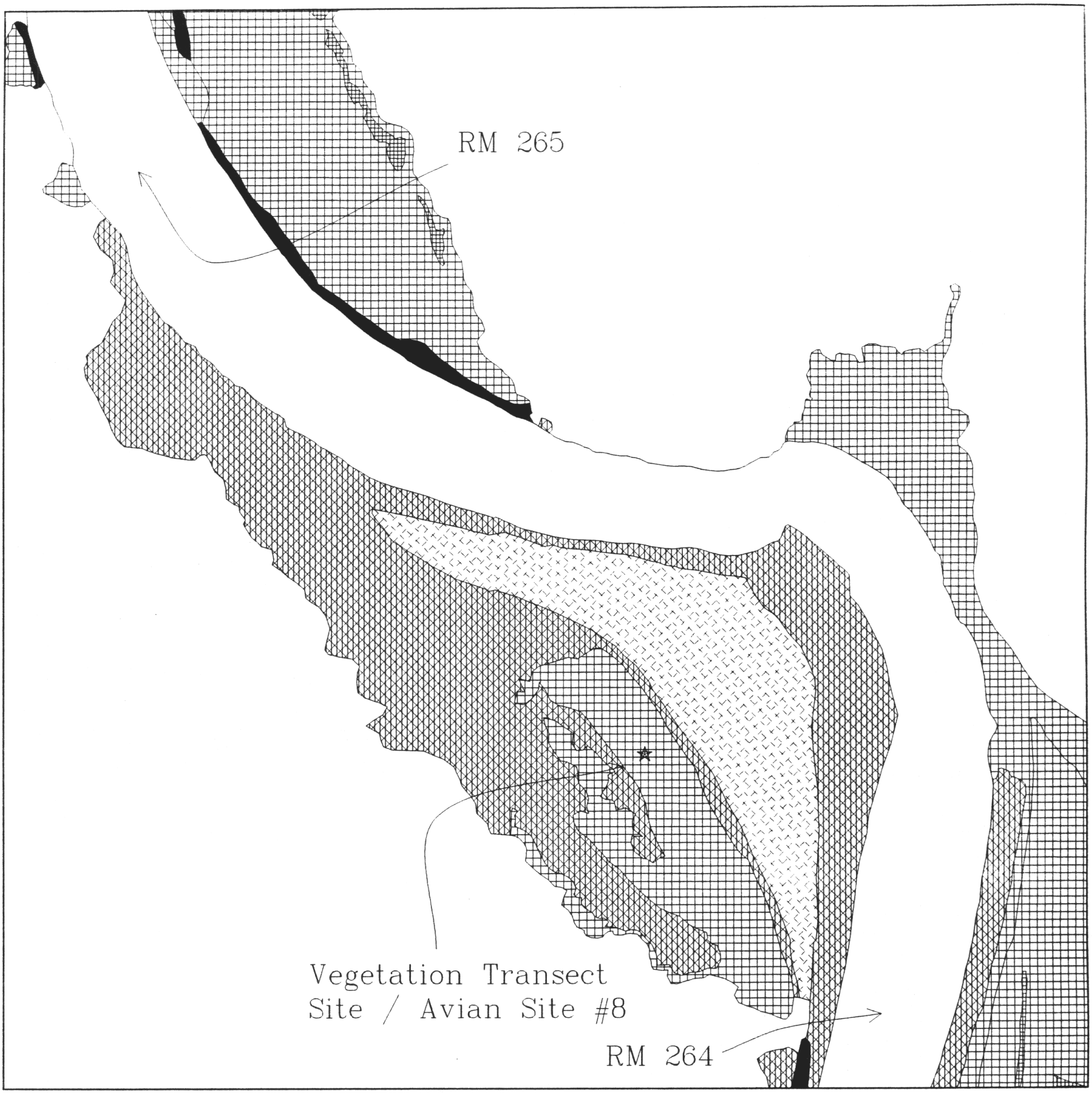


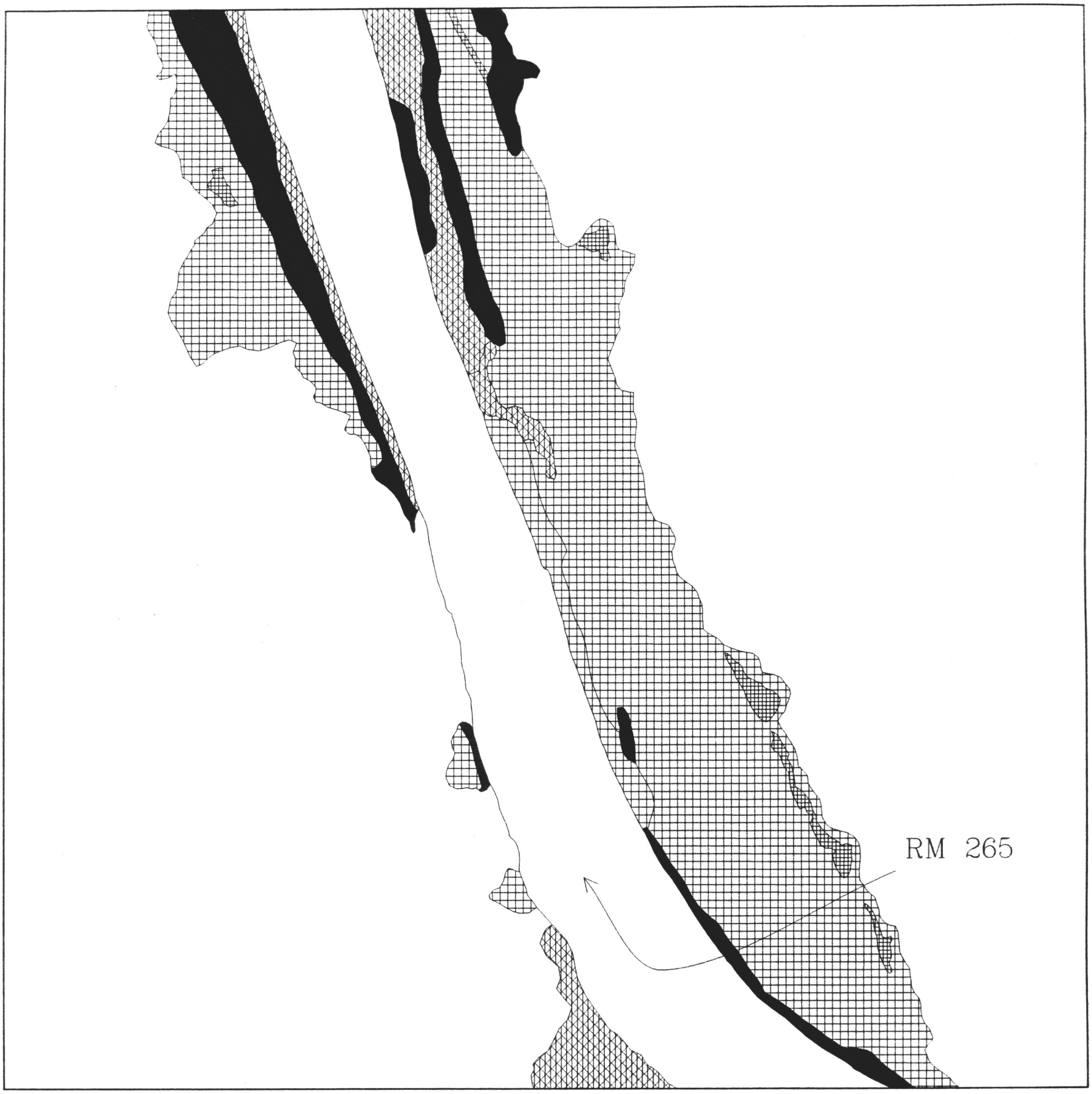
Vegetation Map

Sheet 20 of 32

- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Sparse Grasslands
- Seep Willow
- Coyote Willow

02/09/95

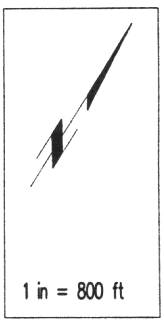
1 in = 800 ft



Vegetation Map

Sheet 21 of 32

- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Sparse Grasslands
- Coyote Willow



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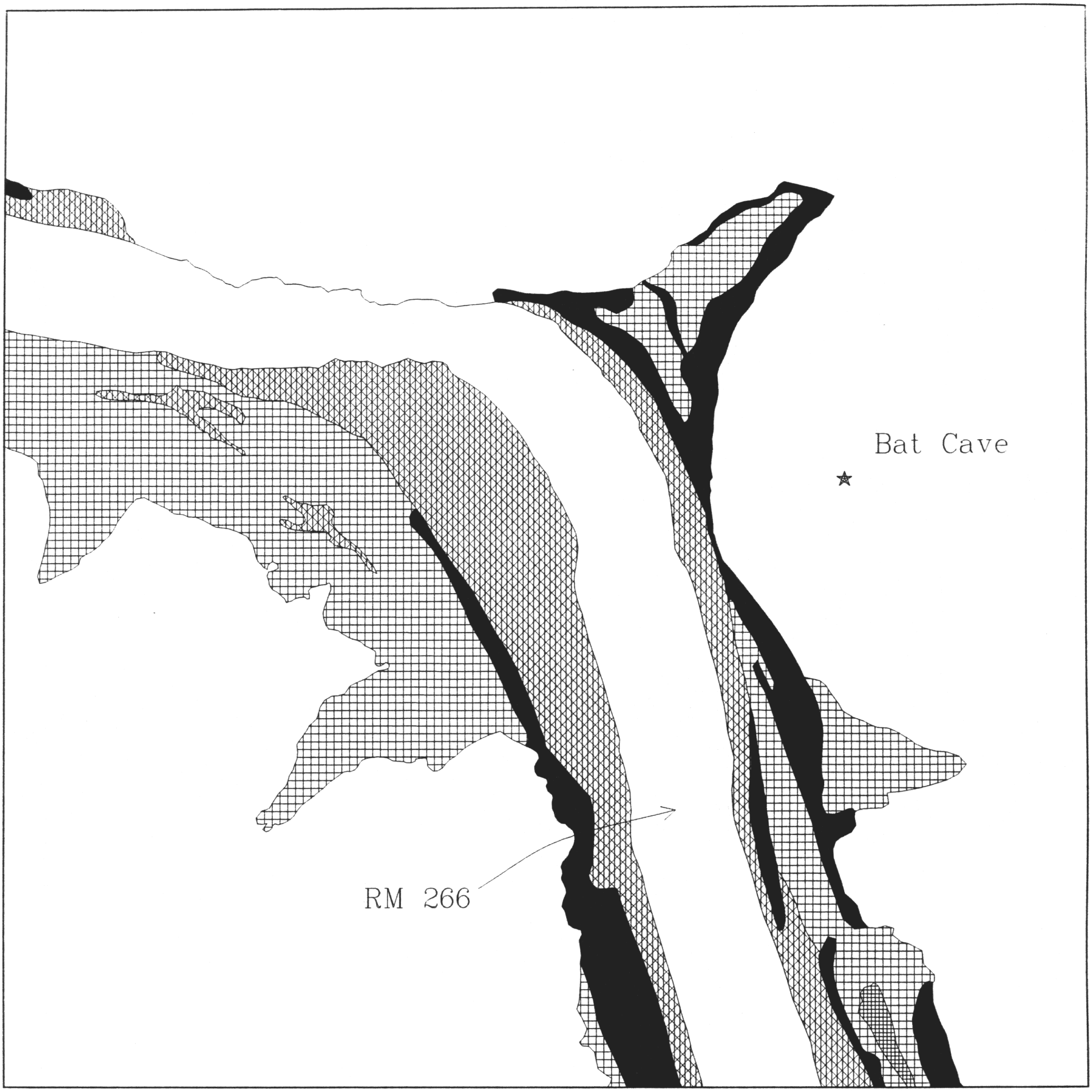
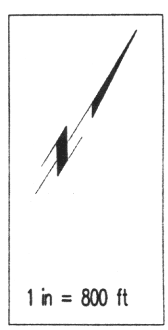


Vegetation Map

Sheet 22 of 32

- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Sparse Grasslands
- Coyote Willow



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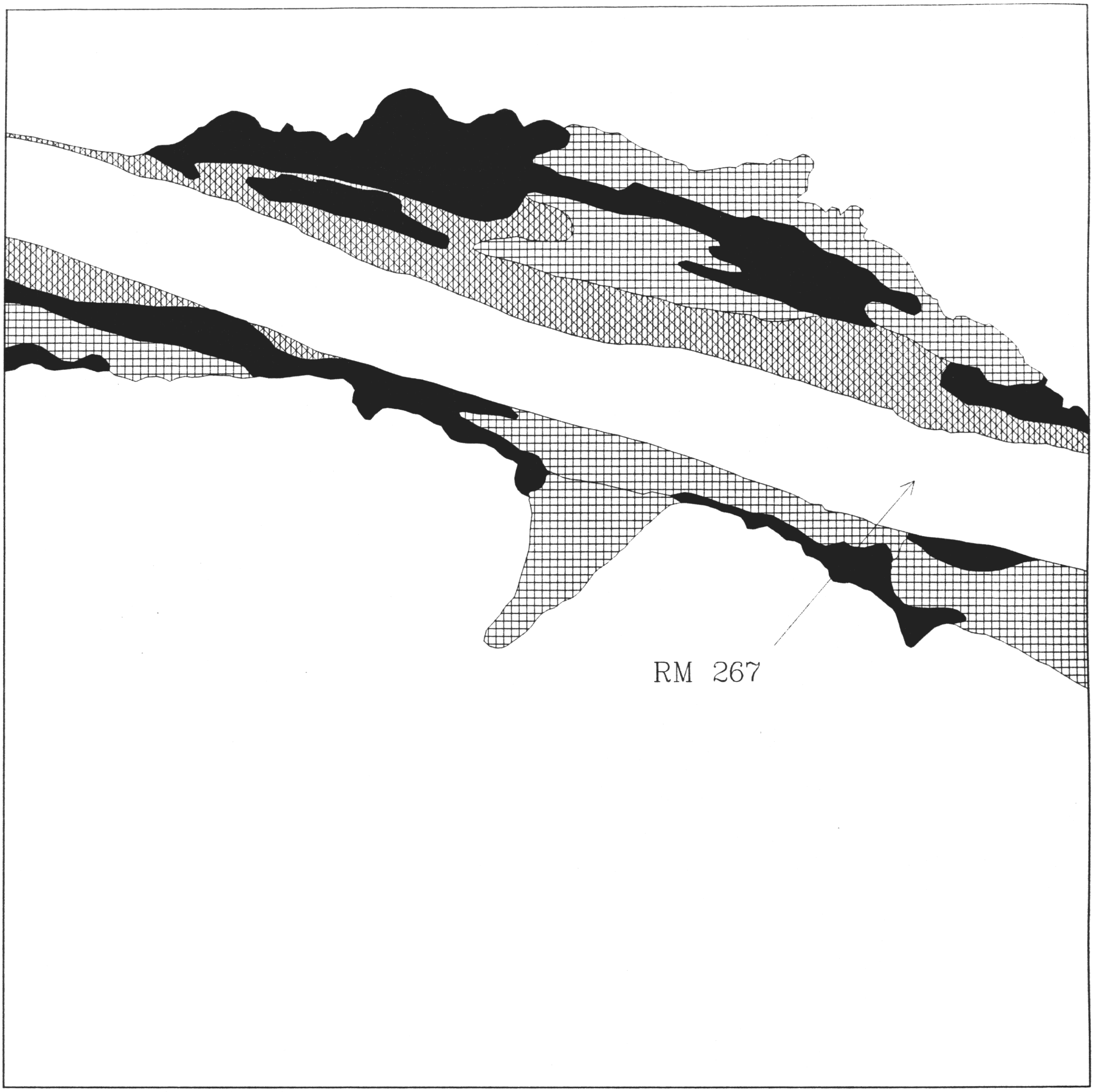
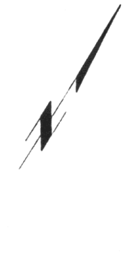


Vegetation Map

Sheet 23 of 32

- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Coyote Willow



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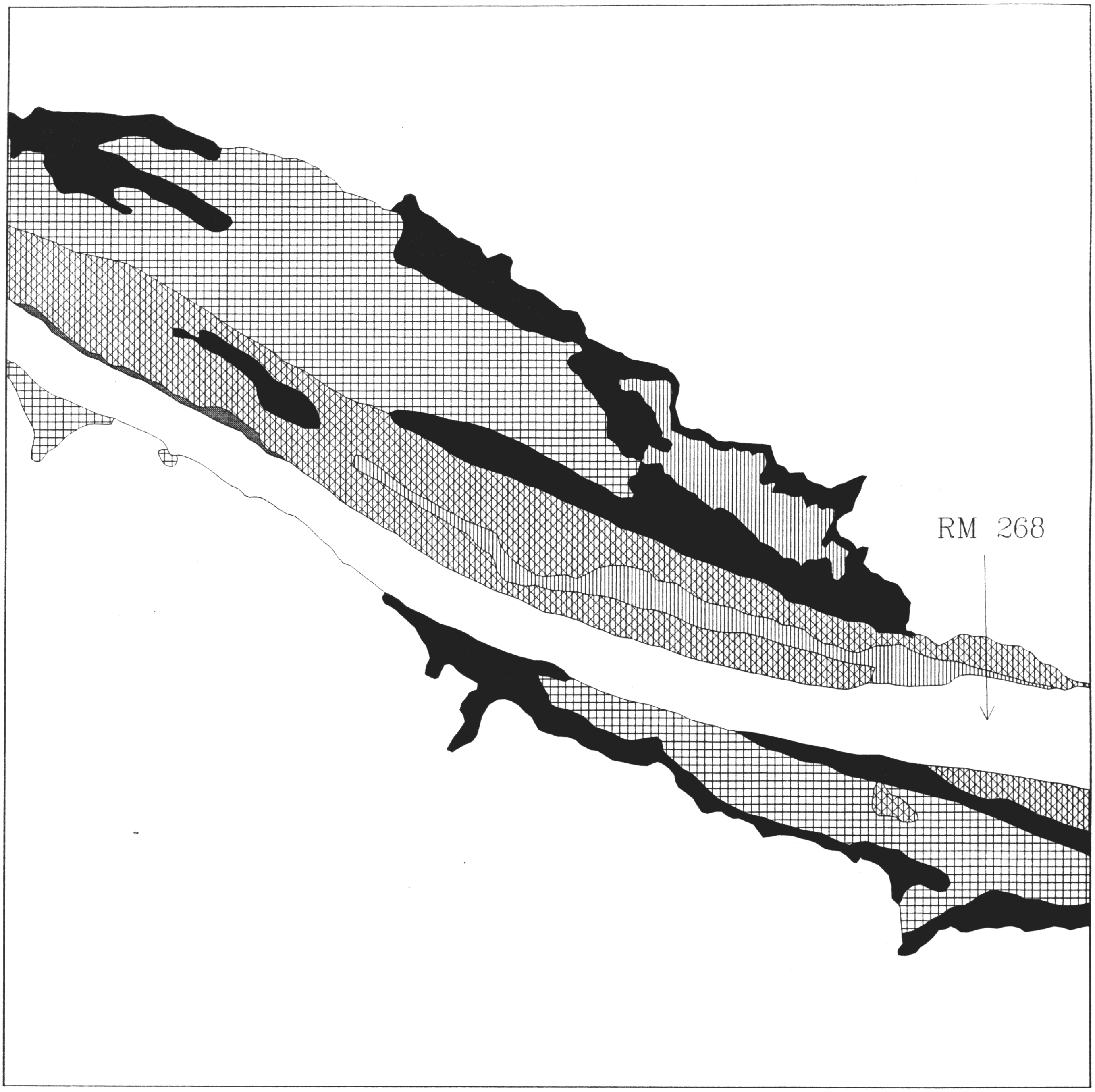
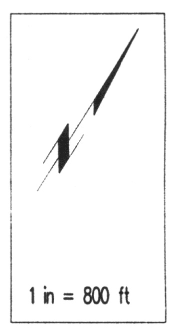


Vegetation Map

Sheet 24 of 32

- Wet Marsh
- Dry Marsh
- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Coyote Willow



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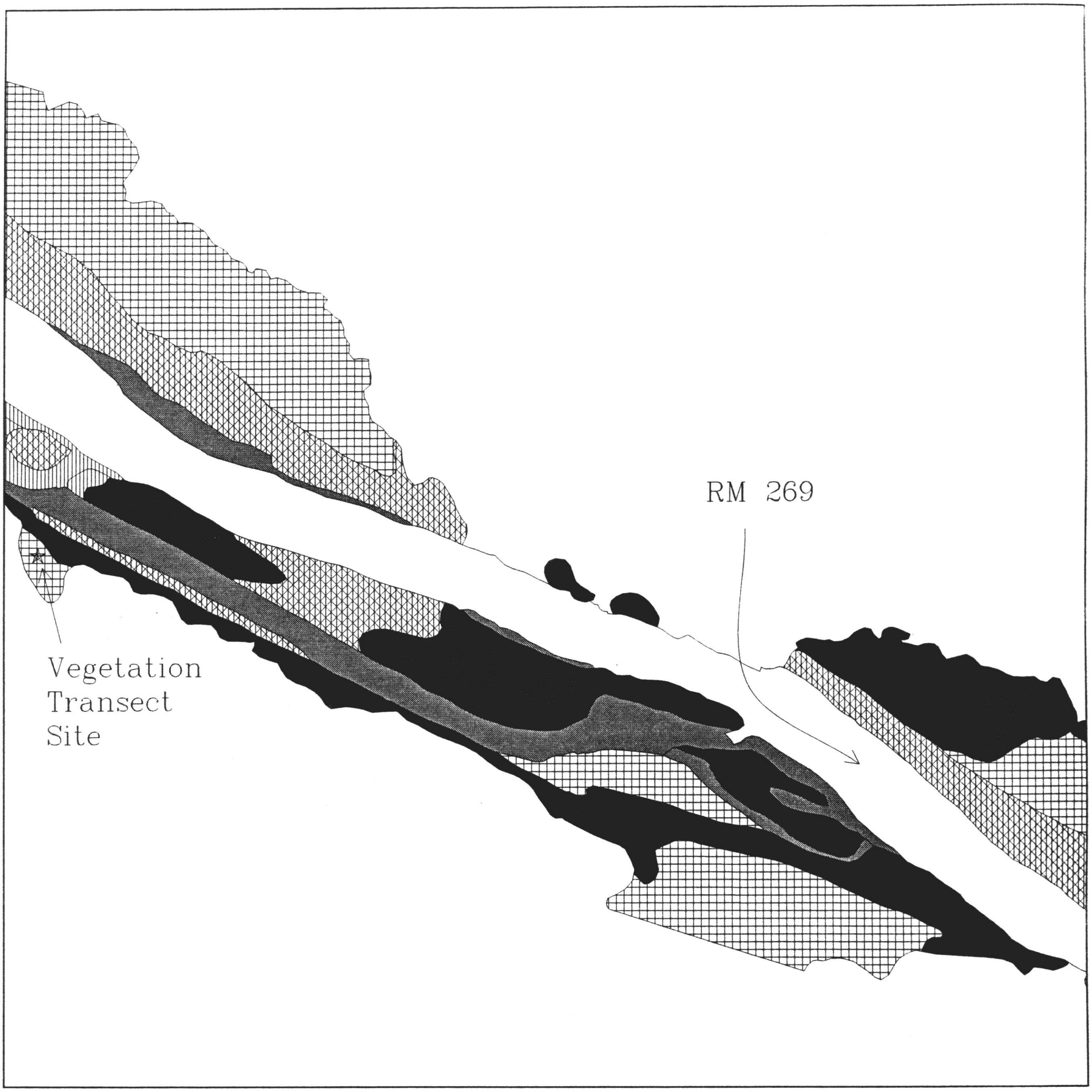
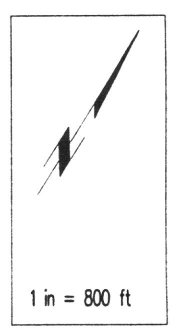


Vegetation Map

Sheet 25 of 32

- Wet Marsh
- Dry Marsh
- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Coyote Willow



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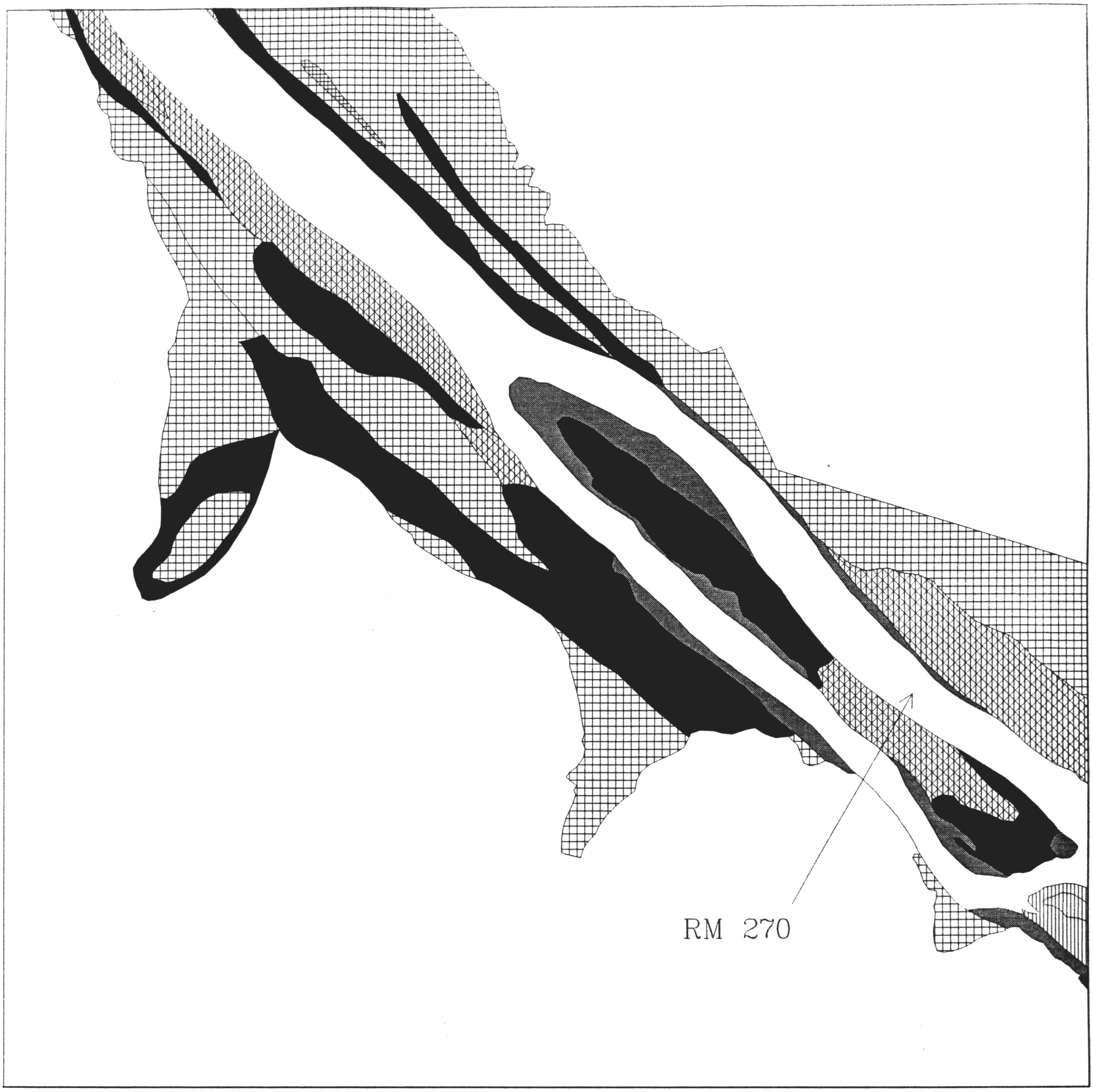


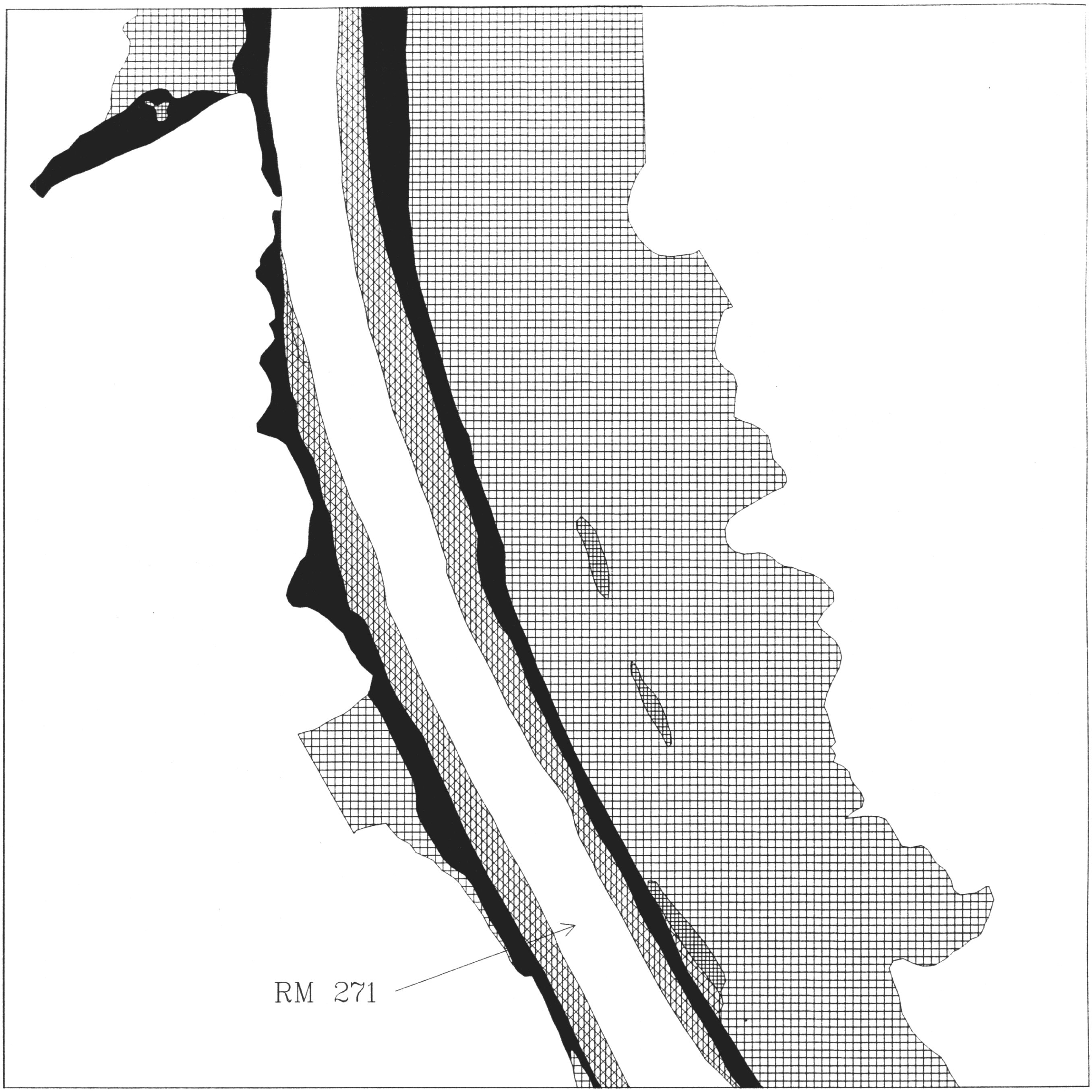
Vegetation Map

Sheet 26 of 32

- Wet Marsh
- Dry Marsh
- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Sparse Grasslands
- Coyote Willow

02/09/95

1 in = 800 ft

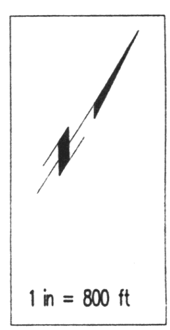


Vegetation Map

Sheet 27 of 32

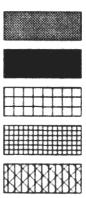
- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Sparse Grasslands
- Coyote Willow

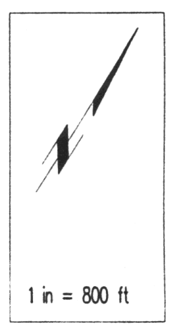
02/09/95



Vegetation Map

Sheet 28 of 32





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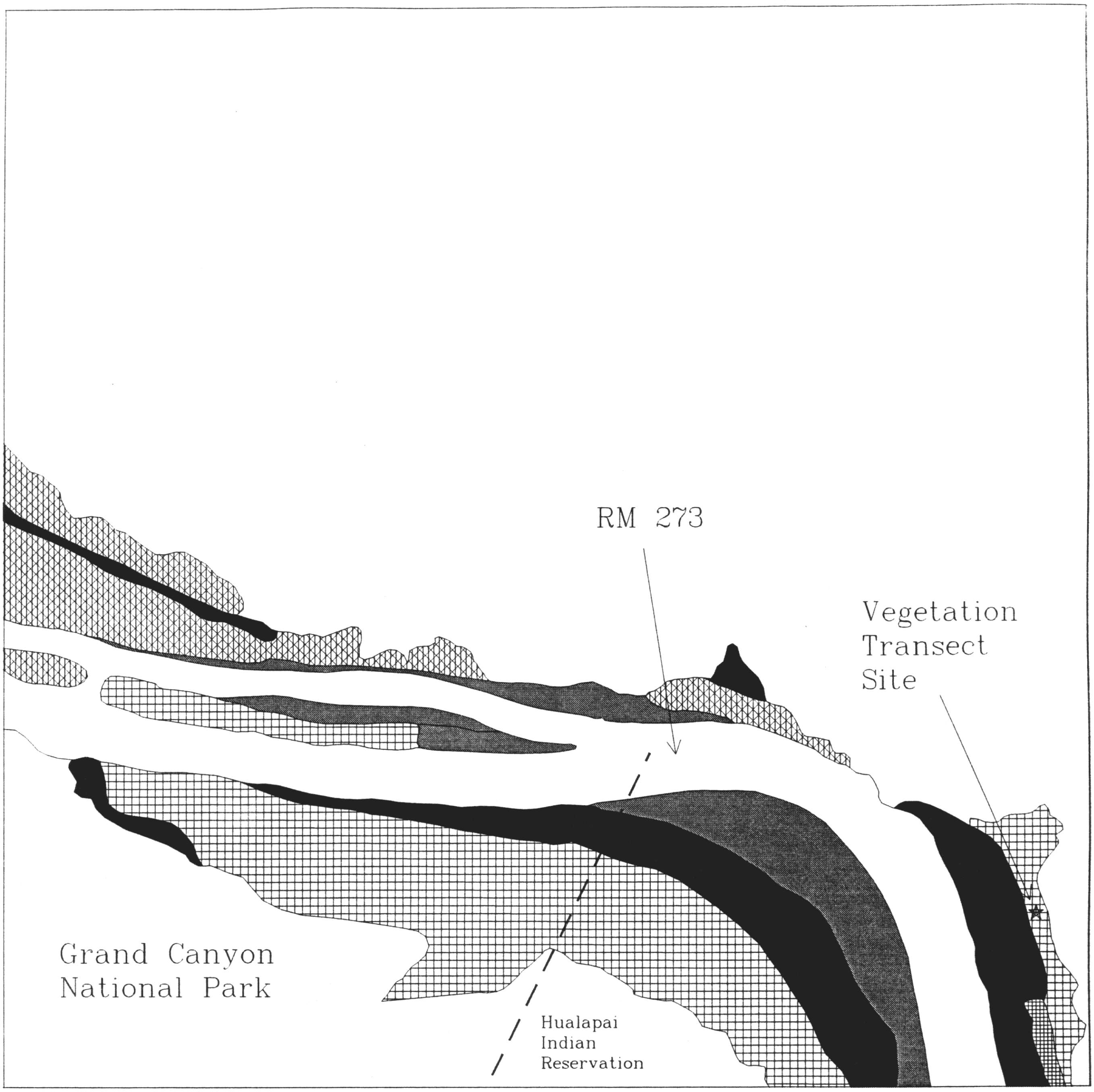
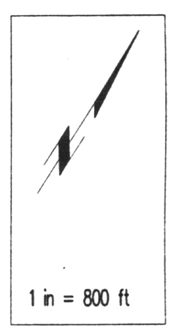


Vegetation Map

Sheet 29 of 32

- Dry Marsh
- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Sparse Grasslands
- Coyote Willow



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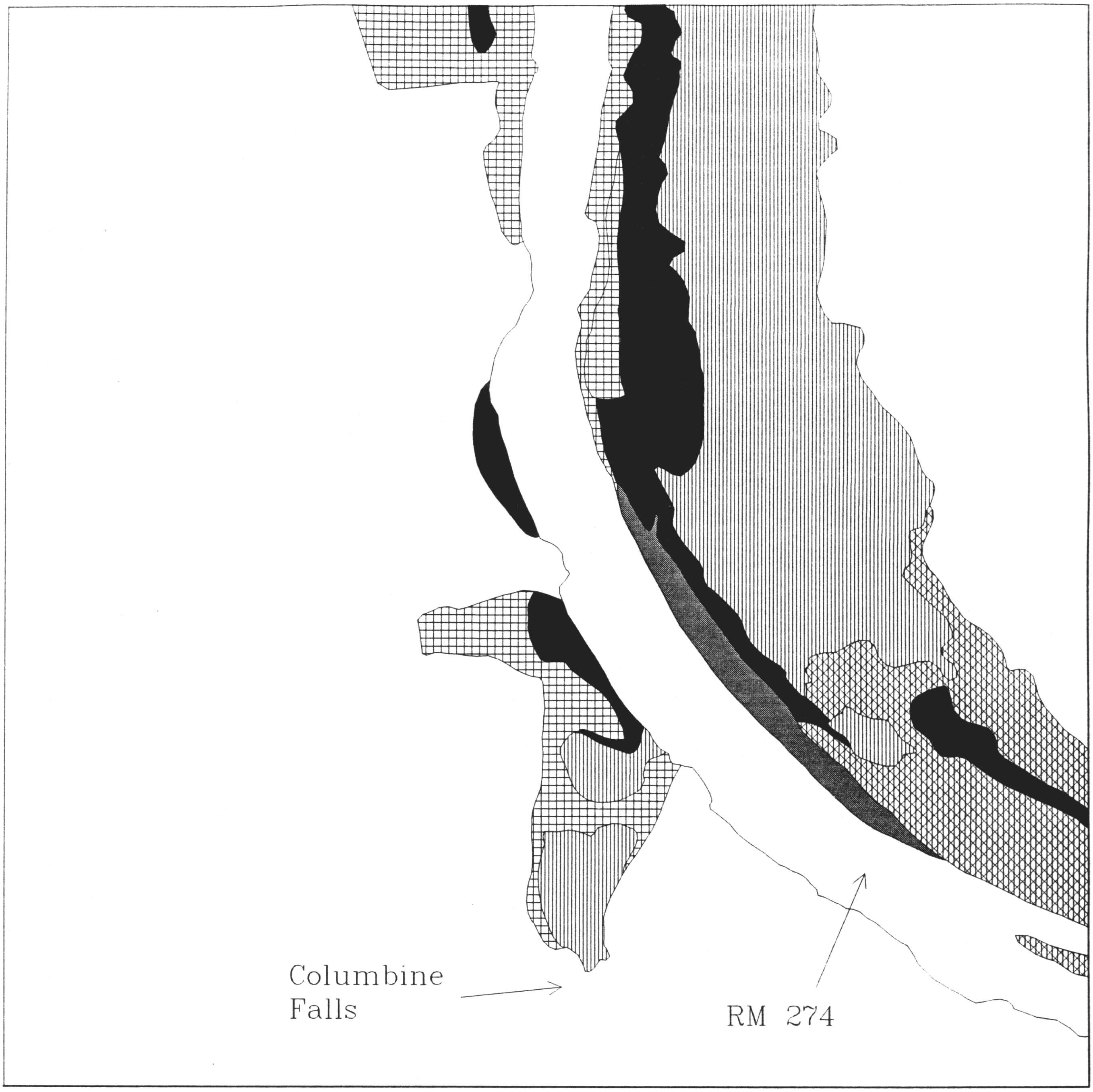
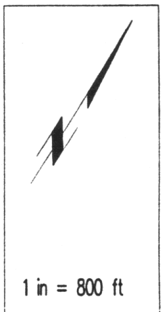


Vegetation Map

Sheet 30 of 32

- Wet Marsh
- Dry Marsh
- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Coyote Willow



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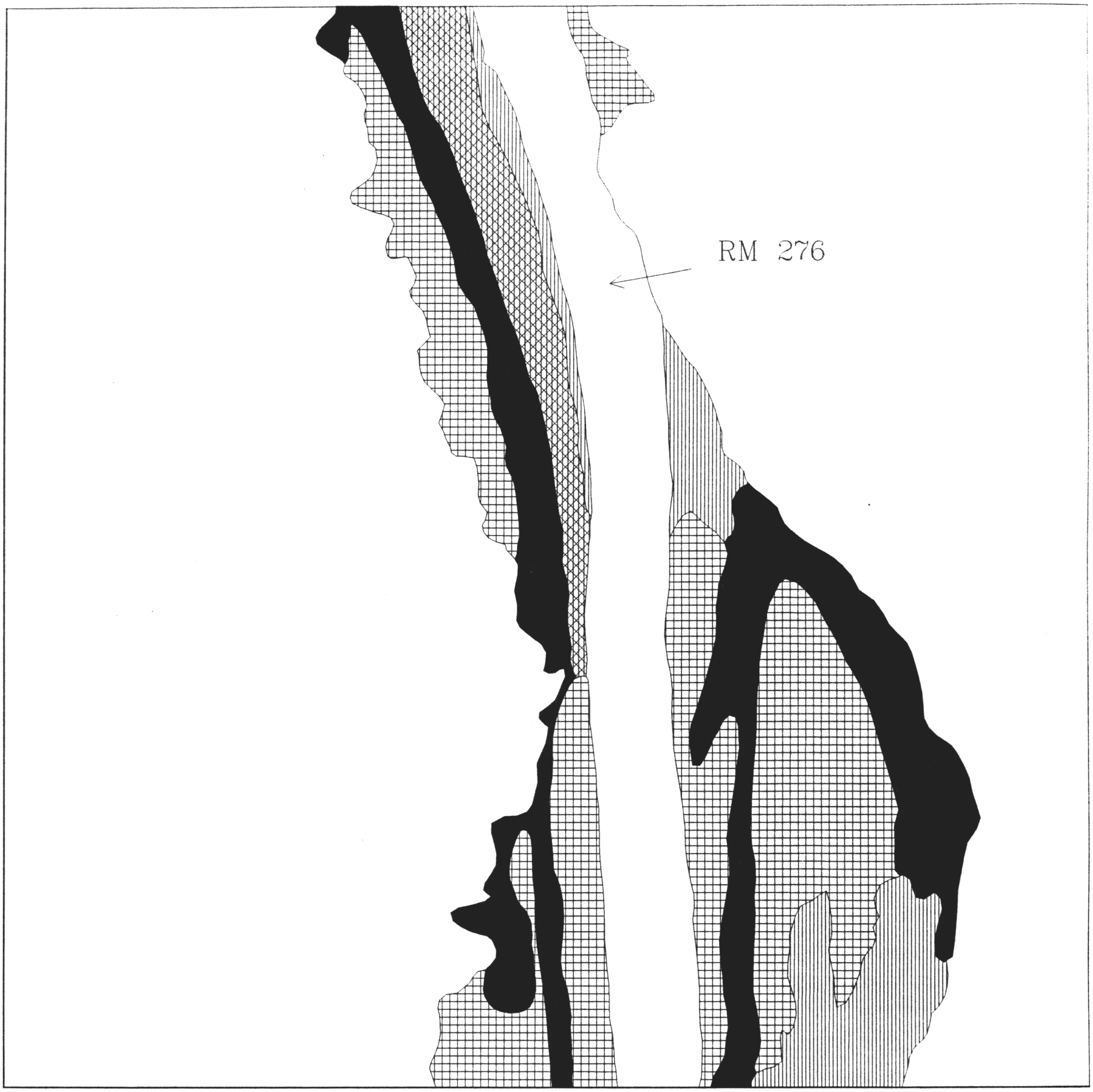
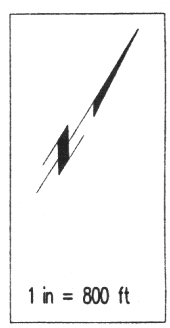


Vegetation Map

Sheet 31 of 32

- Wet Marsh
- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Coyote Willow



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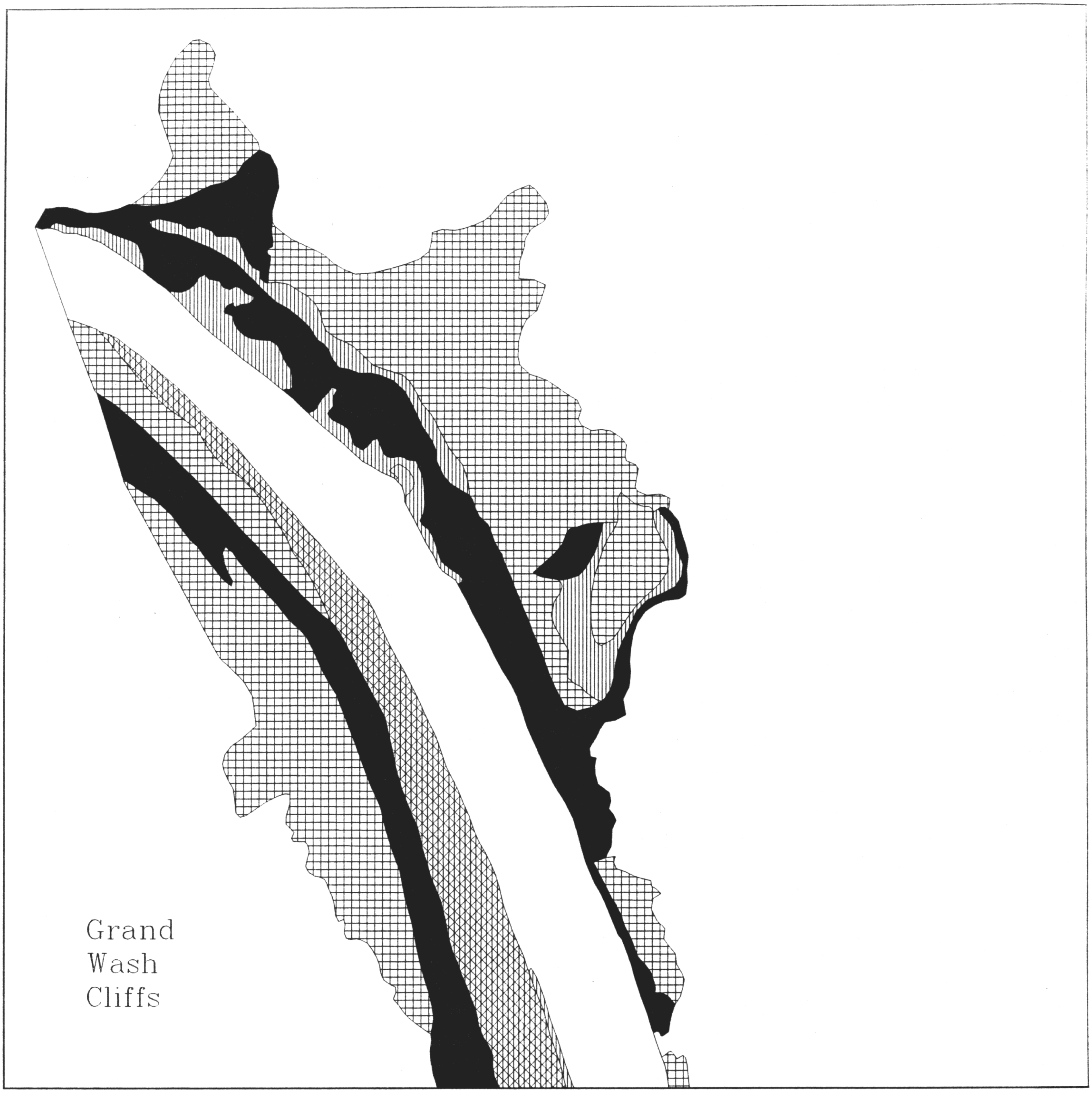

Vegetation Map

Sheet 32 of 32

- Wet Marsh
- Goodding's Willow
- Lush Tamarisk & Arrowweed
- Coyote Willow

1 in = 800 ft

02/09/95

APPENDIX B. ANNOTATED CHECKLIST OF KNOWN OR SUSPECTED NESTING BIRDS IN THE COLORADO RIVER CORRIDOR FROM NATIONAL CANYON TO PEARCE FERRY, ARIZONA

This annotated checklist outlines those bird species known or strongly suspected to nest within the riparian corridor of the Colorado River. Only riparian or riverine-associated species that nest below the high-water mark of the river or Lake Mead have been included.

Species nesting on cliffs in close proximity to the river (swallows and White-throated Swifts) have been included, whereas species nesting on cliffs well above the high-water mark have not been included: Red-tailed Hawk (*Buteo jamaicensis*), Peregrine Falcon (*Falco peregrinus*), American Kestrel (*Falco sparverius*), and Common Raven (*Corvus corax*). Likewise, desert-nesting species that may occasionally venture into the riparian zone but are not known to nest there have not been included: Greater Roadrunner (*Geococcyx californianus*), Great Horned Owl (*Bubo virginianus*), Lesser Nighthawk (*Chordeiles acutipennis*), Cactus Wren (*Campylorhynchus brunneicapillus*), Rock Wren (*Salpinctes obsoletus*), Canyon Wren (*Catherpes mexicanus*), Black-tailed Gnatcatcher (*Polioptila melanura*), and Black-throated Sparrow (*Amphispiza bilineata*).

DEFINITIONS OF TERMS

The following terms describe the species' relative abundance and status at their peak abundance in optimal habitat at the proper time of year.

Abundant: The species is present in numbers, such that more than 50 individuals are usually detected in one day.

Common: The species is easily found and almost always to be seen; between 5 and 50 individuals are usually detected in one day.

Fairly common: The species is found on a daily basis, but in small numbers; 1 to 4 individuals are usually detected per day.

Uncommon: The species is seldom or infrequently seen, and not on a daily basis; no more than several individuals are usually detected per week.

Rare: Low probability of detecting the species, although it is not out of its normal range.

Permanent resident: Species is present in the study area throughout the year, although for some species different summer and winter populations may be involved. Assumed to nest at the proper season.

Summer resident: Species is present in the study area during the breeding season, and is assumed to nest.

SPECIES ACCOUNTS

Western Grebe (*Aechmophorus occidentalis*)
Apparently a common permanent resident on the impounded waters of Upper Lake Mead, where it is thought to nest. This species was taxonomically split in the 1980s to form both the Western Grebe and Clark's Grebe (*Aechmophorous clarkii*). Both species occur on Upper Lake Mead, although their status there is poorly understood. A large adult grebe seen with several young at RM 279 on August 27, 1978, was assumed to be a Western Grebe (Brown et al. 1987).

Great Blue Heron (*Ardea herodias*)
Common permanent resident throughout the study area, although most individuals seen in summer are not known to be nesting. The only known rookery is at Burnt Canyon, where 1 or 2 nests were active (contained eggs or young) each year from 1990 to 1993. The rookery was inactive (no eggs laid) in 1994. Great Blue Herons were not known to nest in the study area prior to the existence of Lake Mead (Brown et al. 1987).

Black-crowned Night-Heron (*Nycticorax nycticorax*)
Uncommon summer resident, primarily downstream of Separation Canyon where it nests in small rookeries. Black-crowned Night-Herons were not known to nest in the study area prior to the existence of Lake Mead (Brown et al. 1987).

Gambel's Quail (*Callipepla gambelii*)
Rare to uncommon, localized permanent resident from at least Parashant Canyon downstream to Pearce Ferry. The only quail detected during the study period was a single male at the Parashant Canyon site on April 11, 1994; however, a U.S. Geological Survey employee (Greg Dick) reported 3-4 Gambel's Quail on river right immediately upstream of Whitmore Rapid (RM 188) on approximately May 23, 1994.

American Coot (*Fulica americana*)
Fairly common permanent resident on the impounded waters of Upper Lake Mead; individuals seen upstream of Separation Canyon in summer are probably not nesting. Nesting on Upper Lake Mead was confirmed by the sighting of an adult with a single young at RM 278 on June 6, 1993; an American Coot nest containing at least 6 eggs being incubated by a female was discovered at Pearce Ferry on April 19, 1994.

Spotted Sandpiper (*Actitis macularia*)
Fairly common summer resident throughout the study area. Nesting is assumed to occur on open sandbars and beaches (Brown et al. 1987), although a nest has yet to be discovered along the river between National Canyon and Pearce Ferry.

Mourning Dove (*Zenaida macroura*)
Common summer resident throughout the study area. Mourning Doves build flimsy stick nests in tamarisk in the NHWZ and mesquite in the OHWZ.

Yellow-billed Cuckoo (*Coccyzus americanus*)
No cuckoos were detected during the study period in the study area, where this species has been assumed to be a rare and irregular summer visitor (Brown et al. 1987). However, sightings in summer 1992 suggest this species may be a rare summer resident (Timothy Tibbitts, U.S. Fish and Wildlife Service, pers. comm.).

Western Screech-Owl (*Otus kennicottii*)
Uncommon permanent resident assumed to be nesting, although a nest has yet to be discovered in the study area. One and occasionally two Western Screech-Owls vocalized repeatedly from the same large patch of tamarisk scrubland at RM 265R on May 23 and June 5, 1993; and again on April 17-18, May 5-7, and June 9-10, 1994. Screech-owl vocalizations were also detected in the Tincanebits Canyon study site (RM 264L) on May 7, 1994.

White-throated Swift (*Aeronautes saxatalis*)
Common to abundant summer resident throughout the study area, nesting in cracks and crevices in cliff faces (Brown et al. 1987).

Black-chinned Hummingbird (*Archilochus alexandri*)
Common summer resident throughout the study area, nesting almost exclusively in tamarisk in the NHWZ. Along the river upstream of Diamond Creek, patches of tamarisk less than 0.5 ha in area apparently are not suitable for nesting (Brown 1992).

Costa's Hummingbird (*Calypte costae*)
Common to uncommon summer resident throughout the study area, nesting in both the OHWZ and adjacent desert (Brown et al. 1987, Brown 1992). This species' abundance in the study area appears to vary from year to year, since males were common in the mid-to-late 1980s, no males were detected during the 1993 study period, and detections were uncommon during the 1994 study period.

Ladder-backed Woodpecker (*Picoides scalaris*)
Rare permanent resident throughout the study area, nesting in riparian areas with trees large enough to accommodate their cavity nests (Brown et al. 1987). This species was detected throughout the study area but was detected most often at the Tincanebits Canyon study site (RM 264L), where it may have been attracted to large numbers of dead and dying willow trees. No nest of this species has been found in the study area.

Black Phoebe (*Sayornis nigricans*)
Common permanent resident throughout the study area, building mud nests on cliffs and ledges directly over water.

Say's Phoebe (*Sayornis saya*)
Fairly common permanent resident throughout the study area, building nests on cliffs and ledges.

Ash-throated Flycatcher (*Myiarchus cinerascens*)
Common to fairly common summer resident throughout the study area, nesting in riparian areas with trees large enough to accommodate their cavity nests (Brown et al. 1987). Since trees of adequate size are relatively uncommon at locales where this species is common, nesting may also occur in cracks or crevices in cliff faces. However, no nest of this species has been found in the study area. The Ash-throated Flycatcher is easily confused with the Brown-crested Flycatcher (*M. tyrannulus*) which occurs irregularly but is not known to nest in the study area (Brown et al. 1987).

Kingbird sp. (*Tyrannus vociferans* and *verticalis*)
Cassin's and Western Kingbirds are uncommon summer residents nesting on both the North and South Rims and along tributaries to the river. Both species are uncommon along the river in summer, but no nest of either species has been found in the river corridor. The only kingbird record from the study period was a single individual (which was not identified to species) at the Quartermaster Canyon study site on May 28, 1994.

Violet-green Swallow (*Tachycineta thalassina*)
Fairly common summer resident upstream of Diamond Creek, this species is a rare to uncommon summer resident downstream of Diamond Creek where nesting is assumed to occur in cracks and crevices in cliff faces, although no nest has been found along the river below National Canyon (Brown et al. 1987).

Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)
Common to abundant summer resident primarily downstream of Diamond Creek. This species typically constructs burrow nests in vertical dirt banks at the river's edge, such as those found at RM 260R in early June 1993. However, a small colony of Rough-winged Swallows was discovered using mud nests constructed on a cliff face and under rock ledges at RM 267R on June 15, 1988.

Bewick's Wren (*Thryomanes bewickii*)
Common permanent resident of both the NHWZ and OHWZ, apparently reaching its highest density in old-growth tamarisk. This is a cavity-nesting species, but when true cavities are unavailable it will nest in hollow logs or limbs, in crevices in tree trunks, or even on the ground under brush or driftwood piles.

Marsh Wren (*Cistothorus palustris*)
Rare permanent resident of the NHWZ and FLLZ whose distribution and status are poorly understood. Nesting is known to have occurred at Lees Ferry (Brown et al. 1987) and on portions of adjacent Lake Mead National Recreation Area (Blake 1978), but nesting in the study area between National Canyon and Pearce Ferry is unconfirmed. Singing males were detected at Columbine Falls in late June 1992 and at RM 264L in May 1993, but no nests were located. Large patches of apparently suitable habitat (i.e. dense stands of cattails) exist for this species downriver of Spencer Canyon, yet Marsh Wren detections in these areas are rare.

Blue-gray Gnatcatcher (*Polioptila caerulea*)
Common summer resident of both the NHWZ and OHWZ throughout the study area. Their cup-shaped nests are found in tamarisk, mesquite, and acacia.

Northern Mockingbird (*Mimus polyglottos*)
Uncommon summer resident, reported only from the OHWZ at Granite Park (RM 208L). No nests of this species have been found in the study area.

Crissal Thrasher (*Toxostoma dorsale*)
The status and distribution of this species are poorly understood. It appears to be a rare, possibly permanent resident throughout the study area although nesting has not been confirmed. Crissal Thrashers have been detected rarely in the study area during the nesting season at the Parashant Canyon (Brown and Johnson 1985), Waterfall Rapids, and Tincanebits Canyon study sites. This species may be more abundant in the nesting season than the findings of this study indicate because of their secretive nature and because males apparently curtail singing activity after early April.

Phainopepla (*Phainopepla nitens*)
Uncommon permanent resident throughout the study area, nesting in March and April. Most nests are located in the OHWZ in mesquite, acacia, and occasionally in clumps of mistletoe, but sometimes nests are located in tamarisk in the NHWZ. Phainopeplas are detected with regularity only at three localities: Spring Canyon (RM 204R), Granite Park (RM 208L), and 220-Mile Canyon.

Bell's Vireo (*Vireo bellii*)
Common to abundant summer resident of both the OHWZ and NHWZ throughout the study area. Their hanging, cup-shaped nests are found in tamarisk, mesquite, and occasionally other woody plants. Two simultaneously active Bell's Vireo territories were documented through contemporary contacts of singing males and discovery of concurrently active nests (each with eggs) in a discrete, isolated, 0.4 ha patch at the mouth of Spencer Canyon in May 1993. Therefore, average territory size in this patch was 0.2 ha (2,000 m^2).

Lucy's Warbler (*Vermivora luciae*)
Common to abundant summer resident of both the OHWZ and NHWZ. Although normally a cavity-nesting species, their nests are also located in pseudo-cavities such as clumps of tamarisk debris, against a tree trunk under a broken limb, or even in rock crevices and ledges immediately adjacent to the riparian zone.

Yellow Warbler (*Dendroica petechia*)
Common summer resident of the NHWZ throughout the study area, although singing males are occasionally detected in well-developed stands of mesquite in the OHWZ. In the extremely large patches of tamarisk downriver of Tincanebits Canyon where Yellow Warblers have a choice of nesting either adjacent to the water or some distance from it, the great majority of territories were

found at the water's edge. Their nests are found in tamarisk, willow, or rarely mesquite, usually high in the canopy.

Common Yellowthroat (*Geothlypis trichas*)
Common summer resident of the NHWZ throughout the study area. The highest Yellowthroat densities apparently occur in cattail marsh habitat, although high densities also occur in pure stands of young tamarisk that may be some distance from water. Yellowthroat nests are small, woven cups usually located less than 1 m above the ground or water.

Yellow-breasted Chat (*Icteria virens*)
Common summer resident of the NHWZ throughout the study area, although singing males are occasionally detected in well-developed stands of mesquite in the OHWZ. Their nests are conspicuous clumps of grass or the herb *Gnaphalium*, usually 2-3 m above ground. Two simultaneously active chat territories were documented through contemporary contacts of singing males and discovery of concurrently active nests (each with eggs) in a discrete, isolated, 0.4 ha patch at the mouth of Spencer Canyon in May 1993. Therefore, average territory size in that patch was 0.2 ha (2,000 m^2).

Summer Tanager (*Piranga rubra*)
Rare to uncommon summer resident of well-developed patches of tamarisk or willow in the NHWZ throughout the study area. Singing males may be secretive and difficult to observe, but their songs can be detected at long distances. Tanager nests are usually located high in the canopy.

Blue Grosbeak (*Guiraca caerulea*)
Uncommon to fairly common summer resident in both the OHWZ and NHWZ throughout the study area. Grosbeak nests resemble chat nests, being relatively large cup nests constructed primarily of grass.

Lazuli Bunting (*Passerina amoena*)
Fairly common summer resident in the river corridor, where most individuals are detected in the NHWZ. Nesting very likely occurs on a regular basis, although no active nest has been confirmed.

Indigo Bunting (*Passerina cyanea*)
Rare summer resident of both the OHWZ, NHWZ, and FLLZ, although none were detected during the 1993 field season. A singing male assumed to be on territory was detected in late June 1992 at Separation Canyon; another singing male was detected at the Tincanebits Canyon study site (RM 264) on May 6-7, 1994. An active nest of this species in the study area has yet to be discovered.

Song Sparrow (*Melospiza melodia*)
Common to abundant permanent resident downstream of Separation Canyon, found entirely in fluctuating lake-level zone habitats on silt deposits at the head of Lake Mead. Song Sparrows

have greatly increased in abundance since falling levels of Lake Mead have allowed the creation of large areas of suitable nesting habitat. It is now one of the two most abundant nesting species in the Upper Lake Mead area. A single male Song Sparrow was detected singing at the Parashant Canyon study site on May 22, 1994; this represents the only record of a singing male upstream of Separation Canyon in the study area.

Red-winged Blackbird (*Agelaius phoeniceus*)
Common permanent resident downriver of Spencer Canyon, where nesting is assumed to occur primarily in cattail marshes along the lake margin or perennial tributaries. An active nest has yet to be documented between National Canyon and Pearce Ferry.

Great-tailed Grackle (*Quiscalus mexicanus*)
Common summer resident of the NHWZ throughout the study area, but an active nest has not been documented between National Canyon and Pearce Ferry.

Brown-headed Cowbird (*Molothrus ater*)
Common summer resident of all riparian habitats throughout the study area. Cowbirds do not build their own nests, but lay eggs in the nests of host species which often successfully raise the cowbird young; brood parasitism by cowbirds is common between National Canyon and Pearce Ferry (Brown 1994). Oddly, no cowbird eggs or young were detected in any of the 69 active passerine nests containing eggs or young discovered during the 1993 and 1994 study periods (sample size of active nests included: 7 Black Phoebe, 1 Say's Phoebe, 1 Bewick's Wren, 8 Blue-gray Gnatcatcher, 1 Phainopepla, 21 Bell's Vireo, 4 Lucy's Warbler, 2 Yellow Warbler, 7 Common Yellowthroat, 10 Yellow-breasted Chat, and 5 Song Sparrow nests).

Hooded Oriole (*Icterus cucullatus*)
Fairly common summer resident primarily in well-developed areas of tamarisk and willow in the NHWZ or FLLZ, but occasionally in areas of large mesquite or hackberry in the OHWZ. Oriole nests are graceful hanging baskets located high in the canopy; many oriole nests from previous seasons were observed throughout the study area.

House Finch (*Carpodacus mexicanus*)
Common to abundant summer resident of all habitats throughout the study area. Nests of this species may be more abundant but are difficult to find in the riparian zone where the few nests discovered were high in tamarisk foliage. Many finches nest in the adjacent desert, where most nests have been found in cholla cactus.

Lesser Goldfinch (*Carduelis psaltria*)
Fairly common to common permanent resident of all habitats throughout the study area. Most nests discovered have been relatively exposed cups of grasses located near the crowns of young tamarisks.

APPENDIX C: AVIAN STUDIES RESEARCH PLAN FOR 1995

Bird Monitoring

Five research trips are proposed for the spring of 1995 to survey bird density and species richness after the methods described in this report. Three trips are proposed from Diamond Creek to Pearce Ferry, to be outfitted by HNRD; two trips are proposed from Lees Ferry to Pearce Ferry, to be outfitted by OARS, Inc. Each of the two trips launching from Lees Ferry will require a 37-foot motorized raft for support, plus boatman, cook, and shuttle services into the trailhead at Havasu Canyon. All trips below Diamond Creek will require a motorized sportboat for auxilliary support, providing the ability to move quickly from one study site to another for increased sample sizes during the critical early-morning sample periods.

Trip # 1. **Diamond Creek to Pearce Ferry:** a 5-day preliminary reconnaissance trip will take place in approximately early March.

Trip # 2. **Lees Ferry to Pearce Ferry: bird monitoring.**

April 12 -- launch at Lees Ferry, deadhead to National
April 15 -- hike-ins at Havasu; camp National
April 16 -- camp National
April 17 -- camp Parashant
April 18 -- camp Parashant
April 19 -- camp Granite Park
April 20 -- camp Granite Park
April 21 -- pass Diamond Creek; camp RM 243L
April 22 -- camp Spencer
April 23 -- camp Quartermaster
April 24 -- camp RM 264L
April 25 -- camp RM 264L
April 26 -- takeout Pearce Ferry, 9 - 10 a.m.

Trip # 3. **Diamond Creek to Pearce Ferry: bird monitoring.**

May 1 -- launch at Diamond Creek, camp 243L
May 2 -- camp Spencer
May 3 -- camp Quartermaster
May 4 -- camp 264L
May 5 -- camp 264L
May 6 -- takeout Pearce Ferry, 9 - 10 a.m.

Trip # 4. Lees Ferry to Pearce Ferry: bird monitoring.

May 13 -- launch at Lees Ferry, deadhead to National
May 16 -- hike-ins at Havasu; camp National
May 17 -- camp National
May 18 -- camp Parashant
May 19 -- camp Parashant
May 20 -- camp Granite Park
May 21 -- camp Granite Park
May 22 -- pass Diamond Creek; camp 243L
May 23 -- camp Spencer
May 24 -- camp Quartermaster
May 25 -- camp 264L
May 26 -- camp 264L
May 27 -- takeout Pearce Ferry, 9 - 10 a.m.

Trip # 5. Diamond Creek to Pearce Ferry: bird monitoring.

June 5 -- launch at Diamond Creek, camp 243L
June 6 -- camp Spencer
June 7 -- camp Quartermaster
June 8 -- camp 264L
June 9 -- camp 264L
June 10 -- takeout Pearce Ferry, 9 - 10 a.m.

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APPENDIX D: LONG-TERM RIPARIAN MONITORING FIELD GUIDE

Colorado River through lower Grand Canyon, Arizona

Introduction

This field guide is intended for use by researchers and field assistants conducting long-term monitoring of riparian study sites in lower Grand Canyon. Study sites were established in 1992 and 1993 to measure several aspects of the rapidly changing riparian ecosystem that exists along the Colorado River between National Canyon (river mile (RM) 166L) and the Grand Wash Cliffs (RM 276). Many of these sites were chosen for use in long-term monitoring due to their placement, vegetation composition, and position along the river corridor. Several sites were excluded from long-term monitoring because they became unstable, were inundated, or were difficult to relocate.

Vegetation, bird, mammal and reptile study sites are included in long-term monitoring, and together make up 24 separate study sites with 54 individual study plots or transects (Table 1). The purpose of this guide is to facilitate relocation of these study sites and replication of the techniques used to sample each site. The 1995 report on this study (SWCA, 1995) provides an explanation of the project background and study purposes. This guide is intended to be used in conjunction with a river guide (Stevens 1983) showing approximate river miles. For sites downstream of Spencer Canyon (RM 246), the vegetation map in Appendix A of the 1995 report will also prove to be useful. Ideally, an individual familiar with all of the sites should accompany research trips to ensure relocation of all sites.

Census Timing

Research trips should be conducted at specific times of year to properly measure the selected populations and to allow precise comparisons of trend data. Avian censusing should take place regularly (with four research trips) between mid-April and mid-June, as this is the prime mating and nesting season for the multitudes of neotropical migrant birds that migrate into the Grand Canyon each year. Mammal and reptile censusing should take place between mid-August and mid-September, as this is the most active period for small mammals and reptiles. Vegetation sampling should be done between mid-September and mid-October, to take advantage of cooler weather and lower Lake Mead levels. Table 2 shows a sample research trip schedule.

Table 1. Long-Term Study Sites

River Mile	Vegetation Studies	Avian Studies	Mammal Studies	Reptile Studies	Censusing Frequency
Upstream Sites					
166.5L		Transect			4x/yr
172.2L	RS, GB, OHWZ				1x/yr
183.2R	RS, GB, OHWZ				1x/yr
194.0L	RS, GB, OHWZ				1x/yr
194.0L	Marsh				1x/yr
198.0R		Transect			4x/yr
209.0L	RS, GB, OHWZ	Transect			1x/yr; 4x/yr (avian)
213.0R	RS, GB, OHWZ				1x/yr
217.4L	RS, GB, OHWZ				1x/yr
220.0R	RS, GB, OHWZ				1x/yr
Sites Downstream of Diamond Creek					
228.8L	Marsh				1x/yr
231.8L	RS, GB, OHWZ				1x/yr
235.0L	GB, DF, OHWZ		Transects	Transects	1x/yr; 4x/yr (m/r)
241.5L	Marsh				1x/yr
243.2L		Transect			8x/yr
246.0L	OHWZ	Transect	Transects	Transects	6x/yr; 4x/yr (m/r)
249.4L	Marsh				1x/yr
254.0R	GB1, GB2, GB3				1x/yr
254.1L	Transect				1x/yr
260.2R		Transect			1x/yr
260.2L		Transect	Transects	Transects	6x/yr; 4x/yr (m/r)
261.5L	Transect				1x/yr
264.5L	Transect	Transect			1x/yr; 8x/yr (avian)
269.6L	Transect				1x/yr
273.1R	Transect				1x/yr

Notes: RS=riparian strip; GB=general beach; OHWZ=old high water zone. River miles (RM) are after Stevens (1983). L or R following river mile designates left or right side of river while facing downstream. OHWZ quadrats should be sampled once every ten years. (m/r) indicates sampling frequency for mammal and reptile studies.

Table 2. Sample Research Trip Schedule

Trip Title	Trip Dates	No. Days	Put In Location
Avian Studies Trail Clearing	3/15 to 3/21	7	Diamond Creek
Vegetation Studies--Herbarium	4/1 to 4/5	5	Diamond Creek
Avian Studies #1	4/12 to 4/26	15	Lees Ferry
Avian Studies #2	5/1 to 5/6	6	Diamond Creek
Avian Studies #3	5/13 to 5/27	15	Lees Ferry
Avian Studies #4	6/5 to 6/10	6	Diamond Creek
Vegetation Studies--Aerial Mapping	7/1	1	N/A
Mammal/Reptile Studies #1	8/15 to 8/20	6	Diamond Creek
Mammal/Reptile Studies #2	9/10 to 9/15	6	Diamond Creek
Vegetation Studies--Census	10/1 to 10/15	15	Lees Ferry

Site and Plot Relocation

Relocating study sites and individual plots and transects may be the most difficult part of long-term monitoring, due to the rapid growth of vegetation and occasional inundation of many sites by river and lake flooding. The majority of vegetation sites have been recorded using standard land survey techniques (including all vegetation quadrats and marshes), but to relocate vegetation sites with these techniques an experienced land surveyor should accompany the trip. Only the two sites upstream of Diamond Creek (RM 225) established by the SWCA/HNRD research team are included in the discussion below; the locations of the remainder of upstream plots have not been described to date by the National Park Service researchers who established and recensused these plots.

RM 166.5L--National Canyon Avian Site

This long, narrow study site encompasses the entire camping beach at the mouth of National Canyon as well as channel margin vegetation patches upstream and downstream of National Canyon. The bird transect at this site stretches from the large, unvegetated talus slope approximately 200m upstream of the cable crossing downstream through the three main National Canyon camps to the unvegetated talus slope approximately 300m downstream of the downstream beach. A full census of the site includes starting at one end, traveling to the other while counting all singing male birds, and conducting a second count while walking back.

RM 198.0R--Parashant Canyon Avian Site

This site is located approximately 1/2 mile upstream of the traditional Parashant Canyon camp, on an eddy deposit upstream of the mouth of Parashant Canyon. The site extends from the large, unvegetated debris fan upstream of the site downstream approximately 500m to a sparsely vegetated talus slope. A transect was cut through the dense vegetation of this site, roughly paralleling the river through the center of the vegetation patch. A full census of the site includes beginning at the upstream edge of the site, walking downstream while counting birds, and climbing up the talus slope at the downstream end to a location which gives a good view of the entire site. After spending 20-30 minutes watching for birds not detected during the first part of the survey (such as phainopepla), a second count should be made while walking the transect in the other direction.

RM 209.0L--Granite Park Quadrat and Avian Site

Three quadrats are located in the large vegetation patch on river left at RM 209. The beach formed by the eddy upstream of the large RM 209 rapid is the common parking spot for all boats visiting this site. The GB quadrat at this site is located approximately 150m upstream of the large Goodding's willow at the center of the camp, in a large patch of arroweed. A path crosses the plot (in subplots 1 and 2). The RS quadrat at this site is approximately 250m upstream of the GB plot, approximately 50m upstream of a large drainage, in an area largely populated by camelthorn (*Alhagi camelorum*). A large *Baccharis sarathroides* in the center of this plot is next to several small mesquites. The OHWZ quadrat at this site is approximately 50m further from the river and 20m downstream from the RS plot. Much of the OHWZ plot is on a small rise and contains no perennial vegetation; prickly pear cactus and acacia are found in the downstream half of the plot.

This large, long avian site is located adjacent to and upstream of RM 209 rapid. The site extends from the large, unvegetated cliff and talus slope at the upstream end to another unvegetated talus slope at the downstream end. A census of this site includes walking a transect crossing through all of the riparian vegetation, excluding the creosote-dominated area in the upland portions of this site. As with other sites, one census should be conducted from one end to the other, and then a second census should be conducted in the other direction. This site also has a good vantage point which is useful for identifying species which may not have been detected.

RM 217.4L--Quadrat Site

Three quadrats are located in the vegetation patches upstream and downstream of the rapid at RM 217. The RS plot is upstream of the rapid and 20m upstream of a large patch of arroweed, in a patch of large, dense (>4m) tamarisk. The GB plot at this site is downstream of the debris flow which forms the rapid, on a the upstream end of a large, nearly bare beach. The OHWZ plot is near the downstream end of this beach, centered around a large, decadent catclaw acacia (*Acacia greggii*).

RM 228.8L--Travertine Canyon Marsh Site

This site is located at the upstream edge of the cove approximately 100m upstream of Travertine Canyon rapids, on a curved sand bank covered with horsetail. A baseline extends from the rock wall at the upstream edge of the sand bank, along the top of the bank to a wooden stake at meter

28. Four transects extend from the baseline to the water's edge, at 7m intervals beginning at meter 7. Each 1m-wide transect is marked with a wooden stake at its downstream edge. Each square meter of each transect between the baseline and the water's edge is censused.

RM 231.8L--Quadrat Site

This site is located upstream and around the bend from the rapids at RM 232, in a more open portion of the gorge with large sand banks on river left. The GB plot is located on the prominent high sand dune covered with sparse arroweed. The talus edge of the plot (corners DT and UT) is at the top of the sand dune, while the stream edge of the plot (corners DS and US) is at the bottom of the dune. The RS plot is approximately 20m downstream of the GB plot, in a patch of horsetail and thistle. The US and UT corners are painted on prominent rocks; the DS and DT corners are not marked. The OHWZ plot at this site is upstream and significantly upslope of the GB plot, and is centered around a 2m high catclaw acacia.

RM 235.0L--Bridge Canyon Quadrat and Mammal/Reptile Site

This site is at the mouth of Bridge Canyon, and includes both vegetation quadrats and mammal/reptile transects.

Of the three vegetation quadrats, the GB plot is easiest to locate. It is placed on the arroweed-covered mound at the narrow canyon mouth, with the trail up the canyon passing through the plot's downstream subplots. One corner (downstream stream--DS) is painted on the downstream rock wall approximately two meters above the trail; the other (downstream talus--DT) is painted on a rock cleft approximately 10cm above the trail. The OHWZ plot is approximately 20m downstream of the GB plot, on a broad talus slope, with four painted corners. The DT plot is in the center of the debris fan, with the upstream edge approximately 5m downstream of Bridge Creek. Corners of this plot are painted on the rocks, but the paint erodes quickly.

Mammal and reptile transects at this site include transects within the riparian vegetation, along the boundary between riparian and xeric vegetation, and in the upland xeric vegetation. The riparian transect runs adjacent to the river for the length of the beach and debris fan. The transition zone transect runs through the middle of the beaches and the debris fan, parallel to the river. The upland transect runs against the rock walls that rise steeply from the beach and debris fan, parallel to the river.

RM 241.5L--Marsh Site

This site is located within the large horsetail marsh that forms the downstream part of the camping beach at RM 241.5L. The reference point for the baseline (the baseline parallels the river, while transects run perpendicular to the river, from the baseline to the water's edge) is an X painted on the reddish rock at the downstream end of the marsh. A T is painted on the rock 1m above the X, pointing down to the X. The baseline stretches from the painted X to a wooden stake 20m upstream at a bearing of 70 degrees east. Five transects extend from the baseline, at

4m intervals beginning at meter 4. A wooden stake marks the upstream edge of each 1m-wide transect. Each square meter of each transect between the baseline and the water's edge is censused.

RM 243.2L--243-Bar Avian Site

This small, L-shaped site is located just downstream and across the river from the large camp at RM 243R. A transect was cut through the dense tamarisk of this site, in order to be able to walk through the center of the vegetation and up the small drainage to the edge of the vegetation patch. As with other sites, a full census of this site entails one survey in one direction and another while returning.

RM 246.0L--Spencer Canyon Quadrat, Avian, and Mammal/Reptile Site

An OHWZ plot at this site was placed at the downstream edge of the mouth of Spencer Canyon, approximately 50m away from the river and centered around a large, prominent mesquite tree.

This avian site includes three major vegetation patches at the mouth of Spencer Canyon: adjacent to the river, it includes the patch upstream of Spencer Creek and the patch downstream of the creek; up Spencer Creek, it includes the large patch which begins approximately 100m up the canyon and fills the final bend of the creek. A transect was cut through the center of these three patches to facilitate censusing. A full census of this site included one survey through all three patches, and then another while returning.

Mammal and reptile transects at this site include transects within the riparian vegetation, along the boundary between riparian and xeric vegetation, and in the upland xeric vegetation. All three transects were placed in and above the patch of vegetation behind the normal camp, upstream of Spencer Creek. The riparian transect was placed in the middle of the dense vegetation patch, parallel to the river; the transition zone transect was placed along the edge of riparian vegetation, against the sloping talus; and the upland transect was placed on the talus slope above camp.

RM 249.4L--Marsh Site

This site is located approximately 200m downstream of the mouth of Clay Tank Canyon (also known as Lost Creek Canyon), on a broad silt terrace. Above the terrace, on a slope, is a large linear patch of decadent horsetail. An X painted on the reddish red wall at the upstream end of the vegetation patch provides a reference point for the transect baseline. The baseline runs parallel to the river, downstream from the X for 50m. Every 5m along the baseline, beginning at meter 5, a wooden stake marks the upstream edge of a perpendicular transect. Each 1m-wide transect runs perpendicular to the baseline from the baseline to the water's edge. Every other square meter of each transect is censused; thus, if two measuring tapes are laid out with zero at the baseline, the portion of the transect from meter 0 to meter 1 would be censused, followed by meter 2 to meter 3, in this manner until the water's edge is reached.

RM 254.0R--Quadrat Site

This site is located on a silt bar upstream of a lava cliff which extends to the water's edge. The site includes three quadrats, termed GB1, GB2, and GB3. GB2 is located near the downstream edge of the site; GB1 is upstream of GB2 and closer to the river; and GB3 is upstream of GB1 on a back terrace against the canyon wall. GB2 can be located using the lava cliff as a reference point. An X is painted at waist height on the rock wall at the back of the site, approximately 8m upstream from the upstream edge of the lava cliff. The DS stake is 12.34 meters from the painted X, at a bearing of 249 degrees. GB3 is located in a small alcove approximately 50m upstream of the lava cliff. An X is painted on the canyon wall at waist height; from this rock the DT stake is 2.0m at 251 degrees. GB1 must be located by searching the terrace area downstream and toward the river from GB3 for distinctive pink and yellow flagging.

RM 254.1L--Silt Terrace Transect Site

This site is located downstream and around a slight bend from the site at RM 254R. The site includes a vegetation patch in a small, shallow alcove. A landmark for this site is a cave in the redwall on river right, shaped like a crescent moon. This cave can first be seen when coming downriver and next to the site. An X is painted against the rock wall at the center rear of the site, and a tape was laid out between the X and the water's edge, perpendicular to the river. In each of the zones at this site (tamarisk adjacent to the talus slope, then seep willow, arroweed, and young tamarisk), ten 1-sq-m plots were sampled. Plot locations were randomized to be within 10m of the tape, and within the width of the zone. Five plots were sampled upstream of the tape, and five downstream. In each plot, basal cover of all live and dead plants was measured and recorded.

RM 260.2L--Quartermaster Canyon Avian and Mammal/Reptile Site

This site includes the entire marsh at Quartermaster Canyon, as well as the riverside vegetation. Two transects were cut at this site: the first cut through the center of the vegetation patch located upstream of Quartermaster Creek and ended on a bench overlooking the marsh. The second cut through the vegetation patch downstream of Quartermaster Creek, with a spur paralleling the river for the length of the patch and the main transect crossing onto a bench, down into the cattail marsh, out of the marsh, and up the drainage to a vantage point above the large springs at the back of Quartermaster marsh. A full census of this site included one survey along the transects and another while returning.

Mammal and reptile transects at this site include transects within the riparian vegetation, along the boundary between riparian and xeric vegetation, and in the upland xeric vegetation. All three transects were placed upstream of Quartermaster Creek. The riparian transect ran along the avian survey trail, roughly parallel to the creek with a spur running perpendicular to the creek. The transition zone transect was placed on an upper terrace covered by annual grasses and dry acacia and tamarisk. The upland zone transect was placed on the steep travertine slope above Quartermaster marsh, parallel to the creek.

RM 260.2R--Waterfall Rapids Avian Site

This site is directly across from the mouth of Quartermaster Canyon, and includes a long, narrow strip of vegetation on a terrace. A transect was cut through the center of the strip to allow a census of this site. Each census includes one survey down the length of the site and another while returning.

RM 261.5L--Silt Terrace Transect Site

This transect can be most easily relocated by using the map in Appendix A of the 1995 report. The transect location is within a large vegetation patch (the first very large patch on river left downstream of Quartermaster Canyon), approximately 300m upstream of the downstream end of the patch. A large X is painted on a 2m cliff face at the talus edge of the patch. A tape was laid perpendicular to the river from the X to the water's edge. Ten random 1-sq-m plots were sampled in each of the zones (a dead zone, tamarisk, Goodding's willow, and coyote willow).

RM 264.5L--Tincanebitts Canyon Silt Terrace Transect and Avian Site

This very large site encompasses a silt bar created at a bend in the river between RM 263.8 and RM 265.1. The upstream end of the site is across from Tincanebitts Canyon, and the downstream end site is approximately one mile upstream of and across the river from the Bat Caves. The vegetation transect cuts through the bend of the site, meeting the river immediately across from the downstream edge of the mouth of Dry Canyon (RM 264.5R). A large X is painted on a rock at the talus end of the transect. The transect runs from the X to where the vegetation patch ends across from the prominent outcrop at the downstream edge of the mouth of dry Canyon. Ten 1-sq-m plots were sampled in each of the zones (tamarisk, dead zone, tamarisk, dead coyote willow, Goodding's willow, and coyote willow).

A looping bird survey transect 2.5 miles long was cut through this site from the camp (cut from the vegetation at the site's downstream end) through the center of the downstream third of the site, and then looping through the upstream two-thirds of the site to allow a census of all resident birds. A spur was cut at the upstream end of the site to encompass a thin vegetation patch which parallels the river. A full census of this site includes one survey along the transect. The length of time required for a survey precludes the possibility of another survey while returning.

RM 269.6L--Silt Terrace Transect

This site is located in a cove approximately 1/2 mile downstream of a prominent travertine outcrop, cut by a slot canyon, on river right. An X is painted on a large rock on a sparsely vegetated silt terrace. The transect runs perpendicular to the river from the X through zones of tamarisk, Goodding's willow and cattail to the water's edge.

RM 273.1R--Silt Terrace Transect

This site is located at the downstream end of a very large vegetation patch on river right. Approximately 200m upstream of the end of the patch, an outcropping of dark red dolomite approximately 30m above the river marks the talus edge of the transect. A T is painted at the top of the dolomite outcrop, and points down to an X painted at the base of the rock cliff. The transect runs perpendicular to the river through tamarisk, Goodding's willow, and coyote willow zones to the river's edge.

Sampling Methodology

Quadrats

As is shown in Figure 1, quadrats are 5m x 10m, with the long axis aligned parallel to river flow. Each quadrat is divided into subplots 2.5m x 2.5m, which are numbered from upstream to downstream. Wooden stakes marked with the corner abbreviation (US, UT, DS, DT) were placed in at least two of the corners of each quadrat. Within each subplot, basal cover (cover at the base of the plant) of all live and dead plants should be measured. All subplots in each quadrat should be measured. All but OHWZ quadrats should be sampled annually, in the fall; OHWZ quadrats should be sampled at ten-year intervals.

Marshes

A baseline tape was laid out at the top edge of each marsh site. At regular intervals (3m or 5m), wooden stakes should be found. These mark the top of 1m transects. Each transect ran from the baseline tape, perpendicular to the tape down to the water's edge. At some sites, transects were upstream of the wooden stake, while at others the transect was downstream; consult the description of each site to determine which is appropriate. Each transect was divided into 1m subplots, numbered sequentially from the tape to the water. Basal cover of all live and dead plants was measured in each subplot.

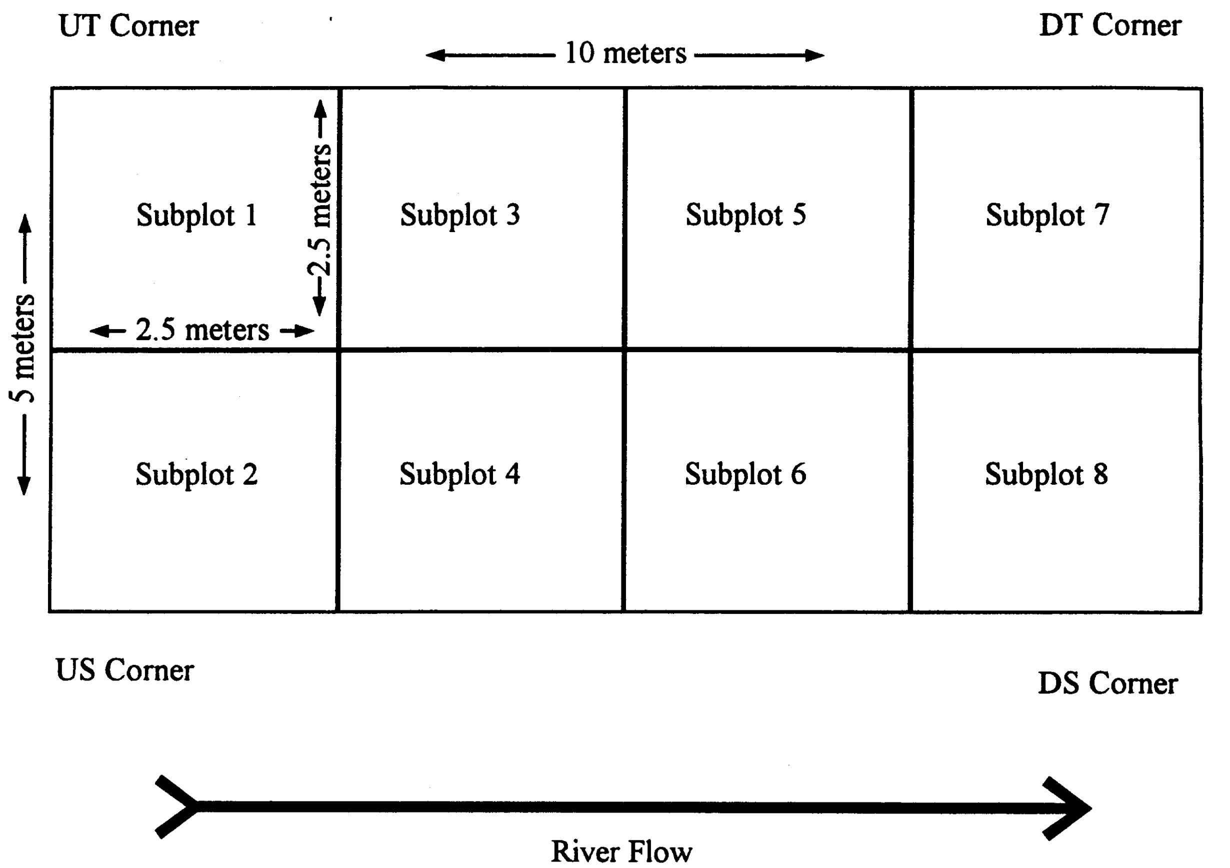
Silt Terrace Transects

From the X which marked the talus edge of each transect, a tape was laid out perpendicular to river flow from the X to the water's edge. Vegetation zones at each site were delineated; these were normally obvious. Ten 1-sq-m plots were sampled in each zone; these plots were randomly placed with five upstream and five downstream of the tape. Position along the tape and within 10m of the tape were randomized to create a unique location for each plot.

Avian Census

An experienced ornithologist walked the length of each avian transect or, where the site was easily crossed, the length of the site, and counted all singing male birds. These surveys were

Figure 1. Vegetation Quadrat Layout



Note: UT=upstream, talus side; US=upstream, stream (river) side; DT=downstream, talus side; DS=downstream, stream side.

begun before dawn, immediately after the peak of the morning bird chorus. The surveyor used a data sheet to track singing males by species and, where necessary, by location. One survey was conducted in one direction through the study site; after a 10 minute pause, another survey was conducted in the other direction. Maximum counts for each species from the two counts were recorded and used for data analysis.

Mammal Trapping

At approximately 10m intervals along each of the three transects at each site, a Sherman live trap was placed and baited with wet oats. Traps were placed in the evening and checked in the morning. Small mammals trapped were identified to species, and their transect type was recorded.

Reptile Census

Surveys for reptiles were conducted using the bird survey technique, but instead looking for lizards, snakes, and amphibians. Each of the three transects at each site was walked by an experienced biologist, and all reptile sightings were recorded by species and transect location. The best time to conduct surveys varies based upon weather and time of year; observation of areas provides an estimate of the best survey time.

APPENDIX E. BIBLIOGRAPHY OF RELEVANT LITERATURE

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APPENDIX F. REVISED PROPOSAL TO CONDUCT RIPARIAN STUDIES

ABSTRACT

SWCA, Inc. Environmental Consultants proposes to assist the Hualapai Tribe in baseline data collection and long-term monitoring through the lower Grand Canyon. Studies on the vegetative and animal communities of the Colorado River on the Hualapai Indian Reservation will be completed in coordination with Glen Canyon Environmental Studies. Changes that have occurred in these communities as a result of Glen Canyon Dam interim flow operations will be identified. Hualapai technicians will be integrated into the program to allow the Hualapai Tribe to perform future scientific monitoring, data collection, and analysis in the Colorado River corridor through the lower Grand Canyon.

STATEMENT OF OBJECTIVES

The riparian zone of the Colorado River through the Hualapai Indian Reservation in lower Grand Canyon is a complex and productive environment, and the Hualapai Tribe has strong cultural, environmental and economic ties to this portion of their reservation. SWCA proposes to work with the Hualapai Tribe and the Glen Canyon Environmental Studies program (GCES) to assess the influence of Glen Canyon Dam interim flow operations on the natural resources of Hualapai lands.

For centuries the riparian zone in the lower Grand Canyon has provided the Hualapai Tribe with resources used for consumption and for medicinal and religious purposes (Watahomigie et al. 1982). The Hualapai are committed to preserving this habitat that has figured so strongly in their history. Traditionally important plants including common reed (*Phragmites*), Goodding's willow (*Salix gooddingii*), arrowweed (*Tessaria sericea*), cattail (*Typha* sp.), seep willow (*Baccharis* sp.) and hackberry (*Celtis reticulata*) still occur in the riparian zone today, while clays used for pottery construction and minerals used for medicinal and religious purposes are also found along the Colorado River corridor.

SWCA proposes to evaluate the impacts of the interim flow operations on the development, structure and maintenance of the riparian plant and animal communities through the lower Grand Canyon. It is clear that this reach of the Grand Canyon has significant value to the Hualapai Tribe, as well as the potential to provide habitat to many riparian plants and animals.

A phased approach will be used to develop and implement the specific elements of the Hualapai interim flow riparian monitoring plan. In Phase I, baseline riparian resource data will be collected during fiscal year (FY) 1992. A preliminary study site and vegetation area map for the Colorado River along the Hualapai Reservation will be produced using GCES developed computer modeling with aerial and video photography. This map will be used in preliminary selection of study sites and will be refined and corrected as data are collected from study sites. Interim flow monitoring site selection will be based upon several factors, including the location of GCES long-term monitoring Geographic Information System (GIS) sites, stratification of the reach, and location of representative vegetation communities. Plant and animal surveys will be conducted at selected study sites to provide baseline data for Phase II monitoring.

Specific resource monitoring efforts will be designed and implemented in Phase II. Data will be collected annually at monitoring sites over a period of two years (FY 93 and FY 94). The impacts of interim flow discharge volumes, fluctuations, minimum and maximum discharges, and changes in discharge (ramping) on the riparian resources of this reach of the Colorado River will be assessed where possible. Data collected will be entered into a Scientific Information Database (SID), and will form an integral part of subsequent long-term riparian monitoring efforts.

Nine specific objectives are identified in this monitoring plan:

PHASE I

1. Review the existing literature and available data on plant and animal studies of the riparian corridor throughout the Grand Canyon.

2. Develop a baseline study site and vegetation area map with the use of the GCES Map Imaging Processing System (MIPS) and existing aerial photography.

3. Perform a baseline validation survey of the riparian communities along the lower Colorado River through the Hualapai Reservation, focusing upon the reach from Diamond Creek to Columbine Falls.

4. Establish interim flow monitoring sites and specific monitoring parameters for the lower Grand Canyon based on information collected under Objectives 1, 2, and 3.

5. Establish a Scientific Information Database (SID), consistent with GCES protocol, for data collected from interim flow monitoring sites.

PHASE II

6. Implement specific monitoring methodology, and conduct monitoring of selected study sites. Identify and evaluate changes in riparian communities and determine, to the extent possible, if they are a result of interim flows, or related to natural ecological processes. This short-term monitoring program will provide a baseline for long-term monitoring efforts. Evaluation will be focused on effects related to monthly volumes, maximum and minimum flow levels, ramping rates, and season.

7. Identify changes in vegetative community size and composition occurring throughout the time frame of the monitoring program at representative sites, and produce an updated map of vegetative communities at specific sites in the lower Grand Canyon.

8. Integrate the riparian and natural resource results with the Hualapai and GCES Geographic Information Systems (GIS), Scientific Information Database (SID), and long-term monitoring program.

9. Develop a long-term riparian system monitoring program for the Hualapai Tribe, with site selection, monitoring techniques, and analysis protocols compiled in a long-term monitoring field guide.

SWCA will implement a training program on all survey and monitoring trips, in which a Hualapai technician is paired with each senior scientist to learn survey methodology, sample collection, identification of plants, reptiles, mammals and birds, and proper data recording techniques. Each evening, project scientists will formally instruct the Hualapai technicians in field biology. This project presents a singular opportunity to provide Hualapai individuals with in-field training by highly qualified and experienced biologists. An herbarium of dried and pressed vegetation samples will be developed and maintained by Hualapai technicians with the aid of SWCA scientists. Pairing is proposed to be as follows:

Scientist	Title	Hualapai Technician
Steven W. Carothers, Ph.D.	Principal Investigator	Clay Bravo
Arthur M. Phillips, Ph.D.	Botanist	Mario Bravo
Bryan T. Brown, Ph.D.	Wildlife Biologist	Lydell Tapija
Amis C. Holm, M.S.	Ecologist/Database Manager	DeShane Quasula

The technical efforts are designed to integrate methodology and deliverables with previous and ongoing GCES research and monitoring in the Grand Canyon. This is important for several reasons: (1) the riparian corridor extending through Grand Canyon is itself an integrated system and must be studied as such; and (2) current and previous GCES studies and prior work of SWCA senior scientists, amounting to more than two decades of Colorado River research, provide compatible methodologies for the performance of vegetative and animal inventories and future monitoring.

JUSTIFICATION

Protection of all natural resources in the Grand Canyon is of profound cultural and religious significance to all members of the Hualapai Tribe. The Colorado River and the riparian zone that it supports provide the Hualapai Tribe with an economic livelihood through the development of a river recreation business and by helping to sustain the Desert Bighorn Sheep (*Ovis canadensis*) population, which is hunted through a permitting process with the Hualapai Tribe.

The riparian ecosystem on the Hualapai Tribal lands represents an important resource that has been affected by the operations of Glen Canyon Dam and which is likely to be affected by the Glen Canyon Dam interim flow operations. Limited previous information exists on baseline riparian structure in the lower Grand Canyon, providing a baseline for the proposed studies (Turner and Karpiscak 1980, Carothers and Aitchison 1976, Phillips 1976). Historic and recent studies have been limited in scope, however, and have typically ended at Diamond Creek and consequently the lower Hualapai riparian ecosystems have been ignored (Pucharelli 1988). Recently important cultural and natural resources have been identified in the lower river corridor. Marshes, vegetation in riparian systems, springs, and a Great Blue Heron (*Ardea herodias*) rookery are important resources that may be affected by the interim flow operations.

The Hualapai Tribe has been involved in the GCES and Glen Canyon Dam Environmental Impact Statement process since 1991. The Hualapai Tribe has identified the need to understand the relationship between the level of Colorado River flow and the riparian resources in the lower 108 miles of the Grand Canyon. Concern for their environmental resources dictates that the relationship between the influential operation of Glen Canyon Dam and the resources of the lower Grand Canyon be better understood.

Due to the current low level of Lake Mead, the flowing Colorado River influences all of the Colorado River corridor through the Hualapai Reservation. As significant changes in the lake level are not anticipated prior to the end of FY 92, the collection of baseline data in the area which was previously inundated by the lake but which is now actively affected by current release levels will provide valuable information regarding the impacts of interim flows on the lower Grand Canyon. The upper end of Lake Mead may provide habitat essential to the survival of the endangered Razorback Sucker (*Xyrauchen texanus*) and Yuma Clapper Rail (*Rallus longirostris*), plants, reptiles, mammals, and other species (USFWS 1991). Should the level of Lake Mead remain low, monitoring in this area will provide an assessment of the long-term effects of interim flows for this unique section.

PHASE I

Objective 1. *Review the existing literature and available data on plant and animal studies of the riparian corridor throughout the Grand Canyon.*

A review of literature, literature studies, and existing data on plant and animal studies in the lower Grand Canyon (Carothers and Aitchison 1976, Phillips 1976, Spamer 1990, Waring 1991, Ohmart et al. 1988) will provide a solid base of historic information from which specific sampling and analysis protocols can be developed.

Survey methodologies will be established which follow scientific practice to allow accurate statistical analysis and integration of this study with other Grand Canyon corridor studies and monitoring efforts.

Objective 2. *Develop a baseline study site and vegetation area map with the use of the GCES Map Imaging Processing System (MIPS) and existing aerial photography.*

Development of a baseline study site and vegetation area map will demonstrate the selection of monitoring sites and will provide a base for the measurement and evaluation of vegetation area changes during the monitoring program. Phase I and Phase II studies will provide comparative data to aid in the evaluation of the impacts of interim flows.

Objective 3. *Perform a baseline validation survey of the riparian communities along the lower Colorado River through the Hualapai Reservation, focusing upon the reach from Diamond Creek to Columbine Falls.*

Conducting a baseline survey of the riparian communities along the lower Grand Canyon will establish an informational base for the Phase II monitoring program. Using GCES maps and the MIPS technology as well as an on-site assessment of potential sites, survey sites will be established, at which specific data concerning plant and animal communities will be collected. This base of information will then permit a comparison of data throughout Phase II monitoring and an evaluation of riparian community changes resulting from interim flows.

Objective 4. *Establish interim flow monitoring sites and specific monitoring parameters for the lower Grand Canyon based on information collected under Objectives 1, 2, and 3.*

Data from a baseline survey of the riparian communities of the lower Grand Canyon will be evaluated and used to select and establish interim flow monitoring protocols and study sites. Use of baseline data for completion of this Objective will allow the use of an incremental, logical approach in the selection of long-term monitoring sites as well as the specific methodologies used to conduct long-term monitoring.

Objective 5. *Establish a Scientific Information Database (SID), consistent with GCES protocol, for data collected from interim flow monitoring sites.*

Maintenance of all monitoring data in a comprehensive database will allow ready comparison of data, precise assessment of accuracy, and continuity in data format throughout the long-term monitoring program.

PHASE II

Objective 6. *Implement specific monitoring methodology, and conduct monitoring of selected study sites. Identify and evaluate changes in riparian communities and determine, to the extent possible, if they are a result of interim flows, or related to natural ecological processes. This short-term monitoring program will provide a baseline for long-term monitoring efforts. Evaluation will be focused on effects related to monthly volumes, maximum and minimum flow levels, ramping rates, and season.*

Monitoring of study sites over a period of at least two years will allow an initial assessment and determination of the impacts of interim flows on riparian communities. Monitoring is essential to identify changes in riparian communities, as such changes occur slowly and in ways which can be difficult to predict. Monitoring will allow the Hualapai Tribe to evaluate changes resulting from interim flows as related to overall vegetative community diversity, structure, and size. Documentation of results throughout the monitoring program will provide a solid base of scientific data for use in future Grand Canyon studies. Development of a long-term monitoring methodology will enable the Hualapai Tribe to continue monitoring changes in the lower Grand Canyon.

Objective 7. *Identify changes in vegetative community size and composition occurring throughout the time frame of the monitoring program at representative sites, and produce an updated map of vegetative communities at specific sites in the lower Grand Canyon.*

Field surveys conducted during Phase I and monitoring conducted during Phase II will be combined with site-specific vegetative community mapping. This will potentially provide an understanding of vegetative community change in the lower Grand Canyon as a result of interim flows. The three GIS sites in the study area will be used for the mapping of vegetative communities. Mapping will take place on a yearly basis and will be supplemented by MIPS planimeter data on these sites to evaluate areal as well as community changes.

Objective 8. *Integrate the riparian and natural resource results with the Hualapai and GCES Geographic Information Systems (GIS), Scientific Information Database (SID), and long-term monitoring program.*

The integration of the technical data into the long-term monitoring, as well as the GIS and SID databases is essential since management of the resources and determination of impacts is a goal of the overall interim flow and monitoring program. GCES is providing the lead in the development and utilization of the data bases. Hualapai technicians will be trained in the use of the GIS and SID systems, allowing the Hualapai to interface with long-term GCES monitoring efforts.

Objective 9. *Develop a long-term riparian system monitoring program for the Hualapai Tribe, with site selection, monitoring techniques, and analysis protocols compiled in a long-term monitoring field guide.*

Based upon two years of monitoring, a long-term monitoring program will be developed which will continue to assess changes in the riparian system of the lower Grand Canyon. Use of the results of the proposed study to develop a long-term monitoring program will allow the subsequent collection of data in a manner which coordinates with previous and ongoing GCES monitoring programs.

BACKGROUND

Riparian habitat in the Southwest supports remarkably complex and productive communities of plants and animals (Carothers and Brown 1991). Numerous GCES studies and others have documented a similar pattern in the riparian zone in the Grand Canyon -- it supports a diverse assemblage of plants and animals. Today, GCES research and monitoring is being designed to address the influence of dam operations on this ecosystem (e.g. Stevens 1989, Stevens and Waring 1988, Anderson and Ruffner 1988, Brian 1988, Brown 1988, Waring and Stevens 1988, Warren and Schwalbe 1988). These studies are providing an understanding of both the initial and subsequent effects that the flow regimes of the Glen Canyon Dam have on riparian habitat in the Grand Canyon.

Several rare, threatened or endangered species are thought to occur in the lower Colorado River corridor, including McDougal's Flaveria (*Flaveria mcdougalli*), California Bear-Poppy (*Arctomecon californica*), Willow Flycatcher (*Empidonax traillii*), Yuma Clapper Rail, Peregrine Falcon, Desert Tortoise (*Xerobates agassizi*), Gila Monster (*Heloderma suspectum*), Zebra-tailed Lizard (*Callisaurus draconoides*), and Leopard Frog (*Rana pipiens*).

Limited studies of the lower Grand Canyon have been conducted prior to this effort, making it imperative that baseline research not be delayed. The riparian zone along the Colorado River through the Hualapai Reservation appears to be experiencing both erosion and aggradation of beaches due to Glen Canyon Dam operations. Between National Canyon and Separation Canyon there is evidence of considerable beach loss (L. Stevens, pers. comm., M. Bravo, pers. comm.), while between Separation Canyon and Lake Mead, aggradation appears to be extensive. Correspondingly, riparian communities in the upper stretch may be at risk, while in the lower stretch new communities are emerging. Riparian communities in the transition zone between Lake Mead and riverine influence represent a unique and highly valued resource.

While an increasing number of studies by GCES and others are documenting flow-related changes of specific taxa within riparian communities (Smith et al. 1991, Fenner et al. 1985), few have considered this relationship at the vegetative community level. With the Hualapai Tribe and GCES, SWCA proposes studies designed to evaluate the effects of Glen Canyon Dam interim flow operations on the vegetative and animal communities that occur along the Colorado River on the Hualapai Reservation. These studies will benefit the Hualapai by determining what species comprise these communities, how the communities are organized, and also will allow an assessment of the impacts of the current interim flow regime on these communities.

The riparian habitat along the Colorado River through the Hualapai Reservation, especially from Diamond Creek (River Mile 225) to the edge of the Grand Canyon at Columbine Falls (RM 274), is not well studied. Studies of riparian plants and animals there have been limited in scope and qualitative in nature (Phillips 1975, Phillips et al. 1977, Willson and Carothers 1978, Carothers and Aitchison 1976, Johnson and Hansen 1977), leaving us with only a preliminary sense of the extent and composition of this habitat.

METHODS

Compatibility of Methodologies Used in Upper and Lower Grand Canyon

To ensure that studies of the Colorado River through the Hualapai Reservation are compatible with methodologies used for similar studies in the upper reaches of the Grand Canyon (Ayers and Stevens 1991, 1992), meetings will be held between SWCA scientists, Hualapai researchers, and the principal investigators for studies in the upper Grand Canyon. Two meetings are scheduled, the first prior to the performance of Objectives 1 and 2, and the second prior to the first full-length survey trip (Objective 3). Formal methodologies for baseline vegetation studies will be established, and a communication base will be formed to ensure that the data collected during both studies will be of similar precision and in similar form. SWCA principal investigators (Carothers and Kimberling) have worked extensively with GCES upper Grand Canyon researchers (Ayers and Stevens), ensuring that similar methodologies will be used.

Sampling and Analysis Techniques

PHASE I

Objective 1. *Review the existing literature and available data on plant and animal studies of the riparian corridor throughout the Grand Canyon.*

The development of the specific interim flow monitoring plan will be preceded by a review of literature, literature studies, and data sources. This literature review will be coordinated with ongoing GCES literature reviews. A review of research previously conducted in the lower Grand Canyon will be used as a factor in the selection of survey sites and in analysis of MIPS maps. Critical parameters for the selection of study sites will be established.

Objective 2. *Develop a baseline study site and vegetation area map with the use of the GCES Map Imaging Processing System (MIPS) and existing aerial photography.*

MIPS technology, making use of recent video photography, will be used to create a map of study sites and vegetated areas in the lower Grand Canyon along the Hualapai Reservation. This map will be used to show the results of MIPS planimetering of vegetated areas and demonstrate the selection of study sites. Study sites will be chosen based upon the need for a stratified random sample and the location of existing GIS sites. This map will also provide an informational base which will be used throughout the monitoring study to measure and evaluate changes in vegetated areas as a result of interim flows. GCES will train SWCA and Hualapai scientists to use the MIPS technology and will provide the necessary equipment and aerial photography.

Objective 3. *Perform a baseline validation survey of the riparian communities along the lower Colorado River through the Hualapai Reservation, focusing upon the reach from Diamond Creek to Columbine Falls.*

Table 1. Schedule for Activities and Deliverables.

Fiscal Year 1992: Phase I

Project Initiation	May 15, 1992
Helicopter Reconnaissance	May, 1992
Meeting Between SWCA, Hualapai, and GCES	May, 1992
Production of Preliminary Vegetation Map Using MIPS	June 20, 1992
Meeting Between SWCA, Hualapai, and GCES	June, 1992
First Sampling Trip	June 1, 1992
Quarterly Report	July 1, 1992
Second Sampling Trip	July 1, 1992
Third Sampling Trip	August 1, 1992
Fourth Sampling Trip	September 1, 1992

Fiscal Year 1993: Phase II

Quarterly Report	October 1, 1992
Establish SID For All Data	November, 1992
Annual Report #1 (DRAFT)	December 15, 1992
Annual Report #1 (FINAL)	January 20, 1993
Quarterly Report	April 1, 1993
First Sampling Trip	May 1, 1993
Second Sampling Trip	June 1, 1993
Quarterly Report	July 1, 1993
Third Sampling Trip	July 1, 1993
Fourth Sampling Trip	August 1, 1993
Fifth Sampling Trip	September 1, 1993

Fiscal Year 1994: Phase II

Quarterly Report	October 1, 1993
Annual Report #2 (DRAFT)	December 1, 1993
Annual Report #2 (FINAL)	January 20, 1994
Quarterly Report	April 1, 1994
First Sampling Trip	May 1, 1994
Second Sampling Trip	June 1, 1994
Quarterly Report	July 1, 1994
Third Sampling Trip	July 1, 1994
Fourth Sampling Trip	August 1, 1994
Fifth Sampling Trip	September 1, 1994
Quarterly Report	October 1, 1994
FINAL REPORT (DRAFT)	December 1994
FINAL REPORT (FINAL)	February 1995

The study area includes both sides of the river corridor from National Canyon (RM 166) to Columbine Falls (RM 274). Study efforts will focus on the portion of the corridor from Diamond Creek (RM 225) to Columbine Falls (RM 274). A helicopter reconnaissance trip to identify potential study sites will be conducted in May of 1992. Four survey trips are scheduled for FY 92: 1) a reconnaissance trip in June to field-check MIPS maps, perform a preliminary selection of study sites, familiarize the project scientists with the current status of the lower Grand Canyon under the interim flows regime, and to establish working relationships between Hualapai technicians and project scientists; 2) an 8-day survey trip from Diamond Creek to Pierce Ferry, in which permanent study sites will be chosen and established, and surveys will begin; 3) a 15-day survey trip from Phantom Ranch to Pierce Ferry, in which the reach from National Canyon to Columbine Falls will be evaluated for establishment of future monitoring sites, comparison of vegetative and animal communities in the upper (above Diamond Creek) and lower (below Diamond Creek) reaches of the Colorado River through the Hualapai Reservation, and continued study of permanent sites in the lower reach; and 4) an 8-day survey trip from Diamond Creek to Pierce Ferry, which will conclude baseline survey efforts (Table 1).

While similar sampling methodologies will be used during Phase I in the upper portion of study area (Diamond Creek to Separation) and the lower portion (Separation to Columbine Falls), it is anticipated that the results and potentially the long-term monitoring techniques for the lower portion will be separate due to the effects of Lake Mead. The lower portion is currently affected by interim flows due to the low level of Lake Mead, and it is expected that the lake will remain low at least through FY 92. The recent inundation of these areas by the lake and the sedimentation which has occurred there since the closing of Glen Canyon Dam will create a unique study area to assess the impacts of interim flows.

VEGETATION COMMUNITY STUDIES

Interim flow monitoring sites will be selected utilizing the locations of previous study sites, the location of the GCES GIS monitoring sites, important resource locations, and representative resource locations. Previous study sites include Bridge Canyon and Rampart Cave (Carothers and Aitchison 1976). Due to its significance to the Hualapai Tribe, Spencer Canyon will also be evaluated as a potential study site. GCES GIS monitoring sites include Diamond Creek (RM 225 to 230) and Columbine Falls (RM 273 to 276).

The reach from Diamond Creek to Columbine Falls will be statistically stratified in order to select representative sites. Sample plots will be placed randomly but within a stratified vegetational community where appropriate. The sites to be monitored will be placed in the following geomorphic settings: marsh, riparian strip, general beach (all in the New High Water Zone), and debris fan environments (Ayers and Stevens 1992). Sampling techniques will be established following the completion of Objective 1 and coordination with GCES riparian system researchers (Ayers and Stevens).

Fluvial Marsh Sites

Fluvial marsh sites will be identified using MIPS during completion of Objective 2. Four marsh sites will be chosen based upon geomorphology, inundation frequency, and vegetative cover. The fluvial marsh sites will be censused once per year during Phase I and Phase II, including low, moderate, and high interim flows. Compositional changes during the interim flows period will be identified. Transects will be established in each marsh, with data on basal area, density and species composition collected. Changes in soil profiles relating to deposition or erosion will also be noted. All above-ground growth and litter will be collected from each of three 0.5 m^2 plots annually in each marsh to monitor productivity. Colonization of these plots will be monitored to evaluate changes in marsh development rates under interim flows. Studies will be coordinated with Hualapai aquatic studies where possible.

Riparian Vegetation

Fifteen study sites will be established, covering the different geomorphic settings and including study sites placed in the study reaches by Stevens *et. al.* A maximum of three 5m x 10m quadrats will be established in each of the study sites. These study sites will be designed for monitoring Glen Canyon Dam discharge impacts on riparian vegetation development. Quadrats will be divided into eight subplots for censusing and mapping purposes, and will be used to monitor species composition, germination, growth rates, soil changes, ground cover, and shrub cover. A species list will be compiled at each site to detect and monitor the distribution of critical native plant species in the river corridor (Phillips 1986, Ayers and Stevens 1991).

It is anticipated that placement of the study sites and quadrats will allow evaluation of plant communities which hold importance for the Hualapai Tribe, including cattail marshes, Goodding's willow and coyote willow stands, tamarisk-dominated stands, tamarisk and *Baccharis salicifolia* stands.

An herbarium collection will be made by SWCA botanists and Hualapai technicians to document the vegetative species currently found in the lower Grand Canyon.

ANIMAL COMMUNITY STUDIES

Mammal Surveys

Transects will be established within each of four vegetative community types sufficient to permit characterization of mammal populations. Three sets of trap lines, each 200m in length, will be established. Live trapping stations will be established within each site, and the area outside each site will be spot-checked to identify sign of mammals which are not identified by trapping (i.e. Desert Bighorn Sheep). These monitoring sites will be surveyed annually to determine the number of species and species individuals occurring in these communities.

All small mammal trapping will be done using folded aluminum Sherman live traps, 8 x 8.5 x 23 cm in size. The bait will be a peanut butter-rolled oats mixture. A space will be cleared of litter and vegetation where each trap will be placed to attract small mammals and locate the station. Traps will be set in late afternoon, checked in the morning, and kept closed during the day. Two traps will be set at each station. Trapped mammals will be identified by species, and after all pertinent information is collected, the mammals will be released near the point of capture except where the mammal should be kept as a museum specimen (Duncan 1990). A minimum of five individuals of each species will be collected, if possible, to provide adequate characterization of the small mammals inhabiting Hualapai lands in the Grand Canyon.

Reptile Surveys

Study sites established for mammal surveys will also be used for reptilian surveys. Pedestrian surveys of each site will be conducted in the morning and evening. Attempts will be made to capture, measure, mark and release all reptiles found. Each will be identified as to species, and relative frequency of capture will be documented. Comparisons will be made between reptile populations in the Old High Water Zone and in the New High Water Zone. In areas of appropriate habitat, drift fences with traps at each end will be used to capture snake species (Rosen and Schwalbe 1988).

Avian Censusing

Surveys will be conducted for breeding birds, Peregrine Falcon and other raptors, and the Yuma Clapper Rail. All avian surveys will be coordinated with National Park Service and GCES avian survey efforts. Modified Emlen censusing techniques known as the Absolute Count method (Carothers and Johnson 1974, Carothers and Brown 1987) will be used to census breeding birds between Diamond Creek and Separation Canyon (RM 240), while the commonly used Emlen censusing techniques, based on the spot-map method (Kendeigh 1944), will be used to census breeding birds between Separation Canyon and Columbine Falls. Breeding bird censuses will be conducted during survey trips in May, June, and July.

A minimum of five study sites will be chosen across a range of geomorphic and vegetative types and patch sizes for breeding bird censuses. Patch sizes will vary to determine distinctions between avifauna found in small versus large patches, and to determine variations in the species composition of sites in the portion of the Grand Canyon affected by the flowing Colorado River, which are generally very small, and sites along Lake Mead, which include large cattail marshes. It is anticipated that breeding bird surveys will include the Southwest Willow Flycatcher.

Peregrine Falcon sampling surveys following the protocol of Brown (Brown et al. 1992) will be conducted at 10-mile intervals during May and July survey trips. Yuma Clapper Rail and Southwest Willow Flycatcher surveys will be coordinated with U.S. Fish and Wildlife Service and National Park Service activities in Grand Canyon, and will consist of tape recorded surveys conducted in at least two large marsh areas (Johnson et al. 1981).

Objective 4. *Establish interim flow monitoring sites and specific monitoring parameters for the lower Grand Canyon based on information collected under Objectives 1, 2, and 3.*

Based upon the results of the literature search, MIPS work, coordination with upper Grand Canyon researchers, and baseline surveys, monitoring techniques and long-term monitoring sites will be established. Study sites established in Objective 3 will become long-term monitoring sites, except in cases where new sites are established or sites are determined to be unsuitable for long-term monitoring. The logic for the selection of long-term monitoring sites will be clearly and decisively established.

Objective 5. *Establish a Scientific Information Database (SID), consistent with GCES protocol, for data collected from interim flow monitoring sites.*

A central database will be established, with protocols developed to ensure consistent data collection, entry, and manipulation throughout the long-term monitoring program. GCES has initiated development of the SID, and will provide the training and use of computers for this Objective.

PHASE II

Objective 6. *Implement specific monitoring methodology, and conduct monitoring of selected study sites. Identify and evaluate changes in riparian communities and determine, to the extent possible, if they are a result of interim flows, or related to natural ecological processes. This short-term monitoring program will provide a baseline for long-term monitoring efforts. Evaluation will be focused on effects related to monthly volumes, maximum and minimum flow levels, ramping rates, and season.*

Objective 6 begins Phase II of the Hualapai riparian monitoring project. It is anticipated that this phase will begin in the first part of FY 93 and extend through the end of FY 94 or until the end of the interim flows. The use of five transects in the reach below RM 240 to characterize and study the vegetation which has colonized depositional silt bars will allow a more complete understanding of this area than using quadrats alone. Transects will begin at the highest vegetated terrace deposited as the level of Lake Mead dropped and extend perpendicular to the river to the water's edge. In each vegetation zone, ten 1m square plots will be randomly selected and censused. Transects will be recensused during each year of Phase II.

Phase II monitoring trips are expected to resemble Phase I trips, both in timing and in coordination with low, moderate, and high flows. Approximately five monitoring trips will be conducted each year, with at least one trip each year to conduct monitoring of vegetative and animal communities between National Canyon and Diamond Creek.

Objective 7. *Identify changes in vegetative community size and composition occurring throughout the time frame of the monitoring program at representative sites, and produce an updated map of vegetative communities at specific sites in the lower Grand Canyon.*

A detailed map will be developed which a) describes vegetative communities and community changes at the three mapping sites; b) shows the area in hectares of vegetation communities; and c) details the locations of vegetation, avian, mammalian and reptile study sites. This map will allow a clear, concise presentation of study results and an evaluation of riparian community changes over time. This Objective will be completed at the end of FY 94, and will form a part of the final report.

Objective 8. *Integrate the riparian and natural resource results with the Hualapai and GCES Geographic Information Systems (GIS), Scientific Information Database (SID), and long-term monitoring program.*

Survey results will be in a format that will allow simple entry into the Hualapai and GCES GIS systems and the GCES SID system as it is developed. As methodologies will be based upon historical data as well as communications with other scientists, all studies will be compatible with the GCES long-term monitoring program.

Objective 9. *Develop a long-term riparian system monitoring program for the Hualapai Tribe, with site selection, monitoring techniques, and analysis protocols compiled in a long-term monitoring field guide.*

Based upon the findings of Objectives 6, 7, and 8 and upon an assessment of established monitoring sites, a long-term riparian monitoring program for the lower Grand Canyon will be developed. The parameters and logic for the establishment of the long-term monitoring program will be clear and will provide a stepwise reasoning for continuing monitoring efforts.

DELIVERABLES

Completion of Phase I will produce data on vegetative and animal species composition and demography in the lower Grand Canyon. An herbarium and mammal specimen collection will be established, which will be expanded as necessary during Phase II. Information collected in Phase I will provide the baseline data for Phase II monitoring and determination of changes in plant communities as a result of interim flows. Quarterly and annual reports will be produced according to the time line shown in Table 1.

During Phase II, updated maps of vegetative communities will be developed, and quantitative data on change in extent and composition of vegetative and animal communities in the lower Grand Canyon will be collected and compiled. Recommendations will be made for long-term monitoring efforts beyond FY 94. Quarterly, annual, and final reports will be produced according to Table 1. The final report will be published in a peer-reviewed scientific journal.

Table 2 details deliverables for each phase.

Table 2. Project Deliverables.

PHASE I: FY 92

1. Base map of vegetation area and study sites.
2. Logic for establishment of interim flow monitoring sites and quadrats within sites.
3. Protocol for entry and manipulation of data with Scientific Information Database.
4. Methodologies and site locations for interim flows monitoring program.
5. Quarterly and annual reports.

PHASE II: FY 93 and FY 94

1. Updated base map showing changes in areal extent and community distribution at six mapping sites; the location of study sites; and the area in hectares of the riparian vegetation of the lower Grand Canyon.
2. Quarterly, annual, and final reports detailing findings of the impacts of interim flows on the riparian community in the lower Grand Canyon.
3. Final database with protocol for analysis.
4. Herbarium collection with slides of all vegetation species collected.
5. Provide data to GCES for inclusion in GIS for the two GIS sites located within the study area.
5. Prioritized recommendations for long-term monitoring efforts beyond FY 94, including additional GIS sites if needed, and compilation of specific long-term monitoring protocols into a field guide.

INTEGRATION WITH OTHER GCES MONITORING EFFORTS

As SWCA and the Hualapai Tribe join the GCES in research, the work being proposed is designed to integrate with previous and current GCES research on plants, animals and sediments in the Grand Canyon. The riparian corridor through Grand Canyon reflects a continuum of processes from erosional to aggradational, and the proposed lower reach interim flow monitoring will help to complete an understanding of this process and its effects on associated resources. The riparian work proposed will be compatible with that ongoing in the upper Grand Canyon, and will enhance the understanding of the structure of riparian plant communities and how they are changing. Other GCES studies ongoing or planned include aquatic studies, GIS surveys, long-term monitoring, and avian surveys.

The proposed studies will contribute essential data on plants and animals to these long-term, multifaceted research efforts. Additionally, the use of MIPS to measure area of beaches, as well as plant communities in the lower Grand Canyon, will be compared with results found in the upper Grand Canyon in other GCES studies.

SCHEDULING

Quarterly and annual reports will be provided to the Glen Canyon Environmental Studies according to the schedule in Table 1. A Draft Final Report will be distributed for technical review as specified by the GCES and a Final report will be developed at the completion of the interim flow monitoring program. The schedule outline in Table 1 will be followed for this interim flow monitoring project, but may be adjusted pending determination of the date of the actual contract initiation.

PERSONNEL

Technical Staff

Four scientists will collect and analyze data for this project. A project manager will be the contact point for the project, establish logistics, and coordinate completion of interim and final reports. Combined, the experience of these professional biologists in studying the plants and animals of the Grand Canyon totals 71 years. Each scientist is involved with ongoing work in the field of riparian ecosystem analysis. Curriculum vitae are attached. Duties will be as follows:

Steven W. Carothers, Ph.D.	Principal Investigator
Arthur M. Phillips III, Ph.D.	Botanist
Bryan T. Brown, Ph.D.	Wildlife Biologist
Amis C. Holm, M.S.	Ecologist/Database Manager
Brice J. Hoskin	Project Manager

Other Agency Involvement

The GCES will provide the primary river and helicopter logistical support and the technical expertise and equipment for the surveying efforts, except where supplies are provided by SWCA or the Hualapai Tribe. Where boats and guides are supplied by SWCA and the Hualapai Tribe, GCES will provide for further logistics including primarily provision of food supplies. The National Park Service will provide technical scientific support and input into the design and development of the monitoring site locations. The GCES will provide the technical support in the training and use of the MIPS system and the development of the GIS sites.

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APPENDIX G. HERBARIUM SPECIES LIST

Scientific Name	Common Name	Collection Locations	Habitat
Abronia elliptica	Sand-verbena	225.5L	Beach
Abutilon incanum	Indian mallow	228.9L	Side canyon
Acacia greggii	Catclaw acacia	236.5L, 238.5L	Beach
Adiantum capillus-veneris	Maidenhair fern	235L, 228.9L	Side canyon
Agave utahensis var. utahensis	Utah agave	272L	Desert
Agrostis semiverticillata	Waterbent	237.3L, 252.3R	Riparian
Allionia incarnata	Trailing four-o'clock	246L, 259.7R	Desert
Ambrosia dumosa	White bursage	238.3L	Desert
Amphipappus fremontii	Chaff-bush	275L	Desert
Amsinckia tessellata	Checker fiddleneck	238.3L	Desert
Andropogon gerardi	Blue-stem	254.6R	Side canyon
Andropogon glomeratus	Bushy beardgrass	235L	Desert
Anemone tuberosa	Desert windflower	238.3L	Desert
Aquilegia chrysantha	Golden columbine	229L	Seep
Arabis perennans	Perennial rock-cress	239.5L	Desert
Arctomecon californica	California bear poppy	270.5L	Side can. desert
Argythamnia neomexicana	New Mexican ditaxis	259.7R	Desert
Aristida parishii	Parish three-awn	231.5L	Desert
Aristida purpurea var. glauca	Purple three-awn	238L	Beach
Aster spinosus	Spiny aster	225.5L	Beach
Aster subulatus var. ligulatus	Aster	225.5 L, 228.9L, 239.6L, 246L, 254R	Riparian
Astragalus episcopus		235L	Beach
Astragalus nuttallianus	Nuttall locoweed	238.3L	Desert
Atrichoseris platyphylla	Parachute plant	259.7R	Desert
Atriplex confertifolia	Shadscale	270L	Desert
Atriplex hymenelytra	Desert holly	268.8L	Desert
Baccharis emoryi	Emory seep-willow	238.5L	Riparian
Baccharis salicifolia	Seep-willow	235L, 252.3R	Riparian
Baccharis sergiloides	Waterweed, Desert-broom	272L	Side canyon
Bebbia juncea	Chuckwalla's delight	230.5L	Beach
Bernardia incana	Bernardia	270.5L	Side canyon
Boerhaavia intermedia	Spiderling	246L	Side canyon
Boerhaavia wrightii	Spiderling	246L	Side canyon
Bothriochloa barbinodis	Cane bluestem	228.9L, 238L	Beach
Bouteloua barbata	Six-weeks grama	246L	Side canyon
Bouteloua trifida	Red grama	259.7R	Desert
Bowlesia incana	Hairy bowlesia	275L	Desert

Scientific Name	Common Name	Collection Locations	Habitat
Brickellia coulteri	Coulter brickell-bush	235L, 239.5L	Desert
Brickellia longifolia	Long-leaf brickell-bush	271.8L	Riparian
Bromus arizonicus	Arizona brome	225.5L	Riparian
Bromus rubens	Red brome, foxtail brome	225.5L	Riparian
Calochortus flexuosus	Weakstem mariposa lily	239.5L, 254.6R	Desert
Camissonia brevipes	Yellow cups	259.7R	Desert
Camissonia multijuga	Evening primrose	235L, 254.6R	Side canyon
Camissonia refracta	Evening primrose	259.7R	Desert
Camissonia speculicola ssp. hesperia	Evening primrose	235L, 246L	Side canyon
Celtis reticulata	Netleaf hackberry	272L	Side canyon
Centaurium calycosum	Buckley's centaury	228.9L, 246L, 249.4L	Riparian
Ceratoides lanata	Winter fat	270.5L	Side canyon
Chaenactis fremontii	Fremont desert pincushion	275L	Desert
Chaenactis stevioides	Desert pincushion	225.5L	Beach
Chorizanthe brevicornu	Brittle spineflower	259.7R	Desert
Chorizanthe rigida	Spiny-herb	259.7R	Desert
Cladium californicum	Saw grass	235L	Side canyon
Conyza canadensis	Horseweed	228.8L, 239.6L	Riparian
Crossosoma bigelovii	Bigelow ragged rock flower	239.5L	Desert
Cryptantha barbigera	Bearded cryptantha	224.6L, 235L	Desert
Cryptantha holoptera	Winged cryptantha	254.6R	Side canyon
Cryptantha maritima	Beach cryptantha	254.6R	Side canyon
Cryptantha micrantha	Purple-rooted cryptantha	225.5L	Beach
Cryptantha pterocarya	Wing nut cryptantha	224.6L	Desert
Cryptantha racemosa	Woody cryptantha	259.5L	Desert
Cryptantha utahensis	Utah cryptantha	238.3L	Desert
Cucurbita palmata	Coyote melon	232.5R	Beach
Cynodon dactylon	Bermuda grass	246L	Riparian
Cyperus erythrorhizos	Flat-sedge	259R	Riparian
Datura meteloides	Sacred datura	246L	Side canyon
Delphinium parishii	Desert larkspur	272L	Desert
Descurainia pinnata	Yellow tansy mustard	235L	Desert
Dichelostemma pulchellum	Blue-dicks	225.5L	Beach
Draba cuneifolia var. integrifolia	Whitlow-grass	224.6L, 259.5L	Desert
Dyssodia pentachaeta	Dogweed, Fetid marigold	259.7R	Desert
Echinochloa crusgalli	Barnyard grass	259.7R	Riparian
Eleocharis parishii	Parish spike-rush	246L	Side canyon
Encelia farinosa	White brittlebush	259.7R	Desert

Scientific Name	Common Name	Collection Locations	Habitat
Ephedra nevadensis	Nevada Indian-tea	238.5L, 275L	
Epipactis gigantea	Helleborine orchid	270.5L	Seeps, springs
Erigeron lobatus	Lobeleaf fleabane	229L	Beach
Eriogonum deflexum	Skeleton weed	246L	Side canyon
Eriogonum fasciculatum	California buckwheat	224.6L	Desert
Eriogonum inflatum	Trumpet buckwheat	259.7R	Desert
Eriogonum wrightii	Wright's shrubby buckwheat	235L	Desert
Erioneuron pulchellum	Fluff grass	259.7R	Desert
Eriophyllum lanosum	Woolly daisy	275L	Desert
Erodium cicutarium	Filaree	238.3L	Desert
Eschscholzia glyptosperma	Desert poppy	275L	Desert
Eschscholzia minutiflora	Little gold poppy	254.6R	Desert
Eucnide urens	Rock nettle	273L	Desert
Eucrypta micrantha	Small-flowered eucrypta	229L	Desert
Euphorbia polycarpa	small-seeded sand mat	246L	Side canyon
Euphorbia revoluta	Spurge	246L	Side canyon
Fouquieria splendens	Ocotillo	259.7R	Desert
Fraxinus pennsylvanica ssp. velutina	Velvet ash	270.5L	Side canyon
Galium aparine	Goose grass bedstraw	275L	Desert
Galium stellatum	Desert bedstraw	224.6L	Desert
Gaura parviflora	Small-flowered gaura	225.5L	Beach
Gilia scopulorum	Rock gilia	268.8L	Desert
Gnaphalium chilense	Cudweed	246L, 252.3R	Riparian
Gutierrezia microcephala	Snakeweed	228.9L	Desert
Haplopappus acradenius	Goldenweed	235L	Riparian
Haplopappus salicinus	Borroweed	228.9L	Side canyon
Haplopappus spinulosus var. gooddingii	Spiny goldenweed	224.6L, 275L	Desert
Hedeoma nanum ssp. nanum	Dwarf mock-pennyroyal	228.9L	Side canyon
Hedeoma oblongifolium	Mock-pennyroyal	254.6R	Side canyon
Hilaria rigida	Big galleta grass	259.7R, 275L	Desert
Hordeum leporinum	Wild barley	225.5L	Riparian
Hutchinsia procumbens		238.3L	Desert
Juncus acutus var. sphaerocarpus	Spiny rush	229L	Riparian
Juncus articulatus	Jointed rush	246L	Riparian
Juncus torreyi	Torrey rush	228.9L, 249.4L, 254R, 266.5R	Riparian
Krameria parvifolia	Range ratany	259.7R	Desert
Lactuca serriola	Prickly lettuce	246L	Riparian
Larrea tridentata	Creosotebush	238.5L, 259.7R	Desert

Scientific Name	Common Name	Collection Locations	Habitat
Layia glandulosa	White layia	259.7R	Desert
Lepidium fremontii	Desert alyssum	272L	Desert
Lepidium lasiocarpum	Peppergrass	235L	Desert
Leptochloa uninerva	Mexican spangletop	254R, 266.5R	Beach
Linanthus aureus	Yellow linanthus	254.6R	Desert
Linanthus bigelovii	Bigelow linanthus	259.7R	Desert
Linanthus demissus	Prostrate linanthus	259.7R	Desert
Lotus wrightii	Wright lotus	246L	Side canyon
Lupinus arizonicus	Arizona lupine	239.5R	Side canyon
Lythrum californicum	Hierba del Cancer	246L	Side canyon
Malacothrix glabrata	Desert dandelion	260.5L	Desert
Maurandya antirrhiniflora	Twining snapdragon	228.9L, 235L	Side can.
Melilotus albus	White sweet-clover	238.5L	Riparian
Mentzelia puberula	Rough-stemmed blazing-star	270.5L	Desert
Mentzelia pumila	Stick-leaf	246L	Side canyon
Mentzelia tricuspis	Shiny-leaved blazing-star	259.7R, 275L	Desert
Mimulus cardinalis	Cardinal monkeyflower	229L, 235L	Seep
Mimulus guttatus	Yellow monkeyflower	246L	Side canyon
Mirabilis bigelovii	Wishbone bush	224.6L	Desert
Mortonia scabrella var. utahensis	Sandpaper-bush	270.5L	Side canyon
Muhlenbergia asperifolia	Alkali muhly	235L	Side canyon
Muhlenbergia porteri	Bush muhly	254.6R	Side canyon
Nemacladus glanduliferus	Thread plant	259.7R	Desert
Nicotiana trigonophylla	Desert tobacco	235L	Desert
Nolina microcarpa	Beargrass	270.5L	Side canyon
Notholaena parryi	Parry lip-fern	238.3L	Desert
Oenothera pallida	Pale evening-primrose	225.5L	Beach
Panicum capillare	Witchgrass	254R	Riparian
Panicum obtusum	Vine mesquite	228.8L	Riparian
Parietaria hespera	Pellitory	235L	Desert
Pectocarya heterocarpa	Hairy-leaved comb-bur	225.5L	Beach
Pectocarya platycarpa	Flat-seeded comb-bur	259.7R	Desert
Penstemon palmeri	Palmer beardtongue	270.5L	Side canyon
Perityle emoryi	Emory rock-daisy	235L	Desert
Petrophytum caespitosum	Rock mat	270.5L	Side canyon
Petunia parviflora	Wild petunia	246L	Side canyon
Peucephyllum schottii	Pygmy cedar	246L	Desert
Phacelia crenulata	Scorpionweed	254.6R, 259.7R	Desert
Phacelia glechomaefolia	Grand Canyon scorpionweed	239.5R, 254.6R, 270.5L	Side canyon
Phacelia ivesiana	Ives phacelia	224.6L	Desert

Scientific Name	Common Name	Collection Locations	Habitat
Phacelia laxiflora	Crevice phacelia	270.5L	Side canyon
Phacelia rotundifolia	Round-leaf phacelia	235L	Desert
Pholistoma auritum	Fiesta flower	238.3L	Desert
Phoradendron californicum	Desert mistletoe	225.5L	Beach
Phragmites australis	Giant common reed	235L	Side canyon
Physalis crassifolia	Thick-leaf ground cherry	235L, 238.3L	Side can.
Plantago insularis	Burro Indianwheat	259.7R	Desert
Plantago major	Common plantain	259R	Riparian
Pleurocoronis pluriseta	Arrowleaf	254.6R, 270.5L	Side canyon
Pluchea purpurascens	Salt-marsh fleabane	249.4L, 259R	Riparian
Poa bigelovii	Bigelow bluegrass	235L	Side can.
Polygonum lapathifolium	Willow weed	254R	Riparian
Polypogon monspeliensis	Rabbitfoot grass	252.3R	Riparian
Populus fremontii	Fremont cottonwood	246L	Side canyon
Porophyllum gracile	Poreleaf	224.6L, 238.5L, 272L	Desert
Prosopis glandulosa var. torreyana	Torrey mesquite	246L	Beach
Pterostagia drymarioides		229L, 238.3L	Side can.
Rafinesquia neomexicana	Desert chicory	275L	Desert
Rorippa palustris	Bog marsh cress	270L	Riparian
Salazaria mexicana	Bladder-sage	239.5L	Desert
Salix exigua	Coyote willow	262.5R	Riparian
Salix gooddingii	Goodding willow	262.5R	Riparian
Sarcostemma cynanchoides	Climbing milkweed	235L	Side can.
Salvia davidsonii	Davidson sage	228.9L	Side canyon
Scirpus americanus	Bulrush	254R	Riparian
Scirpus maritimus var. paludosus	Bulrush	259R, 266.5R	Riparian
Senecio mohavensis	Mohave groundsel	238.3L	Desert
Senecio quercetorum	Groundsel	235L	Side can.
Senna covesii	Hairy senna	246L, 259.7R	Desert
Setaria leucopila	Bristle-grass	228.9L	Side canyon
Silene antirrhina	Sleepy catchfly	259.7R	Desert
Sisymbrium irio	London rocket	225.5L	Riparian
Solanum americanum	American nightshade	239.5R, 264R	Side canyon
Solidago altissima	Late goldenrod	231.5L	Riparian
Solidago occidentalis	Western goldenrod	228.8L, 238L	Riparian
Sonchus oleraceus	Common sow-thistle	225.5L, 235L, 238.3L	Riparian
Sphaeralcea ambigua	Desert mallow	259.5L	Desert

Scientific Name	Common Name	Collection Locations	Habitat
Sphaeralcea grossulariaefolia	Gooseberryleaf globemallow	235L	Desert
Sporobolus airoides	Alkali sacaton	231.5L	Beach
Sporobolus cryptandrus	Sand dropseed	231.5L, 238L	Beach
Sporobolus flexuosus	Mesa dropseed	225.5L	Beach
Sporobolus giganteus	Giant dropseed	236.5L	Beach
Stanleya pinnata	Prince's plume	271.8L	Beach
Stemodia durantifolia	Stemodia	246L	Side canyon
Stephanomeria pauciflora	Wire-lettuce	235L	Beach
Stylocline micropoides	Desert nest straw	224.6L, 239.5L	Desert
Suaeda torreyana	Desert seepweed	270.5L	Seeps, springs
Tamarix chinensis	Salt-cedar, Tamarisk	252.3R	Riparian
Tessaria sericea	Arrowweed	271.8L	Beach
Thamnosma montana	Turpentine broom	270.5L	Side canyon
Tidestromia oblongifolia	Tidestromia	235L	Side canyon
Tiquilia canescens	Shrubby coldenia	259.7R	Desert
Trichachne californica	Cotton-top	247L	Beach
Tridens muticus	Slim tridens	254.6R	Side canyon
Trixis californica	Trixis	235L	Desert
Typha domingensis	Southern cattail	238.5L	Riparian
Verbena gooddingii	Goodding verbena	275L	Desert
Veronica anagallis-aquatica	Water speedwell	238.5L	Side canyon
Viguiera deltoidea	Triangle-leaf goldeneye	272L	Side canyon
Vulpia octoflora	Six-weeks fescue	225.5L	Beach
Xylorhiza tortifolia	Mohave aster	238.3L	Desert

APPENDIX H. VEGETATION DATA SUMMARY

GROWTH-FORM CATEGORIES　　　　TR=transect; plain miles= LTPs

Woody= shrubs, trees, cattails, cactus
HERBACEOUS -(ANNUAL/PERENNIAL when known) includes unknown dicot seedlings
GRASS (ANNUAL/PERENNIAL when known)
UNKNOWN (most are probably herbaceous)

DATE	MILE	Geomorph. ZONE	SPP	# of sp	cm^2 sum B.A.	BA/m^2	Total BA/pl	% of tota Basal are	% of area censused	cm^2 Basal area	growth form % of total	growth form	scientific name
92	TR254	1	CYDA	7	925.334	0.000057	0.0093	0.006	0.0001	5.655	0.611%	grass-perennial	Cynodon dactylon
92	TR254	1	UDS			0.000000		0.000	0.0000	0.008		herbaceous	
92	TR254	1	SPHAERALCEA			0.000000		0.000	0.0000	0.031	0.003%	herbaceous-perennial	
92	TR254	1	BASL			0.000209		0.023	0.0002	20.909	99.385%	woody	Baccharis salicifolia
92	TR254	1	ENFA			0.000008		0.001	0.0000	0.785		woody	Encelia farinosa
92	TR254	1	TARA			0.008965		0.969	0.0090	896.477		woody	Tamarix sp?
92	TR254	1	TESE			0.000015		0.002	0.0000	1.469		woody	Tessaria sericia
931018	TR254	1	BRRU	4	363.820	0.000011	0.0036	0.003	0.0000	1.100		grass-annual	Bromus rubens
931018	TR254	1	CYDA			0.000002		0.000	0.0000	0.157	0.043%	grass-perennial	Cynodon dactylon
931018	TR254	1	TARA			0.003427		0.942	0.0034	342.708	99.655%	woody	Tamarix sp?
931018	TR254	1	TESE			0.000199		0.055	0.0002	19.855		woody	Tessaria sericia
940927	TR254	1	BRRU	5	271.198	0.000275	0.0027	0.101	0.0003	27.489		grass-annual	Bromus rubens
940927	TR254	1	SPCR			0.000007		0.003	0.0000	0.723	0.266%	grass-perennial	Sporobolus cryptandrus
940927	TR254	1	UDS			0.000000		0.000	0.0000	0.008		herbaceous	
940927	TR254	1	TARA			0.002359		0.870	0.0024	235.910	89.595%	woody	Tamarix sp?
940927	TR254	1	TESE			0.000071		0.026	0.0001	7.069		woody	Tessaria sericia
92	TR254	2	CYDA	4	218.942	0.000041	0.0022	0.019	0.0000	4.104	1.874%	grass-perennial	Cynodon dactylon
92	TR254	2	BASL			0.000749		0.342	0.0007	74.927	98.126%	woody	Baccharis salicifolia
92	TR254	2	TARA			0.000074		0.034	0.0001	7.406		woody	Tamarix sp?
92	TR254	2	TESE			0.001325		0.605	0.0013	132.505		woody	Tessaria sericia
931018	TR254	2	CYDA	5	318.804	0.000723	0.0032	0.227	0.0007	72.346	22.737%	grass-perennial	Cynodon dactylon
931018	TR254	2	GP			0.000001		0.000	0.0000	0.141		grass-perennial	
931018	TR254	2	BASAL			0.000388		0.122	0.0004	38.822	77.263%	woody	Baccharis salicifolia
931018	TR254	2	TARA			0.000241		0.076	0.0002	24.112		woody	Tamarix sp?
931018	TR254	2	TESE			0.001834		0.575	0.0018	183.383		woody	Tessaria sericia
940927	TR254	2	SPCR	3	230.098	0.000581	0.0023	0.253	0.0006	58.119	25.259%	grass-perennial	Sporobolus cryptandrus
940927	TR254	2	BASL			0.000151		0.066	0.0002	15.111	74.741%	woody	Baccharis salicifolia
940927	TR254	2	TESE			0.001569		0.682	0.0016	156.868		woody	Tessaria sericia
92	TR254	3	COCA	4	71.944	0.000038	0.0007	0.053	0.0000	3.801		herbaceous-annu	Conyza canadensis
92	TR254	3	BASL			0.000226		0.314	0.0002	22.616	94.716%	woody	Baccharis salicifolia
92	TR254	3	TARA			0.000066		0.091	0.0001	6.563		woody	Tamarix sp?
92	TR254	3	TESE			0.000390		0.542	0.0004	38.964		woody	Tessaria sericia
931018	TR254	3	CYDA	4	167.777	0.000157	0.0017	0.094	0.0002	15.708	9.362%	grass-perennial	Cynodon dactylon
931018	TR254	3	BASAL			0.000583		0.348	0.0006	58.339	90.638%	woody	Baccharis salicifolia
931018	TR254	3	TARA			0.000073		0.043	0.0001	7.281		woody	Tamarix sp?

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
931018	TR254	3	TESE			0.000864		0.515	0.0009	86.449		woody	Tessaria sericia
940927	TR254	3	SPCR	3	146.705	0.000161	0.0015	0.110	0.0002	16.132	10.996%	grass-perennial	Sporobolus cryptandrus
940927	TR254	3	BASL			0.000714		0.487	0.0007	71.401	89.004%	woody	Baccharis salicifolia
940927	TR254	3	TESE			0.000592		0.403	0.0006	59.172		woody	Tessaria sericia
92	TR254	4	BASL	3	47.297	0.000098	0.0005	0.208	0.0001	9.833	100.000%	woody	Baccharis salicifolia
92	TR254	4	TARA			0.000334		0.706	0.0003	33.395		woody	Tamarix sp?
92	TR254	4	TESE			0.000041		0.086	0.0000	4.068		woody	Tessaria sericia
931018	TR254	4	CYDA	5	107.026	0.000002	0.0011	0.002	0.0000	0.188	0.176%	grass-perennial	Cynodon dactylon
931018	TR254	4	COCA			0.000001		0.001	0.0000	0.094		herbaceous-annu	Conyza canadensis
931018	TR254	4	BASAL			0.000015		0.014	0.0000	1.500	99.736%	woody	Baccharis salicifolia
931018	TR254	4	TARA			0.000055		0.052	0.0001	5.537		woody	Tamarix sp?
931018	TR254	4	TESE			0.000997		0.932	0.0010	99.706		woody	Tessaria sericia
940927	TR254	4	SPCR	4	164.769	0.000003	0.0016	0.002	0.0000	0.314	0.191%	grass-perennial	Sporobolus cryptandrus
940927	TR254	4	BASL			0.000006		0.004	0.0000	0.628	99.809%	woody	Baccharis salicifolia
940927	TR254	4	TARA			0.000040		0.024	0.0000	3.982		woody	Tamarix sp?
940927	TR254	4	TESE			0.001598		0.970	0.0016	159.844		woody	Tessaria sericia
92	TR254	5	POMO	8	84.252	0.000503	0.0008	0.597	0.0005	50.265		grass-annual	Polypogon monspeliensis
92	TR254	5	CYDA			0.000003		0.004	0.0000	0.328	0.529%	grass-perennial	Cynodon dactylon
92	TR254	5	GP			0.000001		0.001	0.0000	0.118		grass-perennial	
92	TR254	5	GNCH			0.000001		0.001	0.0000	0.110		herbaceous	Gnaphalium chilense
92	TR254	5	UDS			0.000000		0.001	0.0000	0.043		herbaceous	
92	TR254	5	BASL			0.000204		0.242	0.0002	20.381	39.628%	woody	Baccharis salicifolia
92	TR254	5	TARA			0.000125		0.149	0.0001	12.511		woody	Tamarix sp?
92	TR254	5	TESE			0.000005		0.006	0.0000	0.495		woody	Tessaria sericia
931018	TR254	5	SCIRPUS	5	266.896	0.000006	0.0027	0.002	0.0000	0.628	0.235%	herbaceous-perennial	
931018	TR254	5	BASAL			0.000596		0.223	0.0006	59.596	99.765%	woody	Baccharis salicifolia
931018	TR254	5	SAEX			0.000096		0.036	0.0001	9.621		woody	Salix exigua
931018	TR254	5	TARA			0.001835		0.688	0.0018	183.534		woody	Tamarix sp?
931018	TR254	5	TESE			0.000135		0.051	0.0001	13.517		woody	Tessaria sericia
						0.000000		0.000	0.0000				
940927	TR254	5	PHAU	4	290.354	0.000003	0.0029	0.001	0.0000	0.283	0.097%	grass-perennial	Phragmites australis
940927	TR254	5	BASL			0.000085		0.029	0.0001	8.529	99.903%	woody	Baccharis salicifolia
940927	TR254	5	TARA			0.002789		0.961	0.0028	278.911		woody	Tamarix sp?
940927	TR254	5	TESE			0.000026		0.009	0.0000	2.631		woody	Tessaria sericia
						0.000000			0.0000				
93	TR261	1	GA	7	109.367	0.000010	0.0011	0.009	0.0000	0.990		grass-annual	
93	TR261	1	GP			0.000000		0.000	0.0000	0.008	0.007%	grass-perennial	
93	TR261	1	Cirsium			0.000051		0.047	0.0001	5.137		herbaceous	not all are native
93	TR261	1	APCA			0.000001		0.001	0.0000	0.126	0.115%	herbaceous-pere	Apocynum cannabinum
93	TR261	1	BASL			0.000059		0.054	0.0001	5.898	94.276%	woody	Baccharis salicifolia
93	TR261	1	SAGO			0.000031		0.029	0.0000	3.142		woody	Salix goodingii
93	TR261	1	TARA			0.000941		0.860	0.0009	94.067		woody	Tamarix sp?
						0.000000		0.000	0.0000				
92	TR261	2	BASAL	3	979.973	0.000049	0.0098	0.005	0.0000	4.909	100.000%	woody	Baccharis salicifolia
92	TR261	2	SAGO			0.002138		0.218	0.0021	213.825		woody	Salix goodingii
92	TR261	2	TARA			0.007612		0.777	0.0076	761.239		woody	Tamarix sp?

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
						0.000000		0.000	0.0000				
93	TR261	2	BASL	2	143.924	0.001369	0.0014	0.951	0.0014	136.856	100.000%	woody	Baccharis salicifolia
93	TR261	2	TARA			0.000071		0.049	0.0001	7.069		woody	Tamarix sp?
						0.000000		0.000	0.0000				
940927	TR261	2	TARA	1	6.346	0.000063	0.0001	1.000	0.0001	6.346	100.000%	woody	Tamarix sp?
92	TR261	3	SAEX	4	817.191	0.002032	0.0082	0.249	0.0020	203.206	100.000%	woody	Salix exigua
92	TR261	3	SAGO			0.005940		0.727	0.0059	593.957		woody	Salix goodingii
92	TR261	3	TARA			0.000085		0.010	0.0001	8.522		woody	Tamarix sp?
92	TR261	3	TESE			0.000115		0.014	0.0001	11.506		woody	Tessaria sericia
						0.000000		0.000	0.0000				
93	TR261	3	Cirsium	4	1365.391	0.000222	0.0137	0.016	0.0002	22.242		herbaceous	not all are native
93	TR261	3	SAGO			0.013313		0.975	0.0133	1331.289	98.371%	woody	Salix goodingii
93	TR261	3	TARA			0.000012		0.001	0.0000	1.155		woody	Tamarix sp?
93	TR261	3	TESE			0.000107		0.008	0.0001	10.705		woody	Tessaria sericia
						0.000000		0.000	0.0000				
940927	TR261	3	SAGO	3	1578.328	0.015576	0.0158	0.987	0.0156	1557.649	100.000%	woody	Salix goodingii
940927	TR261	3	TARA			0.000088		0.006	0.0001	8.804		woody	Tamarix sp?
940927	TR261	3	TESE			0.000119		0.008	0.0001	11.875		woody	Tessaria sericia
						0.000000		0.000	0.0000				
92	TR261	4	ASSU	7	206.921	0.000000	0.0021	0.000	0.0000	0.016		herbaceous	Aster subulatus
92	TR261	4	GNCH			0.000001		0.000	0.0000	0.071		herbaceous	Gnaphalium chilense
92	TR261	4	COCA			0.000008		0.004	0.0000	0.825		herbaceous-annu	Conyza canadensis
92	TR261	4	MESA			0.000003		0.002	0.0000	0.314	0.152%	herbaceous-pere	Medicago sativa
92	TR261	4	BASL			0.000001		0.001	0.0000	0.141	99.408%	woody	Baccharis salicifolia
92	TR261	4	SAEX			0.002039		0.986	0.0020	203.929		woody	Salix exigua
92	TR261	4	TARA			0.000016		0.008	0.0000	1.626		woody	Tamarix sp?
						0.000000		0.000	0.0000				
93	TR261	4	ASSU	11	221.301	0.000005	0.0022	0.002	0.0000	0.479		herbaceous	Aster subulatus
93	TR261	4	ASTER			0.000002		0.001	0.0000	0.173		herbaceous	
93	TR261	4	Cirsium			0.000036		0.016	0.0000	3.629		herbaceous	not all are native
93	TR261	4	GNCH			0.000023		0.010	0.0000	2.262		herbaceous	Gnaphalium chilense
93	TR261	4	UDS			0.000008		0.004	0.0000	0.785		herbaceous	
93	TR261	4	COCA			0.000006		0.003	0.0000	0.565		herbaceous-annu	Conyza canadensis
93	TR261	4	MELILOTUS			0.000021		0.010	0.0000	2.128		herbaceous-annu	Melilotus
93	TR261	4	BASL			0.000390		0.176	0.0004	38.987	95.471%	woody	Baccharis salicifolia
93	TR261	4	SAEX			0.001659		0.750	0.0017	165.939		woody	Salix exigua
93	TR261	4	TARA			0.000009		0.004	0.0000	0.895		woody	Tamarix sp?
93	TR261	4	TYPHA			0.000055		0.025	0.0001	5.458		woody	
						0.000000		0.000	0.0000				
940927	TR261	ZONE 4	COCA	7	242.657	0.000002	0.0024	0.001	0.0000	0.220		herbaceous-annu	Conyza canadensis
940927	TR261	ZONE 4	MEAL			0.000005		0.002	0.0000	0.503		herbaceous-annu	Melilotus alba
940927	TR261	ZONE 4	BASL			0.000350		0.144	0.0003	34.974	99.702%	woody	Baccharis salicifolia
940927	TR261	ZONE 4	SAEX			0.001906		0.786	0.0019	190.616		woody	Salix exigua
940927	TR261	ZONE 4	SAGO			0.000162		0.067	0.0002	16.187		woody	Salix goodingii
940927	TR261	ZONE 4	TARA			0.000000		0.000	0.0000	0.031		woody	Tamarix sp?
940927	TR261	ZONE 4	TESE			0.000001		0.001	0.0000	0.126		woody	Tessaria sericia
						0.000000		0.000	0.0000				
921209	TR264	1	BRRU?	3	41.177	0.000012	0.0004	0.030	0.0000	1.217		grass-annual	Bromus rubens
921209	TR264	1	UDS			0.000015		0.036	0.0000	1.476		herbaceous	
921209	TR264	1	TARA			0.000385		0.935	0.0004	38.485	93.460%	woody	Tamarix sp?
						0.000000			0.0000				

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
93	TR264	1	POMO	6	769.533	0.000017	0.0077	0.002	0.0000	1.696		grass-annual	Polypogon monspeliensis
93	TR264	1	POLYGONUM			0.000001		0.000	0.0000	0.063		herbaceous	Polygonum sp
93	TR264	1	Eriogonum			0.000045		0.006	0.0000	4.508		unknown	
93	TR264	1	SAIB			0.000001		0.000	0.0000	0.126	99.186%	woody	Salsola iberica
93	TR264	1	SALSOLA			0.000059		0.008	0.0001	5.859		woody	Salsola
93	TR264	1	TARA			0.007573		0.984	0.0076	757.281		woody	Tamarix sp?
						0.000000			0.0000				
940927	TR264	1	SAIB	2	28.010	0.000008	0.0003	0.028	0.0000	0.790	100.000%	woody	Salsola iberica
940927	TR264	1	TARA			0.000272		0.972	0.0003	27.220		woody	Tamarix sp?
						0.000000		0.000	0.0000				
921209	TR264	2	BRRU	4	17.603	0.000129	0.0002	0.734	0.0001	12.920		grass-annual	Bromus rubens
921209	TR264	2	BRTE			0.000017		0.098	0.0000	1.728		grass-annual	Bromus tectorum
921209	TR264	2	UDS			0.000022		0.123	0.0000	2.170		herbaceous	
921209	TR264	2	APCA			0.000008		0.045	0.0000	0.785	4.462%	herbaceous-pere	Apocynum cannabinum
						0.000000		0.000	0.0000				
93	TR264	2	APCA	4	10.933	0.000034	0.0001	0.315	0.0000	3.440	31.466%	herbaceous-pere	Apocynum cannabinum
93	TR264	2	BASL			0.000045		0.415	0.0000	4.532	68.534%	woody	Baccharis salicifolia
93	TR264	2	SAIB			0.000000		0.003	0.0000	0.031		woody	Salsola iberica
93	TR264	2	TARA			0.000029		0.268	0.0000	2.930		woody	Tamarix sp?
						0.000000		0.000	0.0000				
940927	TR264	2	TARA	1	832.648	0.008326	0.0083	1.000	0.0083	832.648	100.000%	woody	Tamarix sp?
						0.000000			0.0000				
921209	TR264	3	BRRU	4	172.261	0.000028	0.0017	0.016	0.0000	2.780		grass-annual	Bromus rubens
921209	TR264	3	UDS			0.000018		0.011	0.0000	1.846		herbaceous	
921209	TR264	3	APCA			0.000110		0.064	0.0001	10.996	6.383%	herbaceous-pere	Apocynum cannabinum
921209	TR264	3	TARA			0.001566		0.909	0.0016	156.640	90.931%	woody	Tamarix sp?
						0.000000		0.000	0.0000				
93	TR264	3	GA	3	390.382	0.000008	0.0039	0.002	0.0000	0.817		grass-annual	
93	TR264	3	GP			0.000001		0.000	0.0000	0.126	0.032%	grass-perennial	
93	TR264	3	TARA			0.003894		0.998	0.0039	389.440	99.759%	woody	Tamarix sp?
						0.000000		0.000	0.0000				
940927	TR264	3	TARA	2	259.291	0.002159	0.0026	0.833	0.0022	215.898	100.000%	woody	Tamarix sp?
940927	TR264	3	TYPHA			0.000434		0.167	0.0004	43.393		woody	
						0.000000		0.000	0.0000				
921209	TR264	4	UDS	3	128.263	0.000008	0.0013	0.006	0.0000	0.801		herbaceous	
921209	TR264	4	SAEX			0.000805		0.628	0.0008	80.503	99.375%	woody	Salix exigua
921209	TR264	4	TARA			0.000470		0.366	0.0005	46.959		woody	Tamarix sp?
						0.000000		0.000	0.0000				
93	TR264	4	Cirsium	4	722.024	0.000008	0.0072	0.001	0.0000	0.785		herbaceous	not all are native
93	TR264	4	BASL			0.001374		0.190	0.0014	137.437	99.891%	woody	Baccharis salicifolia
93	TR264	4	SAGO			0.005775		0.800	0.0058	577.464		woody	Salix goodingii
93	TR264	4	TARA			0.000063		0.009	0.0001	6.338		woody	Tamarix sp?
						0.000000		0.000	0.0000				
940927	TR264	4	BASL	4	341.240	0.001239	0.0034	0.363	0.0012	123.928	100.000%	woody	Baccharis salicifolia
940927	TR264	4	SAEX			0.000175		0.051	0.0002	17.499		woody	Salix exigua
940927	TR264	4	SAGO			0.001353		0.396	0.0014	135.285		woody	Salix goodingii
940927	TR264	4	TARA			0.000645		0.189	0.0006	64.528		woody	Tamarix sp?
						0.000000		0.000	0.0000				
921209	TR264	5	UNKGRASS	9	94.130	0.000000	0.0009	0.000	0.0000	0.031		grass	
921209	TR264	5	GNCH			0.000001		0.001	0.0000	0.055		herbaceous	Gnaphalium chilense
921209	TR264	5	UDS			0.000374		0.397	0.0004	37.416		herbaceous	
921209	TR264	5	basal rosette?			0.000003		0.004	0.0000	0.338		herbaceous	

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
921209	TR264	5	COCA			0.000099		0.105	0.0001	9.912		herbaceous-annu	Conyza canadensis
921209	TR264	5	BASAL			0.000127		0.135	0.0001	12.716	49.270%	woody	Baccharis salicifolia
921209	TR264	5	SAEX			0.000143		0.151	0.0001	14.255		woody	Salix exigua
921209	TR264	5	SAGO			0.000137		0.146	0.0001	13.705		woody	Salix goodingii
921209	TR264	5	TARA			0.000057		0.061	0.0001	5.702		woody	Tamarix sp?
93	TR264	5	CYDA	5	99.180	0.000009	0.0010	0.010	0.0000	0.942		grass-perennial	Cynodon dactylon
93	TR264	5	BASL			0.000245		0.247	0.0002	24.528	99.050%	woody	Baccharis salicifolia
93	TR264	5	SAEX			0.000144		0.146	0.0001	14.443		woody	Salix exigua
93	TR264	5	SAGO			0.000261		0.263	0.0003	26.114		woody	Salix goodingii
93	TR264	5	TARA			0.000332		0.334	0.0003	33.152		woody	Tamarix sp?
						0.000000		0.000	0.0000				
940927	TR264	5	SOOL	3	162.450	0.000001	0.0016	0.001	0.0000	0.140		herbaceous-annu	Sonchus oleracea
940927	TR264	5	BASL			0.000606		0.373	0.0006	60.625	99.914%	woody	Baccharis salicifolia
940927	TR264	5	SAEX			0.001017		0.626	0.0010	101.686		woody	Salix exigua
						0.000000		0.000	0.0000				
92	TR269	1	BRRU?	3	231.103	0.000089	0.0023	0.039	0.0001	8.938		grass-annual	Bromus rubens
92	TR269	1	UDS			0.000001		0.001	0.0000	0.141		herbaceous	
92	TR269	1	TARA			0.002220		0.961	0.0022	222.024	96.071%	woody	Tamarix sp?
						0.000000		0.000	0.0000				
93	TR269	1	GA	2	135.897	0.000031	0.0014	0.023	0.0000	3.142		grass-annual	
93	TR269	1	TARA			0.001328		0.977	0.0013	132.756	97.688%	woody	Tamarix sp?
						0.000000		0.000	0.0000				
940928	TR269	1	TARA	1	223.116	0.002231	0.0022	1.000	0.0022	223.116	100.000%	woody	Tamarix sp?
						0.000000			0.0000				
92	TR269	2	BRRU?	5	378.146	0.000052	0.0038	0.014	0.0001	5.184		grass-annual	Bromus rubens
92	TR269	2	UDS			0.000014		0.004	0.0000	1.359		herbaceous	
92	TR269	2	BASL			0.000599		0.158	0.0006	59.887	98.270%	woody	Baccharis salicifolia
92	TR269	2	SAGO			0.001681		0.444	0.0017	168.075		woody	Salix goodingii
92	TR269	2	TARA			0.001436		0.380	0.0014	143.641		woody	Tamarix sp?
						0.000000		0.000	0.0000				
93	TR269	2	GA	9	449.845	0.000064	0.0045	0.014	0.0001	6.440		grass-annual	
93	TR269	2	GP			0.000001		0.000	0.0000	0.063	0.014%	grass-perennial	
93	TR269	2	GNCH			0.000001		0.000	0.0000	0.063		herbaceous	Gnaphalium chilense
93	TR269	2	UDS			0.000007		0.001	0.0000	0.660		herbaceous	
93	TR269	2	APCA			0.000012		0.003	0.0000	1.217	0.271%	herbaceous-pere	Apocynum cannabinum
93	TR269	2	UNK MACCROPHITE			0.000010		0.002	0.0000	0.997		unknown	
93	TR269	2	BASL			0.000269		0.060	0.0003	26.900	97.901%	woody	Baccharis salicifolia
93	TR269	2	SAGO			0.003860		0.858	0.0039	385.984		woody	Salix goodingii
93	TR269	2	TARA			0.000275		0.061	0.0003	27.520		woody	Tamarix sp?
						0.000000		0.000	0.0000				
940928	TR269	2	PHAU	7	308.977	0.000722	0.0031	0.234	0.0007	72.178	23.360%	grass-perennial	Phragmites australis
940928	TR269	2	POLA			0.000015		0.005	0.0000	1.461		herbaceous	Polygonum lapathifolium
940928	TR269	2	Polygonum sp			0.000034		0.011	0.0000	3.393		herbaceous	Polygonum sp
940928	TR269	2	BASL			0.000230		0.075	0.0002	23.044	75.069%	woody	Baccharis salicifolia
940928	TR269	2	SAGO			0.001636		0.530	0.0016	163.646		woody	Salix goodingii
940928	TR269	2	TARA			0.000382		0.124	0.0004	38.186		woody	Tamarix sp?
940928	TR269	2	TYPHA			0.000071		0.023	0.0001	7.070		woody	
						0.000000		0.000	0.0000				
92	TR269	3	UNKGRASS	9	211.539	0.000008	0.0021	0.004	0.0000	0.785		grass	
92	TR269	3	Ga			0.000045		0.021	0.0000	4.477		grass-annual	
92	TR269	3	POMO			0.001649		0.780	0.0016	164.934		grass-annual	Polypogon monspeliensis
92	TR269	3	ASSU			0.000026		0.013	0.0000	2.647		herbaceous	Aster subulatus

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
92	TR269	3	UDS			0.000240		0.114	0.0002	24.033		herbaceous	
92	TR269	3	COCA			0.000001		0.000	0.0000	0.079		herbaceous-annu	Conyza canadensis
92	TR269	3	PLUCHEA?			0.000006		0.003	0.0000	0.573		herbaceous-annual	
92	TR269	3	BASL			0.000013		0.006	0.0000	1.288	6.624%	woody	Baccharis salicifolia
92	TR269	3	SAGO			0.000127		0.060	0.0001	12.723		woody	Salix goodingii
						0.000000		0.000	0.0000				
940928	TR269	3	ECCR	6	265.394	0.000143	0.0027	0.054	0.0001	14.318		grass-annual	Echinochloa crusgalii
940928	TR269	3	PHAU			0.001021		0.385	0.0010	102.102	38.472%	grass-perennial	Phragmites australis
940928	TR269	3	CYPERUS			0.000504		0.190	0.0005	50.399		herbaceous-annu	Cyperus erythrorhizos
940928	TR269	3	SAGO			0.000014		0.005	0.0000	1.429	37.143%	woody	Salix goodingii
940928	TR269	3	TARA			0.000001		0.000	0.0000	0.063		woody	Tamarix sp?
940928	TR269	3	TYPHA			0.000971		0.366	0.0010	97.083		woody	
						0.000000		0.000	0.0000				
92	TR269	4	GRASS	13	80.645	0.000079	0.0008	0.097	0.0001	7.854		grass	
92	TR269	4	UNKGRASS			0.000008		0.010	0.0000	0.785		grass	
92	TR269	4	POMO			0.000040		0.050	0.0000	4.045		grass-annual	Polypogon monspeliensis
92	TR269	4	AGROSTIS			0.000031		0.039	0.0000	3.142	3.896%	grass-perennial	
92	TR269	4	ASSU			0.000008		0.010	0.0000	0.785		herbaceous	Aster subulatus
92	TR269	4	GNCH			0.000000		0.000	0.0000	0.024		herbaceous	Gnaphalium chilense
92	TR269	4	UDS			0.000374		0.464	0.0004	37.385		herbaceous	
92	TR269	4	basal rosette			0.000000		0.001	0.0000	0.047		herbaceous	
92	TR269	4	COCA			0.000108		0.133	0.0001	10.760		herbaceous-annu	Conyza canadensis
92	TR269	4	BASL			0.000008		0.010	0.0000	0.825	19.614%	woody	Baccharis salicifolia
92	TR269	4	SAEX			0.000012		0.015	0.0000	1.233		woody	Salix exigua
92	TR269	4	TARA			0.000002		0.002	0.0000	0.173		woody	Tamarix sp?
92	TR269	4	TYDO			0.000136		0.168	0.0001	13.587		woody	Typha domingensis
						0.000000		0.000	0.0000				
92	TR269	5	JUNCUS	12	88.109	0.000001	0.0009	0.002	0.0000	0.134	0.152%	herbaceous-perennial	
92	TR269	5	Ga			0.000039		0.045	0.0000	3.927		grass-annual	
92	TR269	5	POMO			0.000020		0.022	0.0000	1.966		grass-annual	Polypogon monspeliensis
92	TR269	5	Gp			0.000094		0.107	0.0001	9.448	10.723%	grass-perennial	
92	TR269	5	GNCH			0.000000		0.000	0.0000	0.008		herbaceous	Gnaphalium chilense
92	TR269	5	UDS			0.000008		0.009	0.0000	0.825		herbaceous	
92	TR269	5	basal rosette			0.000011		0.013	0.0000	1.123		herbaceous	
92	TR269	5	VERONICA			0.000000		0.000	0.0000	0.039	0.045%	herbaceous-perennial	
92	TR269	5	UNK			0.000063		0.071	0.0001	6.283		unknown	
92	TR269	5	SAEX			0.000144		0.164	0.0001	14.412	73.041%	woody	Salix exigua
92	TR269	5	TARA			0.000015		0.017	0.0000	1.461		woody	Tamarix sp?
92	TR269	5	TYPHA			0.000485		0.550	0.0005	48.483		woody	
						0.000000		0.000	0.0000				
92	TR273	1	BRRU?	2	1014.075	0.000003	0.0101	0.000	0.0000	0.314		grass-annual	Bromus rubens
92	TR273	1	TARA			0.010138		1.000	0.0101	1013.761	99.969%	woody	Tamarix sp?
						0.000000			0.0000				
940928	TR273	1	ECCR	6	154.700	0.000006	0.0015	0.004	0.0000	0.565		grass-annual	Echinochloa crusgalii
940928	TR273	1	Polygonum sp			0.000024		0.015	0.0000	2.356		herbaceous	Polygonum sp
940928	TR273	1	THISTLE			0.000031		0.020	0.0000	3.142		herbaceous	
940928	TR273	1	KOCHIA			0.000008		0.005	0.0000	0.785		unknown	not in Phillips
940928	TR273	1	SAGO			0.000126		0.081	0.0001	12.566	95.573%	woody	Salix goodingii
940928	TR273	1	TARA			0.001353		0.874	0.0014	135.285		woody	Tamarix sp?
						0.000000		0.000	0.0000				
92	TR273	2	BRRU?	5	281.322	0.000027	0.0028	0.010	0.0000	2.749		grass-annual	Bromus rubens
92	TR273	2	ASSU			0.000005		0.002	0.0000	0.550		herbaceous	Aster subulatus

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
92	TR273	2	UDS			0.000011		0.004	0.0000	1.107		herbaceous	
92	TR273	2	SAEX			0.001313		0.467	0.0013	131.350	98.434%	woody	Salix exigua
92	TR273	2	TARA			0.001456		0.517	0.0015	145.566		woody	Tamarix sp?
						0.000000		0.000	0.0000				
940928	TR273	2	ECCR	5	112.990	0.000296	0.0011	0.262	0.0003	29.649		grass-annual	Echinochloa crusgalii
940928	TR273	2	Polygonum sp			0.000378		0.334	0.0004	37.778		herbaceous	Polygonum sp
940928	TR273	2	CYPERUS			0.000177		0.156	0.0002	17.671		herbaceous-annu	Cyperus erythrorhizos
940928	TR273	2	SAGO			0.000196		0.174	0.0002	19.630	24.686%	woody	Salix goodingii
940928	TR273	2	TARA			0.000083		0.073	0.0001	8.262		woody	Tamarix sp?
						0.000000		0.000	0.0000				
92	TR273	3	ASSU	5	544.562	0.000002	0.0054	0.000	0.0000	0.173		herbaceous	Aster subulatus
92	TR273	3	UDS			0.000000		0.000	0.0000	0.014		herbaceous	
92	TR273	3	SAEX			0.000230		0.042	0.0002	22.973	99.966%	woody	Salix exigua
92	TR273	3	SAGO			0.005105		0.937	0.0051	510.501		woody	Salix goodingii
92	TR273	3	TARA			0.000109		0.020	0.0001	10.901		woody	Tamarix sp?
						0.000000		0.000	0.0000				
940928	TR273	3	ECCR	7	101.992	0.000060	0.0010	0.059	0.0001	5.969		grass-annual	Echinochloa crusgalii
940928	TR273	3	CYER			0.000303		0.297	0.0003	30.254		herbaceous-annu	Cyperus erythrorhizos
940928	TR273	3	CYPERUS			0.000020		0.019	0.0000	1.979		herbaceous-annu	Cyperus erythrorhizos
940928	TR273	3	SODO=Solanum douglasii			0.000004		0.004	0.0000	0.416	0.408%	herbaceous-pere	SODO=Solanum douglasii
940928	TR273	3	SAEX			0.000008		0.008	0.0000	0.785	62.136%	woody	Salix exigua
940928	TR273	3	SAGO			0.000603		0.591	0.0006	60.326		woody	Salix goodingii
940928	TR273	3	TARA			0.000023		0.022	0.0000	2.262		woody	Tamarix sp?
						0.000000		0.000	0.0000				
92	TR273	4	JUNCUS	9	258.286	0.000259	0.0026	0.100	0.0003	25.918	10.035%	herbaceous-perennial	
92	TR273	4	UNKGRASS			0.000001		0.000	0.0000	0.126		grass	
92	TR273	4	Ga			0.000002		0.001	0.0000	0.157		grass-annual	
92	TR273	4	UDS			0.000083		0.032	0.0001	8.317		herbaceous	
92	TR273	4	WDYASTER			0.000058		0.023	0.0001	5.843		unknown	
92	TR273	4	BASL			0.000028		0.011	0.0000	2.827	84.373%	woody	Baccharis salicifolia
92	TR273	4	SAEX			0.001664		0.644	0.0017	166.418		woody	Salix exigua
92	TR273	4	TARA			0.000475		0.184	0.0005	47.548		woody	Tamarix sp?
92	TR273	4	TESE			0.000011		0.004	0.0000	1.131		woody	Tessaria sericia
						0.000000		0.000	0.0000				
940928	TR273	4	ECCR	6	113.812	0.000162	0.0011	0.142	0.0002	16.203		grass-annual	Echinochloa crusgalii
940928	TR273	4	CYER			0.000400		0.352	0.0004	40.047		herbaceous-annu	Cyperus erythrorhizos
940928	TR273	4	SODO=Solanum douglasii			0.000000		0.000	0.0000	0.031	0.028%	herbaceous-pere	SODO=Solanum douglasii
940928	TR273	4	BASL			0.000006		0.005	0.0000	0.589	50.549%	woody	Baccharis salicifolia
940928	TR273	4	SAEX			0.000380		0.333	0.0004	37.950		woody	Salix exigua
940928	TR273	4	TARA			0.000190		0.167	0.0002	18.991		woody	Tamarix sp?
920929	172	DF	GA	21	672.828	0.000013	0.0067	0.002	0.0000	1.253		grass-annual	
920929	172	DF	BOBA			0.003170		0.471	0.0006	316.959	57.909%	grass-perennial	Bothriochloa barbanodis
920929	172	DF	CYDA			0.000339		0.050	0.0001	33.927		grass-perennial	Cynodon dactylon
920929	172	DF	ERPU			0.000000		0.000	0.0000	0.031		grass-perennial	Erioneuron pulchellum
920929	172	DF	SPCR			0.000251		0.037	0.0001	25.054		grass-perennial	Sporobolus cryptandrus
920929	172	DF	SPFL			0.000137		0.020	0.0000	13.658		grass-perennial	Sporobolus flexuosus
920929	172	DF	CAMU			0.000002		0.000	0.0000	0.236		herbaceous	Camissonia multijuga
920929	172	DF	ERLO			0.000009		0.001	0.0000	0.872		herbaceous	Erigeron lobatus
920929	172	DF	MAPI			0.000011		0.002	0.0000	1.100		herbaceous	Machaeranthera
920929	172	DF	UDS			0.000008		0.001	0.0000	0.789		herbaceous	
920929	172	DF	DIBR			0.000000		0.000	0.0000	0.031		herbaceous-annu	Dicoria brandegei

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920929	172	DF	SONCHUS			0.000000		0.000	0.0000	0.008		herbaceous-annual	
920929	172	DF	DYPE			0.000001		0.000	0.0000	0.094	0.925%	herbaceous-pere	Dyssodia pentachaeta
920929	172	DF	POGR			0.000024		0.004	0.0000	2.397		herbaceous-pere	Porophyllum gracile
920929	172	DF	SACY			0.000037		0.006	0.0000	3.735		herbaceous-pere	Sarcostema cyanchoides
920929	172	DF	ACGR			0.000001		0.000	0.0000	0.141	40.528%	woody	Acacia greggii
920929	172	DF	BRLN			0.000038		0.006	0.0000	3.801		woody	Brickellia longifolia
920929	172	DF	GUSA			0.000018		0.003	0.0000	1.767		woody	Gutierrezia sarothrae
920929	172	DF	HAAC			0.000076		0.011	0.0000	7.577		woody	HAAC=ISAC : Isocoma acradenia
920929	172	DF	STTE			0.000207		0.031	0.0000	20.742		woody	Stephanomeria tenuifolia
920929	172	DF	TARA			0.002387		0.355	0.0005	238.654		woody	Tamarix sp?
						0.000000		0.000	0.0000				
930921	172	DF	ARISTIDA	19	381.933	0.000166	0.0038	0.043	0.0000	16.563		grass	
930921	172	DF	BRRU			0.000008		0.002	0.0000	0.785		grass-annual	Bromus rubens
930921	172	DF	BRTE			0.000000		0.000	0.0000	0.018		grass-annual	Bromus tectorum
930921	172	DF	BOBA			0.001141		0.299	0.0002	114.116	41.164%	grass-perennial	Bothriochloa barbanodis
930921	172	DF	CYDA			0.000197		0.052	0.0000	19.729		grass-perennial	Cynodon dactylon
930921	172	DF	SPCR			0.000229		0.060	0.0000	22.933		grass-perennial	Sporobolus cryptandrus
930921	172	DF	SPOROBOLUS			0.000004		0.001	0.0000	0.442		grass-perennial	
930921	172	DF	MAC			0.000016		0.004	0.0000	1.579		herbaceous	Machaeranthera
930921	172	DF	UDS			0.000006		0.002	0.0000	0.589		herbaceous	
930921	172	DF	DYPE			0.000001		0.000	0.0000	0.126	0.455%	herbaceous-pere	Dyssodia pentachaeta
930921	172	DF	ERIGERON			0.000000		0.000	0.0000	0.016		herbaceous-perennial	
930921	172	DF	POGR			0.000006		0.002	0.0000	0.593		herbaceous-pere	Porophyllum gracile
930921	172	DF	SACY			0.000010		0.003	0.0000	1.005		herbaceous-pere	Sarcostema cyanchoides
930921	172	DF	ACGR			0.000001		0.000	0.0000	0.134	53.266%	woody	Acacia greggii
930921	172	DF	BRLN			0.000126		0.033	0.0000	12.566		woody	Brickellia longifolia
930921	172	DF	GUMI			0.000049		0.013	0.0000	4.909		woody	Gutierrezia microcephala
930921	172	DF	HAAC			0.000057		0.015	0.0000	5.694		woody	HAAC=ISAC : Isocoma acradenia
930921	172	DF	STTE			0.000378		0.099	0.0001	37.783		woody	Stephanomeria tenuifolia
930921	172	DF	TARA			0.001424		0.373	0.0003	142.353		woody	Tamarix sp?
						0.000000		0.000	0.0000				
941003	172	DF	ARGL	14	882.441	0.000178	0.0088	0.020	0.0000	17.789		grass	Aristida glauca
941003	172	DF	BOBA			0.004791		0.543	0.0010	479.124	58.865%	grass-perennial	Bothriochloa barbanodis
941003	172	DF	CYDA			0.000139		0.016	0.0000	13.862		grass-perennial	Cynodon dactylon
941003	172	DF	SPCR			0.000265		0.030	0.0001	26.460		grass-perennial	Sporobolus cryptandrus
941003	172	DF	MAPI			0.000019		0.002	0.0000	1.893		herbaceous	Machaeranthera
941003	172	DF	DYPE			0.000003		0.000	0.0000	0.322	0.336%	herbaceous-pere	Dyssodia pentachaeta
941003	172	DF	POGR			0.000010		0.001	0.0000	1.029		herbaceous-pere	Porophyllum gracile
941003	172	DF	SACY			0.000016		0.002	0.0000	1.618		herbaceous-pere	Sarcostema cyanchoides
941003	172	DF	ACGR			0.000002		0.000	0.0000	0.196	38.568%	woody	Acacia greggii
941003	172	DF	BRLN			0.000091		0.010	0.0000	9.079		woody	Brickellia longifolia
941003	172	DF	GUSA			0.000020		0.002	0.0000	2.011		woody	Gutierrezia sarothrae
941003	172	DF	ISAC			0.000104		0.012	0.0000	10.446		woody	HAAC=ISAC : Isocoma acradenia
941003	172	DF	STTE			0.000133		0.015	0.0000	13.328		woody	Stephanomeria tenuifolia
941003	172	DF	TARA			0.003053		0.346	0.0006	305.284		woody	Tamarix sp?
						0.000000		0.000	0.0000				
920929	172	GB	GA	16	3375.724	0.000108	0.0338	0.003	0.0000	10.830		grass-annual	
920929	172	GB	SPCO			0.021258		0.630	0.0043	2125.803	90.736%	grass-perennial	Sporobolus contractus
920929	172	GB	SPCR			0.007950		0.236	0.0016	795.023		grass-perennial	Sporobolus cryptandrus
920929	172	GB	SPFL			0.000283		0.008	0.0001	28.270		grass-perennial	Sporobolus flexuosus
920929	172	GB	SPGI			0.000503		0.015	0.0001	50.265		grass-perennial	Sporobolus giganteus
920929	172	GB	SPORABOLIS			0.000636		0.019	0.0001	63.620		grass-perennial	

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920929	172	GB	UDS			0.000072		0.002	0.0000	7.190		herbaceous	
920929	172	GB	ARDR			0.000068		0.002	0.0000	6.750	0.228%	herbaceous-pere	Artemesia dracunculus
920929	172	GB	ARLU			0.000008		0.000	0.0000	0.810		herbaceous-pere	Artemesia ludoviciana
920929	172	GB	OEPA			0.000002		0.000	0.0000	0.150		herbaceous-pere	Oenothera pallida
920929	172	GB	RATTLESNAKE WEED(EUPOCH?)			0.000000		0.000	0.0000	0.030		unknown	Guttierezia ?
920929	172	GB	Solanum			0.000004		0.000	0.0000	0.350		unknown	comes in all diff. categories
920929	172	GB	GUMI			0.000024		0.001	0.0000	2.419	8.491%	woody	Gutierrezia microcephala
920929	172	GB	GUSA?			0.000002		0.000	0.0000	0.170		woody	Gutierrezia sarothrae
920929	172	GB	SAEX			0.000001		0.000	0.0000	0.060		woody	Salix exigua
920929	172	GB	TARA			0.002840		0.084	0.0006	283.984		woody	Tamarix sp?
						0.000000		0.000	0.0000				
930921	172	GB	ERAGROSTIS	18	357.259	0.001612	0.0036	0.451	0.0003	161.158		grass-annual	native and exotic
930921	172	GB	SPCO			0.000019		0.005	0.0000	1.901	10.195%	grass-perennial	Sporobolus contractus
930921	172	GB	SPCR			0.000310		0.087	0.0001	30.963		grass-perennial	Sporobolus cryptandrus
930921	172	GB	SPOROBOLUS SP			0.000036		0.010	0.0000	3.558		grass-perennial	
930921	172	GB	AMBROSIA			0.000002		0.000	0.0000	0.165		herbaceous	
930921	172	GB	Euphorbia			0.000000		0.000	0.0000	0.016		herbaceous	
930921	172	GB	PURPLE ASTER			0.000016		0.004	0.0000	1.579		herbaceous	
930921	172	GB	UDS			0.000000		0.000	0.0000	0.031		herbaceous	
930921	172	GB	COCA			0.000005		0.001	0.0000	0.487		herbaceous-annu	Conyza canadensis
930921	172	GB	ARDR			0.000012		0.003	0.0000	1.233	1.768%	herbaceous-pere	Artemesia dracunculus
930921	172	GB	ARLU			0.000051		0.014	0.0000	5.082		herbaceous-pere	Artemesia ludoviciana
930921	172	GB	Solanum			0.000004		0.001	0.0000	0.369		unknown	comes in all diff. categories
930921	172	GB	UNK#1			0.000001		0.000	0.0000	0.071		unknown	
930921	172	GB	ACGR			0.000000		0.000	0.0000	0.008	42.168%	woody	Acacia greggii
930921	172	GB	GUMI			0.000021		0.006	0.0000	2.123		woody	Gutierrezia microcephala
930921	172	GB	Gutierrezia sp			0.000001		0.000	0.0000	0.071		woody	
930921	172	GB	SAIB			0.000001		0.000	0.0000	0.081		woody	Salsola iberica
930921	172	GB	TARA			0.001484		0.415	0.0003	148.366		woody	Tamarix sp?
						0.000000		0.000	0.0000				
941003	172	GB	SPCO	8	193.302	0.000001	0.0019	0.000	0.0000	0.071	0.102%	grass-perennial	Sporobolus contractus
941003	172	GB	SPCR			0.000001		0.001	0.0000	0.126		grass-perennial	Sporobolus cryptandrus
941003	172	GB	ARLU			0.000017		0.009	0.0000	1.736		herbaceous-pere	Artemesia ludoviciana
941003	172	GB	SPAI			0.000374		0.194	0.0001	37.448		unknown	
941003	172	GB	Solanum			0.000004		0.002	0.0000	0.369		unknown	comes in all diff. categories
941003	172	GB	GUMI			0.000007		0.004	0.0000	0.699	79.437%	woody	Gutierrezia microcephala
941003	172	GB	Gutierrezia sp			0.000044		0.023	0.0000	4.390		woody	
941003	172	GB	TARA			0.001485		0.768	0.0003	148.464		woody	Tamarix sp?
						0.000000		0.000	0.0000				
920826	172	ND	CYDA	6	34.501	0.000145	0.0003	0.422	0.0000	14.549	44.460%	grass-perennial	Cynodon dactylon
920826	172	ND	GP			0.000008		0.023	0.0000	0.790		grass-perennial	
920826	172	ND	COCA			0.000070		0.203	0.0000	6.996		herbaceous-annu	Conyza canadensis
920826	172	ND	DIBR			0.000117		0.339	0.0000	11.710		herbaceous-annu	Dicoria brandegei
920826	172	ND	MELILOTUS			0.000004		0.011	0.0000	0.393		herbaceous-annu	Melilotus
920826	172	ND	BACCHARIS			0.000001		0.002	0.0000	0.062	0.180%	woody	
						0.000000		0.000	0.0000				
941003	172	ND	CYDA	7		0.108330	0.1087	0.996	0.0217	10832.997	99.758%	grass-perennial	Cynodon dactylon
941003	172	ND	SPFL			0.000091		0.001	0.0000	9.079		grass-perennial	Sporobolus flexuosus
941003	172	ND	SPOROBOLUS			0.000046		0.000	0.0000	4.602		grass-perennial	
941003	172	ND	COCA			0.000019		0.000	0.0000	1.924		herbaceous-annu	Conyza canadensis
941003	172	ND	DIBR			0.000241		0.002	0.0000	24.072		herbaceous-annu	Dicoria brandegei
941003	172	ND	SACY			0.000000		0.000	0.0000	0.008	0.000%	herbaceous-pere	Sarcostema cyanchoides

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941003	172	ND	ISAC			0.000003		0.000	0.0000	0.275	0.003%	woody	HAAC=ISAC : Isocoma acradenia
						0.000000		0.000	0.0000				
920929	172	RS	UNK GRASS	14	573.463	0.000020	0.0057	0.004	0.0000	2.010		grass	
920929	172	RS	CYDA			0.000103		0.018	0.0000	10.330	6.122%	grass-perennial	Cynodon dactylon
920929	172	RS	MUAS?			0.000001		0.000	0.0000	0.090		grass-perennial	Muhlenbergia asperfolia
920929	172	RS	SPCR			0.000050		0.009	0.0000	5.040		grass-perennial	Sporobolus cryptandrus
920929	172	RS	SPOROBOLIS SP.			0.000197		0.034	0.0000	19.650		grass-perennial	
920929	172	RS	UDS			0.000000		0.000	0.0000	0.030		herbaceous	
920929	172	RS	ARLU			0.003142		0.548	0.0006	314.160	55.507%	herbaceous-pere	Artemesia ludoviciana
920929	172	RS	EQHY			0.000037		0.006	0.0000	3.650		herbaceous-pere	Equisetum hiemale
920929	172	RS	SACY			0.000005		0.001	0.0000	0.500		herbaceous-pere	Sarcostema cyanchoides
920929	172	RS	ACGR			0.000008		0.001	0.0000	0.790	38.015%	woody	Acacia greggii
920929	172	RS	BASA			0.000015		0.003	0.0000	1.540		woody	Baccharis sarathroides
920929	172	RS	HAAC			0.000578		0.101	0.0001	57.787		woody	HAAC=ISAC : Isocoma acradenia
920929	172	RS	TARA			0.001124		0.196	0.0002	112.425		woody	Tamarix sp?
920929	172	RS	TESE			0.000455		0.079	0.0001	45.461		woody	Tessaria sericia
						0.000000		0.000	0.0000				
930921	172	RS	BRRU	16	313.168	0.000000	0.0031	0.000	0.0000	0.006		grass-annual	Bromus rubens
930921	172	RS	BRTE			0.000000		0.000	0.0000	0.024		grass-annual	Bromus tectorum
930921	172	RS	BOBA			0.000000		0.000	0.0000	0.047	2.375%	grass-perennial	Bothriochloa barbanodis
930921	172	RS	CYDA			0.000021		0.007	0.0000	2.058		grass-perennial	Cynodon dactylon
930921	172	RS	Gp			0.000014		0.004	0.0000	1.382		grass-perennial	
930921	172	RS	SPCO			0.000032		0.010	0.0000	3.165		grass-perennial	Sporobolus contractus
930921	172	RS	SPOROBOLUS			0.000008		0.003	0.0000	0.785		grass-perennial	
930921	172	RS	ARLU			0.000031		0.010	0.0000	3.142	2.164%	herbaceous-pere	Artemesia ludoviciana
930921	172	RS	EQUISETUM			0.000034		0.011	0.0000	3.440		herbaceous-pere	Equisetum
930921	172	RS	???BASEXSA			0.000096		0.031	0.0000	9.621		unknown	
930921	172	RS	SACY			0.000002		0.001	0.0000	0.196		herbaceous-pere	Sarcostema cyanchoides
930921	172	RS	ACGR			0.000000		0.000	0.0000	0.031	92.379%	woody	Acacia greggii
930921	172	RS	GAST			0.000000		0.000	0.0000	0.031		woody	Galium stellatum
930921	172	RS	HAAC			0.001397		0.446	0.0003	139.691		woody	HAAC=ISAC : Isocoma acradenia
930921	172	RS	TARA			0.001044		0.333	0.0002	104.372		woody	Tamarix sp?
930921	172	RS	TESE			0.000452		0.144	0.0001	45.176		woody	Tessaria sericia
						0.000000		0.000	0.0000				
941003	172	RS	CYDA	12	440.137	0.000006	0.0044	0.001	0.0000	0.636	3.362%	grass-perennial	Cynodon dactylon
941003	172	RS	GP			0.000006		0.001	0.0000	0.628		grass-perennial	
941003	172	RS	SPCR			0.000096		0.022	0.0000	9.621		grass-perennial	Sporobolus cryptandrus
941003	172	RS	SPOROBOLUS			0.000039		0.009	0.0000	3.911		grass-perennial	
941003	172	RS	ARLU			0.000013		0.003	0.0000	1.257	1.679%	herbaceous-pere	Artemesia ludoviciana
941003	172	RS	EQUISETUM			0.000061		0.014	0.0000	6.063		herbaceous-pere	Equisetum
941003	172	RS	SACY			0.000001		0.000	0.0000	0.071		herbaceous-pere	Sarcostema cyanchoides
941003	172	RS	ACGR			0.000000		0.000	0.0000	0.031	94.959%	woody	Acacia greggii
941003	172	RS	BASA			0.000075		0.017	0.0000	7.548		woody	Baccharis sarathroides
941003	172	RS	ISAC			0.002390		0.543	0.0005	239.044		woody	HAAC=ISAC : Isocoma acradenia
941003	172	RS	TARA			0.000995		0.226	0.0002	99.534		woody	Tamarix sp?
941003	172	RS	TESE			0.000718		0.163	0.0001	71.793		woody	Tessaria sericia
						0.000000		0.000	0.0000				
921031	183	GB	SPCR	2	134.409	0.000003	0.0013	0.002	0.0000	0.310	0.231%	grass-perennial	Sporobolus cryptandrus
921031	183	GB	TESE			0.001341		0.998	0.0003	134.099	99.769%	woody	Tessaria sericia
						0.000000			0.0000				
930922	183	GB	TESE	1	133.392	0.001334	0.001334	1.000	0.0003	133.392	100.000%	woody	Tessaria sericia
						0.000000			0.0000				

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
941003	183	GB	TESE	1	149.296	0.001493	0.0015	1.000	0.0003	149.296	100.000%	woody	Tessaria sericia
						0.000000			0.0000				
921031	183	RS	CYDA	9	407.406	0.001333	0.0041	0.327	0.0003	133.280	32.714%	grass-perennial	Cynodon dactylon
921031	183	RS	UDS			0.001000		0.245	0.0002	100.000		herbaceous	
921031	183	RS	MEAL?			0.000017		0.004	0.0000	1.660		herbaceous-annu	Melilotus alba
921031	183	RS	ARLU			0.000015		0.004	0.0000	1.490	2.251%	herbaceous-pere	Artemesia ludoviciana
921031	183	RS	EQHY			0.000077		0.019	0.0000	7.682		herbaceous-pere	Equisetum hiemale
921031	183	RS	ALCA			0.000898		0.220	0.0002	89.787	40.081%	woody	Alhagi camelorum
921031	183	RS	BASA			0.000084		0.021	0.0000	8.360		woody	Baccharis sarathroides
921031	183	RS	TARA			0.000049		0.012	0.0000	4.910		woody	Tamarix sp?
921031	183	RS	TESE			0.000602		0.148	0.0001	60.237		woody	Tessaria sericia
						0.000000		0.000	0.0000				
930922	183	RS	BRTE	12	336.848	0.000008	0.0034	0.002	0.0000	0.785		grass-annual	Bromus tectorum
930922	183	RS	CYDA			0.001030		0.306	0.0002	103.027	30.665%	grass-perennial	Cynodon dactylon
930922	183	RS	SPOROBOLUS			0.000003		0.001	0.0000	0.267		grass-perennial	
930922	183	RS	COCA			0.000007		0.002	0.0000	0.715		herbaceous-annu	Conyza canadensis
930922	183	RS	ARLU			0.000006		0.002	0.0000	0.581	11.709%	herbaceous-pere	Artemesia ludoviciana
930922	183	RS	EQUISETUM			0.000387		0.115	0.0001	38.736		herbaceous-pere	Equisetum
930922	183	RS	SOLIDAGO			0.000001		0.000	0.0000	0.126		herbaceous-perennial	
930922	183	RS	ALCA			0.000793		0.235	0.0002	79.286	57.180%	woody	Alhagi camelorum
930922	183	RS	BASA			0.000092		0.027	0.0000	9.173		woody	Baccharis sarathroides
930922	183	RS	GUMI			0.000001		0.000	0.0000	0.126		woody	Gutierrezia microcephala
930922	183	RS	TARA			0.000283		0.084	0.0001	28.274		woody	Tamarix sp?
930922	183	RS	TESE			0.000758		0.225	0.0002	75.752		woody	Tessaria sericia
						0.000000		0.000	0.0000				
941003	183	RS	CYDA	9	337.203	0.001498	0.0034	0.444	0.0003	149.775	44.417%	grass-perennial	Cynodon dactylon
941003	183	RS	COCA			0.000012		0.004	0.0000	1.217		herbaceous-annu	Conyza canadensis
941003	183	RS	ARLU			0.000004		0.001	0.0000	0.408	4.195%	herbaceous-pere	Artemesia ludoviciana
941003	183	RS	EQsp			0.000137		0.041	0.0000	13.737		herbaceous-pere	Equisetum
941003	183	RS	ACGRsdl			0.000000		0.000	0.0000	0.008	51.027%	woody	Acacia greggii
941003	183	RS	ALCA			0.000772		0.229	0.0002	77.158		woody	Alhagi camelorum
941003	183	RS	BASA			0.000031		0.009	0.0000	3.055		woody	Baccharis sarathroides
941003	183	RS	TARA			0.000159		0.047	0.0000	15.904		woody	Tamarix sp?
941003	183	RS	TESE			0.000759		0.225	0.0002	75.940		woody	Tessaria sericia
						0.000000		0.000	0.0000				
920930	194	DF	ARGL	10	719.874	0.003957	0.0072	0.550	0.0008	395.660		grass	Aristida glauca
920930	194	DF	CYDA			0.000204		0.028	0.0000	20.381	24.026%	grass-perennial	Cynodon dactylon
920930	194	DF	HIRI			0.000497		0.069	0.0001	49.663		grass-perennial	Hilaria rigida
920930	194	DF	SPCR			0.001029		0.143	0.0002	102.911		grass-perennial	Sporobolus cryptandrus
920930	194	DF	POGR			0.000342		0.047	0.0001	34.165	4.746%	herbaceous-pere	Porophyllum gracile
920930	194	DF	ACGR			0.000179		0.025	0.0000	17.923	16.266%	woody	Acacia greggii
920930	194	DF	BASA			0.000196		0.027	0.0000	19.635		woody	Baccharis sarathroides
920930	194	DF	BEJU			0.000018		0.002	0.0000	1.791		woody	Bebbia juncea
920930	194	DF	Gutierrezia sp			0.000728		0.101	0.0001	72.838		woody	
920930	194	DF	STTE			0.000049		0.007	0.0000	4.909		woody	Stephanomeria tenuifolia
						0.000000		0.000	0.0000				
930922	194	DF	ARISTIDA	12	697.469	0.002287	0.0070	0.328	0.0005	228.684		grass	
930922	194	DF	CYDA			0.000014		0.002	0.0000	1.414	38.124%	grass-perennial	Cynodon dactylon
930922	194	DF	HIRI			0.000081		0.012	0.0000	8.121		grass-perennial	Hilaria rigida
930922	194	DF	SPCR			0.002564		0.368	0.0005	256.370		grass-perennial	Sporobolus cryptandrus
930922	194	DF	MAC			0.000001		0.000	0.0000	0.141		herbaceous	Machaeranthera
930922	194	DF	ASSP			0.000242		0.035	0.0000	24.222	12.886%	herbaceous-pere	Aster spinosus

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930922	194	DF	DYPE			0.000000		0.000	0.0000	0.024		herbaceous-pere	Dyssodia pentachaeta
930922	194	DF	POGR			0.000656		0.094	0.0001	65.634		herbaceous-pere	Porophyllum gracile
930922	194	DF	ACGR			0.000208		0.030	0.0000	20.839	16.181%	woody	Acacia greggii
930922	194	DF	BASA			0.000283		0.041	0.0001	28.274		woody	Baccharis sarathroides
930922	194	DF	GUMI			0.000622		0.089	0.0001	62.176		woody	Gutierrezia microcephala
930922	194	DF	STTE			0.000016		0.002	0.0000	1.571		woody	Stephanomeria tenuifolia
						0.000000		0.000	0.0000				
941004	194	DF	ARGL	9	514.308	0.003012	0.0051	0.586	0.0006	301.246		grass	Aristida glauca
941004	194	DF	HIRI			0.000147		0.028	0.0000	14.656	11.592%	grass-perennial	Hilaria rigida
941004	194	DF	SPCR			0.000450		0.087	0.0001	44.964		grass-perennial	Sporobolus cryptandrus
941004	194	DF	ACGR			0.000095		0.018	0.0000	9.456	29.835%	woody	Acacia greggii
941004	194	DF	BASA			0.000122		0.024	0.0000	12.189		woody	Baccharis sarathroides
941004	194	DF	BEJU			0.000117		0.023	0.0000	11.655		woody	Bebbia juncea
941004	194	DF	Gutierrezia sp			0.001137		0.221	0.0002	113.663		woody	
941004	194	DF	PRGL			0.000057		0.011	0.0000	5.726		woody	Prosopis glandulosa
941004	194	DF	STTE			0.000008		0.001	0.0000	0.754		woody	Stephanomeria tenuifolia
921001	194	GB	UNK GRASS S	3	54.519	0.000000	0.0005	0.000	0.0000	0.020		grass	
921001	194	GB	SPOROBOLIS			0.000001		0.001	0.0000	0.071	0.130%	grass-perennial	
921001	194	GB	SAEX			0.000544		0.998	0.0001	54.428	99.834%	woody	Salix exigua
						0.000000		0.000	0.0000				
930922	194	GB	SPOROBOLUS	2	44.210	0.000002	0.0004	0.004	0.0000	0.173	0.391%	grass-perennial	
930922	194	GB	SAEX			0.000440		0.996	0.0001	44.037	99.609%	woody	Salix exigua
						0.000000		0.000	0.0000				
941004	194	GB	DIBR	2	208.154	0.000039	0.0021	0.019	0.0000	3.896		herbaceous-annu	Dicoria brandegei
941004	194	GB	SAEX			0.002043		0.981	0.0004	204.259	98.129%	woody	Salix exigua
						0.000000		0.000	0.0000				
920930	194	RS	CYDA	8	500.001	0.000577	0.0050	0.115	0.0001	57.710	26.780%	grass-perennial	Cynodon dactylon
920930	194	RS	SPCO			0.000605		0.121	0.0001	60.480		grass-perennial	Sporobolus contractus
920930	194	RS	SPCR			0.000157		0.031	0.0000	15.710		grass-perennial	Sporobolus cryptandrus
920930	194	RS	ARLU			0.001772		0.354	0.0004	177.210	39.079%	herbaceous-pere	Artemesia ludoviciana
920930	194	RS	EQHY			0.000182		0.036	0.0000	18.185		herbaceous-pere	Equisetum hiemale
920930	194	RS	SP			0.000102		0.020	0.0000	10.210		unknown	?
920930	194	RS	ACGR			0.000000		0.000	0.0000	0.020	32.099%	woody	Acacia greggii
920930	194	RS	BASA			0.001605		0.321	0.0003	160.477		woody	Baccharis sarathroides
						0.000000		0.000	0.0000				
930922	194	RS	BOBA	11	311.999	0.000094	0.0031	0.030	0.0000	9.362	18.099%	grass-perennial	Bothriochloa barbanodis
930922	194	RS	CYDA			0.000443		0.142	0.0001	44.296		grass-perennial	Cynodon dactylon
930922	194	RS	SPCR			0.000028		0.009	0.0000	2.812		grass-perennial	Sporobolus cryptandrus
930922	194	RS	COCA			0.000002		0.001	0.0000	0.204		herbaceous-annu	Conyza canadensis
930922	194	RS	ARLU			0.000036		0.012	0.0000	3.629	9.407%	herbaceous-pere	Artemesia ludoviciana
930922	194	RS	EQUISETUM			0.000256		0.082	0.0001	25.643		herbaceous-pere	Equisetum
930922	194	RS	MESA			0.000000		0.000	0.0000	0.008		herbaceous-pere	Medicago sativa
930922	194	RS	TAOF			0.000001		0.000	0.0000	0.071		herbaceous-pere	Taraxacum officinale
930922	194	RS	ACGR			0.000000		0.000	0.0000	0.008	72.428%	woody	Acacia greggii
930922	194	RS	BASA			0.002259		0.724	0.0005	225.896		woody	Baccharis sarathroides
930922	194	RS	BASE			0.000001		0.000	0.0000	0.071		woody	Baccharis sergiloides
						0.000000		0.000	0.0000				
941004	194	RS	BOBA	8	877.792	0.001361	0.0088	0.155	0.0003	136.070	67.244%	grass-perennial	Bothriochloa barbanodis
941004	194	RS	CYDA			0.004440		0.506	0.0009	443.986		grass-perennial	Cynodon dactylon
941004	194	RS	SPCR			0.000102		0.012	0.0000	10.210		grass-perennial	Sporobolus cryptandrus
941004	194	RS	ARLU			0.000003		0.000	0.0000	0.298	0.980%	herbaceous-pere	Artemesia ludoviciana
941004	194	RS	EQsp			0.000052		0.006	0.0000	5.223		herbaceous-pere	Equisetum

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941004	194	RS	SOOC			0.000031		0.004	0.0000	3.079		herbaceous-pere	Solidago occidentalis
941004	194	RS	BAEM			0.002767		0.315	0.0006	276.727	31.776%	woody	Baccharis emoryi
941004	194	RS	BASA			0.000022		0.003	0.0000	2.199		woody	Baccharis sarathroides
						0.000000		0.000	0.0000				
931007	209	GB	BRRU	7	574.283	0.000012	0.0057	0.002	0.0000	1.217		grass-annual	Bromus rubens
931007	209	GB	CYDA			0.000598		0.104	0.0001	59.847	10.421%	grass-perennial	Cynodon dactylon
931007	209	GB	COCA			0.000008		0.001	0.0000	0.785		herbaceous-annu	Conyza canadensis
931007	209	GB	ALCA			0.000307		0.054	0.0001	30.740	89.230%	woody	Alhagi camelorum
931007	209	GB	HAAC			0.000084		0.015	0.0000	8.443		woody	HAAC=ISAC : Isocoma acradenia
931007	209	GB	TARA			0.003214		0.560	0.0006	321.424		woody	Tamarix sp?
931007	209	GB	TESE			0.001518		0.264	0.0003	151.825		woody	Tessaria sericia
						0.000000		0.000	0.0000				
941109	209	GB	BRRU	7	701.471	0.000018	0.0070	0.003	0.0000	1.791		grass-annual	Bromus rubens
941109	209	GB	Bromus			0.000013		0.002	0.0000	1.335		grass-annual	
941109	209	GB	CYDA			0.000708		0.101	0.0001	70.780	10.090%	grass-perennial	Cynodon dactylon
941109	209	GB	COCA			0.000001		0.000	0.0000	0.126		herbaceous-annu	Conyza canadensis
941109	209	GB	ALCA			0.000702		0.100	0.0001	70.238	89.446%	woody	Alhagi camelorum
941109	209	GB	TARA			0.003128		0.446	0.0006	312.808		woody	Tamarix sp?
941109	209	GB	TESE			0.002444		0.348	0.0005	244.392		woody	Tessaria sericia
921217	209	OHW	UNK. GRASS	10	693.602	0.000181	0.0069	0.026	0.0000	18.060		grass	
921217	209	OHW	UNK.GRASS SDL			0.000006		0.001	0.0000	0.630		grass	
921217	209	OHW	GA			0.000055		0.008	0.0000	5.500		grass-annual	
921217	209	OHW	UDS			0.003104		0.448	0.0006	310.390		herbaceous	
921217	209	OHW	ALIN			0.000000		0.000	0.0000	0.030	0.004%	herbaceous-pere	Allionia incarnata
921217	209	OHW	DEPI?			0.000000		0.000	0.0000	0.010		unknown	?
921217	209	OHW	OPCH			0.001353		0.195	0.0003	135.290		unknown	?
921217	209	OHW	RUSH?			0.000051		0.007	0.0000	5.140		unknown	
921217	209	OHW	ACGR			0.001208		0.174	0.0002	120.768	31.510%	woody	Acacia greggii
921217	209	OHW	ZIOB			0.000978		0.141	0.0002	97.785		woody	Ziziphus obtusifolia
						0.000000		0.000	0.0000				
921217	209	RS	CYDA	6	273.865	0.000819	0.0027	0.299	0.0002	81.890	29.902%	grass-perennial	Cynodon dactylon
921217	209	RS	ASSP			0.000011		0.004	0.0000	1.100	0.402%	herbaceous-pere	Aster spinosus
921217	209	RS	ALCA			0.001199		0.438	0.0002	119.915	69.697%	woody	Alhagi camelorum
921217	209	RS	BAEM			0.000071		0.026	0.0000	7.070		woody	Baccharis emoryi
921217	209	RS	BASA			0.000442		0.161	0.0001	44.180		woody	Baccharis sarathroides
921217	209	RS	PRGL			0.000197		0.072	0.0000	19.710		woody	Prosopis glandulosa
						0.000000		0.000	0.0000				
931007	209	RS	CYDA	6	465.254	0.002221	0.0047	0.477	0.0004	222.111	47.740%	grass-perennial	Cynodon dactylon
931007	209	RS	ASSP			0.000003		0.001	0.0000	0.283	0.061%	herbaceous-pere	Aster spinosus
931007	209	RS	ALCA			0.000453		0.097	0.0001	45.286	52.200%	woody	Alhagi camelorum
931007	209	RS	BAEM			0.000139		0.030	0.0000	13.854		woody	Baccharis emoryi
931007	209	RS	BASA			0.001481		0.318	0.0003	148.071		woody	Baccharis sarathroides
931007	209	RS	PRGL			0.000356		0.077	0.0001	35.649		woody	Prosopis glandulosa
						0.000000		0.000	0.0000				
941109	209	RS	BRRU	8	311.426	0.000002	0.0031	0.001	0.0000	0.236		grass-annual	Bromus rubens
941109	209	RS	CYDA			0.000584		0.188	0.0001	58.402	18.753%	grass-perennial	Cynodon dactylon
941109	209	RS	ASSU			0.000004		0.001	0.0000	0.353		herbaceous	Aster subulatus
941109	209	RS	ASSP			0.000019		0.006	0.0000	1.885	0.605%	herbaceous-pere	Aster spinosus
941109	209	RS	ALCA			0.000747		0.240	0.0001	74.707	80.452%	woody	Alhagi camelorum
941109	209	RS	BAEM			0.000293		0.094	0.0001	29.256		woody	Baccharis emoryi
941109	209	RS	BASA			0.000950		0.305	0.0002	95.033		woody	Baccharis sarathroides
941109	209	RS	PRGL			0.000516		0.166	0.0001	51.554		woody	Prosopis glandulosa

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						0.000000		0.000	0.0000				
921101	213	DF	ARGL	14	543.043	0.000181	0.0054	0.036	0.0000	18.096		grass	Aristida glauca -- not in Phillips
921101	213	DF	GA			0.000016		0.003	0.0000	1.649		grass-annual	
921101	213	DF	BOBA			0.000380		0.076	0.0001	38.037	50.526%	grass-perennial	Bothriochloa barbanodis
921101	213	DF	CYDA			0.000282		0.056	0.0001	28.227		grass-perennial	Cynodon dactylon
921101	213	DF	SPCO			0.001859		0.372	0.0004	185.896		grass-perennial	Sporobolus contractus
921101	213	DF	SPFL			0.000005		0.001	0.0000	0.471		grass-perennial	Sporobolus flexuosus
921101	213	DF	UDS			0.000008		0.002	0.0000	0.825		herbaceous	
921101	213	DF	DYPE			0.000004		0.001	0.0000	0.369	0.159%	herbaceous-pere	Dyssodia pentachaeta
921101	213	DF	POGR			0.000004		0.001	0.0000	0.424		herbaceous-pere	Porophyllum gracile
921101	213	DF	ACGR			0.000000		0.000	0.0000	0.008	53.810%	woody	Acacia greggii
921101	213	DF	BASA			0.002641		0.528	0.0005	264.069		woody	Baccharis sarathroides
921101	213	DF	GUMI			0.000010		0.002	0.0000	0.982		woody	Gutierrezia microcephala
921101	213	DF	HAAC			0.000034		0.007	0.0000	3.409		woody	HAAC=ISAC : Isocoma acradenia
921101	213	DF	STTE			0.000006		0.001	0.0000	0.581		woody	Stephanomeria tenuifolia
						0.000000		0.000	0.0000				
941005	213	DF	ARGL	12	506.354	0.001088	0.0051	0.215	0.0002	108.755		grass	Aristida glauca
941005	213	DF	Agrostis sp			0.000005		0.001	0.0000	0.479	46.090%	grass-perennial	
941005	213	DF	BOBA			0.000172		0.034	0.0000	17.202		grass-perennial	Bothriochloa barbanodis
941005	213	DF	CYDA			0.000048		0.010	0.0000	4.830		grass-perennial	Cynodon dactylon
941005	213	DF	SPCR			0.000184		0.036	0.0000	18.438		grass-perennial	Sporobolus cryptandrus
941005	213	DF	Sporobolus sp			0.001924		0.380	0.0004	192.430		grass-perennial	
941005	213	DF	DYPE			0.000005		0.001	0.0000	0.456	0.090%	herbaceous-pere	Dyssodia pentachaeta
941005	213	DF	BASA			0.001490		0.294	0.0003	149.037	32.342%	woody	Baccharis sarathroides
941005	213	DF	Gutierrezia sp			0.000121		0.024	0.0000	12.056		woody	
941005	213	DF	ISAC			0.000021		0.004	0.0000	2.105		woody	HAAC=ISAC : Isocoma acradenia
941005	213	DF	PRGL			0.000000		0.000	0.0000	0.031		woody	Prosopis glandulosa
941005	213	DF	STTE			0.000005		0.001	0.0000	0.534		woody	Stephanomeria tenuifolia
						0.000000		0.000	0.0000				
921101	213	GB	GA	8	822.566	0.000003	0.0082	0.000	0.0000	0.270		grass-annual	
921101	213	GB	SPCO			0.006328		0.769	0.0013	632.789	85.516%	grass-perennial	Sporobolus contractus
921101	213	GB	SPFL			0.000020		0.002	0.0000	1.963		grass-perennial	Sporobolus flexuosus
921101	213	GB	SPGI			0.000687		0.083	0.0001	68.672		grass-perennial	Sporobolus giganteus
921101	213	GB	UDS			0.000004		0.001	0.0000	0.420		herbaceous	
921101	213	GB	DEPA			0.000001		0.000	0.0000	0.130		unknown	?
921101	213	GB	BASA			0.000050		0.006	0.0000	.5.000	14.384%	woody	Baccharis sarathroides
921101	213	GB	HAAC			0.001133		0.138	0.0002	113.321		woody	HAAC=ISAC : Isocoma acradenia
						0.000000		0.000	0.0000				
930923	213	GB	Gp	9	621.689	0.000004	0.0062	0.001	0.0000	0.393	79.662%	grass-perennial	
930923	213	GB	HIRI			0.000075		0.012	0.0000	7.524		grass-perennial	Hilaria rigida
930923	213	GB	SPCO			0.001049		0.169	0.0002	104.874		grass-perennial	Sporobolus contractus
930923	213	GB	SPCR			0.000084		0.014	0.0000	8.443		grass-perennial	Sporobolus cryptandrus
930923	213	GB	SPFL			0.003740		0.602	0.0007	374.000		grass-perennial	Sporobolus flexuosus
930923	213	GB	SPOROBOLUS			0.000000		0.000	0.0000	0.016		grass-perennial	
930923	213	GB	DICORIA			0.000063		0.010	0.0000	6.291		herbaceous-annual	
930923	213	GB	BASA			0.000044		0.007	0.0000	4.359	19.326%	woody	Baccharis sarathroides
930923	213	GB	HAAC			0.001158		0.186	0.0002	115.789		woody	HAAC=ISAC : Isocoma acradenia
						0.000000		0.000	0.0000				
941005	213	GB	SPCO	5	168.774	0.000313	0.0017	0.185	0.0001	31.282	47.736%	grass-perennial	Sporobolus contractus
941005	213	GB	SPCR			0.000018		0.010	0.0000	1.767		grass-perennial	Sporobolus cryptandrus
941005	213	GB	SPFL			0.000475		0.282	0.0001	47.517		grass-perennial	Sporobolus flexuosus
941005	213	GB	BASA			0.000114		0.067	0.0000	11.373	52.264%	woody	Baccharis sarathroides

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
941005	213	GB	ISAC			0.000768		0.455	0.0002	76.836		woody	HAAC=ISAC : Isocoma acradenia
						0.000000		0.000	0.0000				
921101	213	RS	ARGL	13	220.288	0.000063	0.0022	0.029	0.0000	6.280		grass	Aristida glauca
921101	213	RS	GA			0.000001		0.000	0.0000	0.070		grass-annual	
921101	213	RS	CYDA			0.000762		0.346	0.0002	76.182	34.665%	grass-perennial	Cynodon dactylon
921101	213	RS	SPCR			0.000002		0.001	0.0000	0.180		grass-perennial	Sporobolus cryptandrus
921101	213	RS	ASSU			0.000001		0.000	0.0000	0.090		herbaceous	Aster subulatus
921101	213	RS	UDS			0.000058		0.026	0.0000	5.830		herbaceous	
921101	213	RS	POGR			0.000004		0.002	0.0000	0.390	0.177%	herbaceous-pere	Porophyllum gracile
921101	213	RS	UNK SPINY			0.000004		0.002	0.0000	0.350		unknown	
921101	213	RS	ACGR			0.000002		0.001	0.0000	0.150	59.429%	woody	Acacia greggii
921101	213	RS	BASA			0.001099		0.499	0.0002	109.863		woody	Baccharis sarathroides
921101	213	RS	BRAT			0.000000		0.000	0.0000	0.030		woody	Brickellia atractyloides
921101	213	RS	BRLN			0.000005		0.002	0.0000	0.540		woody	Brickellia longifolia
921101	213	RS	HAAC			0.000203		0.092	0.0000	20.333		woody	HAAC=ISAC : Isocoma acradenia
						0.000000		0.000	0.0000				
930923	213	RS	ARGL	11	239.092	0.000096	0.0024	0.040	0.0000	9.621		grass	Aristida glauca
930923	213	RS	BOBA			0.000127		0.053	0.0000	12.661	11.859%	grass-perennial	Bothriochloa barbanodis
930923	213	RS	CYDA			0.000129		0.054	0.0000	12.896		grass-perennial	Cynodon dactylon
930923	213	RS	HIRI			0.000000		0.000	0.0000	0.024		grass-perennial	Hilaria rigida
930923	213	RS	MUAS			0.000028		0.012	0.0000	2.772		grass-perennial	Muhlenbergia asperfolia
930923	213	RS	BORAGE			0.000000		0.000	0.0000	0.039		herbaceous	
930923	213	RS	POGR			0.000080		0.034	0.0000	8.031	3.359%	herbaceous-pere	Porophyllum gracile
930923	213	RS	ACGR			0.000001		0.001	0.0000	0.134	80.742%	woody	Acacia greggii
930923	213	RS	BASA			0.001279		0.535	0.0003	127.945		woody	Baccharis sarathroides
930923	213	RS	BRLN			0.000006		0.002	0.0000	0.581		woody	Brickellia longifolia
930923	213	RS	HAAC			0.000644		0.269	0.0001	64.388		woody	HAAC=ISAC : Isocoma acradenia
						0.000000		0.000	0.0000				
941005	213	RS	ARGL	8	138.373	0.000023	0.0014	0.017	0.0000	2.325		grass	Aristida glauca
941005	213	RS	BOBA			0.000012		0.008	0.0000	1.155	4.853%	grass-perennial	Bothriochloa barbanodis
941005	213	RS	CYDA			0.000056		0.040	0.0000	5.561		grass-perennial	Cynodon dactylon
941005	213	RS	POGR			0.000009		0.007	0.0000	0.911	0.658%	herbaceous-pere	Porophyllum gracile
941005	213	RS	ACGR			0.000000		0.000	0.0000	0.033	92.809%	woody	Acacia greggii
941005	213	RS	BASA			0.001210		0.874	0.0002	120.991		woody	Baccharis sarathroides
941005	213	RS	BRLN			0.000005		0.004	0.0000	0.542		woody	Brickellia longifolia
941005	213	RS	ISAC			0.000069		0.050	0.0000	6.857		woody	HAAC=ISAC : Isocoma acradenia
						0.000000		0.000	0.0000				
921102	217	GB	GA	4	42.605	0.000001	0.0004	0.002	0.0000	0.070		grass-annual	
921102	217	GB	SPFL			0.000360		0.845	0.0001	36.000	84.497%	grass-perennial	Sporobolus flexuosus
921102	217	GB	UDS			0.000001		0.001	0.0000	0.060		herbaceous	
921102	217	GB	TESE			0.000065		0.152	0.0000	6.475	15.198%	woody	Tessaria sericia
						0.000000		0.000	0.0000				
931008	217	GB	SPFL	3	64.976	0.000424	0.0006	0.653	0.0001	42.427	65.297%	grass-perennial	Sporobolus flexuosus
931008	217	GB	DICORIA			0.000020		0.031	0.0000	2.026		herbaceous-annual	
931008	217	GB	TESE			0.000205		0.316	0.0000	20.522	31.585%	woody	Tessaria sericia
						0.000000		0.000	0.0000				
941109	217	GB	HAAC	2	8.404	0.000011	0.0001	0.131	0.0000	1.100	100.000%	woody	HAAC=ISAC : Isocoma acradenia
941109	217	GB	TESE			0.000073		0.869	0.0000	7.304		woody	Tessaria sericia
						0.000000		0.000	0.0000				
921102	217	OHW	FEAC	14	2727.358	0.000238	0.0273	0.009	0.0000	23.760		woody	Ferocactus acanthodes
921102	217	OHW	Mammalaria			0.000752		0.028	0.0002	75.248		woody	
921102	217	OHW	ARISTIDA			0.001472		0.054	0.0003	147.216		grass	

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
921102	217	OHW	GA			0.000027		0.001	0.0000	2.660		grass-annual	
921102	217	OHW	ERPU			0.000079		0.003	0.0000	7.860	0.288%	grass-perennial	Erioneuron pulchellum
921102	217	OHW	BORAGE?			0.000004		0.000	0.0000	0.350		herbaceous	
921102	217	OHW	UDS			0.000002		0.000	0.0000	0.230		herbaceous	
921102	217	OHW	UDS1			0.000004		0.000	0.0000	0.380		herbaceous	
921102	217	OHW	UDS2			0.000003		0.000	0.0000	0.330		herbaceous	
921102	217	OHW	TRCA			0.000293		0.011	0.0001	29.290		unknown	xphyte
921102	217	OHW	ACGR			0.023611		0.866	0.0047	2361.103	93.095%	woody	Acacia greggii
921102	217	OHW	BEJU			0.000164		0.006	0.0000	16.370		woody	Bebbia juncea
921102	217	OHW	ENFA			0.000602		0.022	0.0001	60.210		woody	Encelia farinosa
921102	217	OHW	GAST			0.000024		0.001	0.0000	2.350		woody	Galium stellatum
						0.000000		0.000	0.0000				
921102	217	RS	CYDA	4	4334.853	0.000027	0.0433	0.001	0.0000	2.710	0.189%	grass-perennial	Cynodon dactylon
921102	217	RS	PHAU			0.000055		0.001	0.0000	5.470		grass-perennial	Phragmites australis
921102	217	RS	TARA			0.042098		0.971	0.0084	4209.806	99.811%	woody	Tamarix sp?
921102	217	RS	TESE			0.001169		0.027	0.0002	116.867		woody	Tessaria sericia
						0.000000		0.000	0.0000				
931008	217	RS	BRRU	5	4509.686	0.000039	0.0451	0.001	0.0000	3.927		grass-annual	Bromus rubens
931008	217	RS	CYDA			0.000002		0.000	0.0000	0.196	9.859%	grass-perennial	Cynodon dactylon
931008	217	RS	PHAU			0.004444		0.099	0.0009	444.410		grass-perennial	Phragmites australis
931008	217	RS	TARA			0.039246		0.870	0.0078	3924.595	90.054%	woody	Tamarix sp?
931008	217	RS	TESE			0.001366		0.030	0.0003	136.557		woody	Tessaria sericia
						0.000000		0.000	0.0000				
941109	217	RS	CYDA	3	2630.833	0.000025	0.0263	0.001	0.0000	2.513	0.096%	grass-perennial	Cynodon dactylon
941109	217	RS	TARA			0.021639		0.822	0.0043	2163.858	99.904%	woody	Tamarix sp?
941109	217	RS	TESE			0.004645		0.177	0.0009	464.461		woody	Tessaria sericia
						0.000000		0.000	0.0000				
921102	220	DF	ARISTIDA	11	1588.334	0.014740	0.0159	0.928	0.0029	1473.996		grass	
921102	220	DF	GA			0.000014		0.001	0.0000	1.374		grass-annual	
921102	220	DF	BOBA			0.000272		0.017	0.0001	27.198	1.829%	grass-perennial	Bothriochloa barbanodis
921102	220	DF	CYDA			0.000016		0.001	0.0000	1.587		grass-perennial	Cynodon dactylon
921102	220	DF	GP			0.000003		0.000	0.0000	0.259		grass-perennial	
921102	220	DF	UDS			0.000012		0.001	0.0000	1.217		herbaceous	
921102	220	DF	ACGR			0.000014		0.001	0.0000	1.398	5.207%	woody	Acacia greggii
921102	220	DF	BASA			0.000720		0.045	0.0001	72.005		woody	Baccharis sarathroides
921102	220	DF	EPNE			0.000002		0.000	0.0000	0.157		woody	Ephedra nevadensis
921102	220	DF	HAAC			0.000090		0.006	0.0000	9.016		woody	HAAC=ISAC : Isocoma acradenia
921102	220	DF	KRAMERIA			0.000001		0.000	0.0000	0.126		woody	
						0.000000		0.000	0.0000				
941005	220	DF	ARGL	9	1508.838	0.012888	0.0151	0.854	0.0026	1288.831		grass	Aristida glauca
941005	220	DF	Ga			0.000000		0.000	0.0000	0.002		grass-annual	
941005	220	DF	BOBA			0.001704		0.113	0.0003	170.369	11.585%	grass-perennial	Bothriochloa barbanodis
941005	220	DF	CYDA			0.000044		0.003	0.0000	4.430		grass-perennial	Cynodon dactylon
941005	220	DF	ACGR			0.000025		0.002	0.0000	2.529	2.996%	woody	Acacia greggii
941005	220	DF	ALCA			0.000002		0.000	0.0000	0.196		woody	Alhagi camelorum
941005	220	DF	EPNE			0.000031		0.002	0.0000	3.142		woody	Ephedra nevadensis
941005	220	DF	ISAC			0.000387		0.026	0.0001	38.704		woody	HAAC=ISAC : Isocoma acradenia
941005	220	DF	KRAMERIA			0.000006		0.000	0.0000	0.636		woody	
						0.000000		0.000	0.0000				
930923	220	GB	CYDA	3	758.852	0.000287	0.0076	0.038	0.0001	28.651	3.850%	grass-perennial	Cynodon dactylon
930923	220	GB	SPCO			0.000006		0.001	0.0000	0.565		grass-perennial	Sporobolus contractus
930923	220	GB	BASA			0.007296		0.961	0.0015	729.635	96.150%	woody	Baccharis sarathroides

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941005	220	GB	CYDA	3	285.312	0.000425	0.0029	0.149	0.0001	42.506	14.898%	grass-perennial	Cynodon dactylon
941005	220	GB	ACGR			0.000000		0.000	0.0000	0.031	85.102%	woody	Acacia greggii
941005	220	GB	BASA			0.002428		0.851	0.0005	242.774		woody	Baccharis sarathroides
						0.000000		0.000	0.0000				
941005	220	MARSH	CYDA	8	977.294	0.000823	0.0098	0.084	0.0002	82.325	8.424%	grass-perennial	Cynodon dactylon
941005	220	MARSH	COCA			0.000000		0.000	0.0000	0.031		herbaceous-annu	Conyza canadensis
941005	220	MARSH	melilotus			0.000001		0.000	0.0000	0.063		herbaceous-annu	Melilotus
941005	220	MARSH	EQsp			0.008796		0.900	0.0018	879.638	90.942%	herbaceous-pere	Equisetum
941005	220	MARSH	POGR			0.000000		0.000	0.0000	0.008		herbaceous-pere	Porophyllum gracile
941005	220	MARSH	SOOC			0.000091		0.009	0.0000	9.126		herbaceous-pere	Solidago occidentalis
941005	220	MARSH	BASA			0.000001		0.000	0.0000	0.126	0.624%	woody	Baccharis sarathroides
941005	220	MARSH	TARA			0.000060		0.006	0.0000	5.977		woody	Tamarix sp?
						0.000000		0.000	0.0000				
921101	220	RS	ARISTIDA	13	208.506	0.000079	0.0021	0.038	0.0000	7.854		grass	
921101	220	RS	GA			0.000004		0.002	0.0000	0.432		grass-annual	
921101	220	RS	BOBA			0.000390		0.187	0.0001	39.050	42.722%	grass-perennial	Bothriochloa barbanodis
921101	220	RS	CYDA			0.000082		0.039	0.0000	8.221		grass-perennial	Cynodon dactylon
921101	220	RS	SPCO			0.000418		0.201	0.0001	41.807		grass-perennial	Sporobolus contractus
921101	220	RS	UDS			0.000024		0.011	0.0000	2.388		herbaceous	
921101	220	RS	MEAL			0.000008		0.004	0.0000	0.809		herbaceous-annu	Melilotus alba
921101	220	RS	ALCA			0.000262		0.126	0.0001	26.248	51.771%	woody	Alhagi camelorum
921101	220	RS	BASA			0.000461		0.221	0.0001	46.150		woody	Baccharis sarathroides
921101	220	RS	BASL			0.000005		0.002	0.0000	0.503		woody	Baccharis salicifolia
921101	220	RS	HAAC			0.000019		0.009	0.0000	1.893		woody	HAAC=ISAC : Isocoma acradenia
921101	220	RS	TARA			0.000226		0.108	0.0000	22.564		woody	Tamarix sp?
921101	220	RS	TESE			0.000106		0.051	0.0000	10.587		woody	Tessaria sericia
						0.000000		0.000	0.0000				
941005	220	RS	ANGL	12	289.144	0.000391	0.0029	0.135	0.0001	39.081		grass	Andropogon glomeratus
941005	220	RS	ARGL			0.000255		0.088	0.0001	25.518		grass	Aristida glauca
941005	220	RS	CYDA			0.000275		0.095	0.0001	27.489	18.348%	grass-perennial	Cynodon dactylon
941005	220	RS	MUAS			0.000243		0.084	0.0000	24.347		grass-perennial	Muhlenbergia asperfolia
941005	220	RS	PAOB			0.000012		0.004	0.0000	1.217		grass-perennial	Panicum obtusum
941005	220	RS	COCA			0.000001		0.000	0.0000	0.126		herbaceous-annu	Conyza canadensis
941005	220	RS	ASSP			0.000071		0.024	0.0000	7.061	14.013%	herbaceous-pere	Aster spinosus
941005	220	RS	EQsp			0.000335		0.116	0.0001	33.458		herbaceous-pere	Equisetum
941005	220	RS	ALCA			0.000554		0.192	0.0001	55.418	45.253%	woody	Alhagi camelorum
941005	220	RS	BASA			0.000005		0.002	0.0000	0.503		woody	Baccharis sarathroides
941005	220	RS	ISAC			0.000161		0.056	0.0000	16.061		woody	HAAC=ISAC : Isocoma acradenia
941005	220	RS	TESE			0.000589		0.204	0.0001	58.866		woody	Tessaria sericia
						0.000000		0.000	0.0000				
920929	231	GB	SPCR	3	204.498	0.000365	0.0020	0.179	0.0001	36.517	17.857%	grass-perennial	Sporobolus cryptandrus
920929	231	GB	HAAC			0.000000		0.000	0.0000	0.010	82.143%	woody	HAAC=ISAC : Isocoma acradenia
920929	231	GB	TESE			0.001680		0.821	0.0003	167.971		woody	Tessaria sericia
						0.000000		0.000	0.0000				
931014	231	GB	ANDROPOGON?	7	436.909	0.000999	0.0044	0.229	0.0002	99.942		grass	
931014	231	GB	BRRU			0.000002		0.000	0.0000	0.196		grass-annual	Bromus rubens
931014	231	GB	GA			0.000000		0.000	0.0000	0.016		grass-annual	
931014	231	GB	SPCR			0.000073		0.017	0.0000	7.281	42.654%	grass-perennial	Sporobolus cryptandrus
931014	231	GB	SPFL			0.001741		0.398	0.0003	174.084		grass-perennial	Sporobolus flexuosus
931014	231	GB	Sporabolus sp			0.000050		0.011	0.0000	4.995		grass-perennial	
931014	231	GB	TESE			0.001504		0.344	0.0003	150.396	34.423%	woody	Tessaria sericia
						0.000000		0.000	0.0000				

DATE	MILE	ZONE	SPP	# of sp	sum B.A.	BA/m^2	Total BA/pl	Basal are	censused	Basal area	% of total	growth form	scientific name
940925	231	GB	SPFL	2	1190.656	0.009780	0.0119	0.821	0.0020	978.017	82.141%	grass-perennial	Sporobolus flexuosus
940925	231	GB	TESE			0.002126		0.179	0.0004	212.639	17.859%	woody	Tessaria sericia
						0.000000		0.000	0.0000				
920929	231	OHW	GA	11	2795.175	0.000006	0.0280	0.000	0.0000	0.630		grass-annual	
920929	231	OHW	ARPU			0.001037		0.037	0.0002	103.667	12.727%	grass-perennial	Aristida purpurea
920929	231	OHW	SPCR			0.002521		0.090	0.0005	252.074		grass-perennial	Sporobolus cryptandrus
920929	231	OHW	POGR			0.000017		0.001	0.0000	1.710		herbaceous-pere	Porophyllum gracile
920929	231	OHW	Selaginella			0.015977		0.572	0.0032	1597.700	57.159%	herbaceous-perennial	
920929	231	OHW	CRPO			0.000057		0.002	0.0000	5.730		unknown	
920929	231	OHW	HAHE			0.003796		0.136	0.0008	379.587		unknown	?
920929	231	OHW	SA SP.			0.000008		0.000	0.0000	0.820		unknown	
920929	231	OHW	ACGR			0.000197		0.007	0.0000	19.650	16.216%	woody	Acacia greggii
920929	231	OHW	ENFR			0.000283		0.010	0.0001	28.270		woody	Encelia frutescens
920929	231	OHW	HAAC			0.004053		0.145	0.0008	405.338		woody	HAAC=ISAC : Isocoma acradenia
						0.000000		0.000	0.0000				
920929	231	RS	ANGL	11	168.990	0.000001	0.0017	0.000	0.0000	0.060		grass	Andropogon glomeratus
920929	231	RS	CYDA			0.000100		0.059	0.0000	10.000	12.658%	grass-perennial	Cynodon dactylon
920929	231	RS	MUAS			0.000114		0.067	0.0000	11.390		grass-perennial	Muhlenbergia asperfolia
920929	231	RS	Cirsium			0.000191		0.113	0.0000	19.080		herbaceous	not all are native
920929	231	RS	GNWR			0.000002		0.001	0.0000	0.210		herbaceous	Gnaphalium wrightii
920929	231	RS	COCA			0.000003		0.002	0.0000	0.340		herbaceous-annu	Conyza canadensis
920929	231	RS	AQUILEGIA?			0.000001		0.000	0.0000	0.070	75.407%	herbaceous-perennial	
920929	231	RS	EQHY			0.001272		0.753	0.0003	127.230		herbaceous-pere	Equisetum hiemale
920929	231	RS	ERIGERON			0.000001		0.001	0.0000	0.130		herbaceous-perennial	
920929	231	RS	BAEM			0.000001		0.000	0.0000	0.070	0.284%	woody	Baccharis emoryi
920929	231	RS	TESE			0.000004		0.002	0.0000	0.410		woody	Tessaria sericia
						0.000000		0.000	0.0000				
931014	231	RS	JUNCUS SP.	11	658.973	0.000004	0.0066	0.001	0.0000	0.353	0.054%	herbaceous-perennial	
931014	231	RS	UNK GRASS			0.000002		0.000	0.0000	0.196		grass	
931014	231	RS	CYDA			0.000525		0.080	0.0001	52.488	71.817%	grass-perennial	Cynodon dactylon
931014	231	RS	GP			0.004204		0.638	0.0008	420.384		grass-perennial	
931014	231	RS	MUAS			0.000004		0.001	0.0000	0.385		grass-perennial	Muhlenbergia asperfolia
931014	231	RS	Cirsium			0.000552		0.084	0.0001	55.174		herbaceous	not all are native
931014	231	RS	COCA			0.000001		0.000	0.0000	0.071		herbaceous-annu	Conyza canadensis
931014	231	RS	AQUILEGIA			0.000003		0.000	0.0000	0.251	19.646%	herbaceous-perennial	
931014	231	RS	EQHY			0.001292		0.196	0.0003	129.214		herbaceous-pere	Equisetum hiemale
931014	231	RS	BAEM			0.000004		0.001	0.0000	0.385	0.069%	woody	Baccharis emoryi
931014	231	RS	TESE			0.000001		0.000	0.0000	0.071		woody	Tessaria sericia
						0.000000		0.000	0.0000				
940925	231	RS	ANGE	7	380.525	0.000754	0.0038	0.198	0.0002	75.430		grass	Andropogon gerandi
940925	231	RS	CYDA			0.001443		0.379	0.0003	144.278	37.915%	grass-perennial	Cynodon dactylon
940925	231	RS	Cirsium			0.000459		0.121	0.0001	45.946		herbaceous	not all are native
940925	231	RS	AQCH			0.000000		0.000	0.0000	0.039	28.256%	herbaceous-pere	Aquilegia chrysantha
940925	231	RS	EQHY			0.001075		0.282	0.0002	107.482		herbaceous-pere	Equisetum hiemale
940925	231	RS	BAEM			0.000071		0.019	0.0000	7.069	1.932%	woody	Baccharis emoryi
940925	231	RS	TESE			0.000003		0.001	0.0000	0.283		woody	Tessaria sericia
						0.000000		0.000	0.0000				
920929	235	DF	SPCR	3	22.710	0.000222	0.0002	0.978	0.0000	22.200	97.754%	grass-perennial	Sporobolus cryptandrus
920929	235	DF	UDS			0.000000		0.000	0.0000	0.010		herbaceous	
920929	235	DF	POGR			0.000005		0.022	0.0000	0.500	2.202%	herbaceous-pere	Porophyllum gracile
						0.000000		0.000	0.0000				
931014	235	DF	UNK.GRASS	4	3.872	0.000001	0.0000	0.018	0.0000	0.071		grass	

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931014	235	DF	GP			0.000031		0.813	0.0000	3.149	81.339%	grass-perennial	
931014	235	DF	CAMASSONIA			0.000006		0.150	0.0000	0.581		herbaceous	
931014	235	DF	COCA			0.000001		0.018	0.0000	0.071		herbaceous-annu	Conyza canadensis
						0.000000		0.000	0.0000				
940926	235	DF	CYDA	5	74.487	0.000010	0.0007	0.013	0.0000	1.005	1.898%	grass-perennial	Cynodon dactylon
940926	235	DF	SPFL			0.000004		0.005	0.0000	0.408		grass-perennial	Sporobolus flexuosus
940926	235	DF	CAMU			0.000724		0.972	0.0001	72.382		herbaceous	Camissonia multijuga
940926	235	DF	COCA			0.000006		0.008	0.0000	0.565		herbaceous-annu	Conyza canadensis
940926	235	DF	ENFA			0.000001		0.002	0.0000	0.126	0.169%	woody	Encelia farinosa
						0.000000		0.000	0.0000				
920929	235	GB	SPCR	4	656.761	0.005243	0.0066	0.798	0.0010	524.258	79.825%	grass-perennial	Sporobolus cryptandrus
920929	235	GB	SPAM			0.000002		0.000	0.0000	0.200	0.030%	herbaceous-pere	Sphaeralcea ambigua
920929	235	GB	ACGR			0.000001		0.000	0.0000	0.070	20.145%	woody	Acacia greggii
920929	235	GB	TESE			0.001322		0.201	0.0003	132.232		woody	Tessaria sericia
						0.000000		0.000	0.0000				
931014	235	GB	ANDRO.	6	757.579	0.000745	0.0076	0.098	0.0001	74.519		grass	
931014	235	GB	BRRU			0.000010		0.001	0.0000	0.982		grass-annual	Bromus rubens
931014	235	GB	SPCR			0.000284		0.037	0.0001	28.400	65.138%	grass-perennial	Sporobolus cryptandrus
931014	235	GB	SPFL			0.004651		0.614	0.0009	465.074		grass-perennial	Sporobolus flexuosus
931014	235	GB	ACGR			0.000000		0.000	0.0000	0.031	24.896%	woody	Acacia greggii
931014	235	GB	TESE			0.001886		0.249	0.0004	188.574		woody	Tessaria sericia
						0.000000		0.000	0.0000				
940926	235	GB	BRRU	6	635.348	0.000003	0.0064	0.000	0.0000	0.251		grass-annual	Bromus rubens
940926	235	GB	SPCO			0.002445		0.385	0.0005	244.455	60.670%	grass-perennial	Sporobolus contractus
940926	235	GB	SPCR			0.001410		0.222	0.0003	141.010		grass-perennial	Sporobolus cryptandrus
940926	235	GB	SPAM			0.000008		0.001	0.0000	0.785	0.124%	herbaceous-pere	Sphaeralcea ambigua
940926	235	GB	ACGR			0.000002		0.000	0.0000	0.173	39.167%	woody	Acacia greggii
940926	235	GB	TESE			0.002487		0.391	0.0005	248.673		woody	Tessaria sericia
						0.000000		0.000	0.0000				
920929	235	OHW	ARPU	8	1516.679	0.004730	0.0152	0.312	0.0009	472.990	46.172%	grass-perennial	Aristida purpurea
920929	235	OHW	ERPU			0.002273		0.150	0.0005	227.286		grass-perennial	Erioneuron pulchellum
920929	235	OHW	POGR			0.001067		0.070	0.0002	106.653	7.032%	herbaceous-pere	Porophyllum gracile
920929	235	OHW	ERFA			0.003982		0.263	0.0008	398.150		unknown	?
920929	235	OHW	Eriogonum			0.000165		0.011	0.0000	16.530		unknown	
920929	235	OHW	AMDU			0.000011		0.001	0.0000	1.130	19.455%	woody	Ambrosia dumosa
920929	235	OHW	BEBBIA			0.001808		0.119	0.0004	180.839		woody	
920929	235	OHW	EPNE			0.001131		0.075	0.0002	113.100		woody	Ephedra nevadensis
						0.000000		0.000	0.0000				
920930	237	GB	UNK. GRASS	4	21.987	0.000004	0.0002	0.018	0.0000	0.400		grass	
920930	237	GB	SCIRPUS			0.000008		0.036	0.0000	0.785	3.572%	herbaceous-perennial	
920930	237	GB	UNKseedlings			0.000000		0.001	0.0000	0.020		unknown	
920930	237	GB	TARA			0.000208		0.945	0.0000	20.782	94.518%	woody	Tamarix sp?
						0.000000		0.000	0.0000				
920930	237	ND	GA	4	22.080	0.000005	0.0002	0.023	0.0000	0.500		grass-annual	
920930	237	ND	UDS			0.000000		0.001	0.0000	0.020		herbaceous	
920930	237	ND	SCIRPUS			0.000008		0.036	0.0000	0.790	3.578%	herbaceous-perennial	
920930	237	ND	TARA			0.000208		0.941	0.0000	20.770	94.067%	woody	Tamarix sp?
						0.000000		0.000	0.0000				
920711	240	GB	EQHY	3	1229.959	0.000438	0.0123	0.036	0.0001	43.780	3.559%	herbaceous-pere	Equisetum hiemale
920711	240	GB	TARA			0.002277		0.185	0.0005	227.703	96.441%	woody	Tamarix sp?
920711	240	GB	TESE			0.009585		0.779	0.0019	958.476		woody	Tessaria sericia
						0.000000		0.000	0.0000				

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920711	240	RS1	ARISTIDA	5	938.737	0.000511	0.0094	0.054	0.0001	51.050		grass	
920711	240	RS1	CYDA			0.004207		0.448	0.0008	420.680	93.703%	grass-perennial	Cynodon dactylon
920711	240	RS1	SPCO			0.004589		0.489	0.0009	458.947		grass-perennial	Sporobolus contractus
920711	240	RS1	TRCA			0.000071		0.008	0.0000	7.070		unknown	xphyte
920711	240	RS1	ENFA			0.000010		0.001	0.0000	0.990	0.105%	woody	Encelia farinosa
						0.000000		0.000	0.0000				
920930	240	RS2	GA	15	88.535	0.000005	0.0009	0.005	0.0000	0.460		grass-annual	
920930	240	RS2	GA trace			0.000000		0.000	0.0000	0.001		grass-annual	
920930	240	RS2	HOJU? TRACE			0.000000		0.000	0.0000	0.001	0.001%	grass-perennial	Hordeum jubatum
920930	240	RS2	ASSU			0.000229		0.259	0.0000	22.943		herbaceous	Aster subulatus
920930	240	RS2	POLYGONUM			0.000006		0.006	0.0000	0.570		herbaceous	Polygonum sp
920930	240	RS2	UDS			0.000035		0.040	0.0000	3.530		herbaceous	
920930	240	RS2	UNK. DICOT			0.000006		0.007	0.0000	0.630		herbaceous	
920930	240	RS2	LASE?			0.000019		0.021	0.0000	1.880		herbaceous-annu	Lactuca serriola
920930	240	RS2	EQLA			0.000006		0.007	0.0000	0.620	1.626%	herbaceous-pere	Equisetum laevigatum
920930	240	RS2	OEPA			0.000003		0.003	0.0000	0.280		herbaceous-pere	Oenothera pallida
920930	240	RS2	PLMA			0.000005		0.006	0.0000	0.540		herbaceous-pere	Plantago major
920930	240	RS2	SCAM			0.000168		0.190	0.0000	16.840		unknown	?
920930	240	RS2	BASA			0.000010		0.012	0.0000	1.040	45.451%	woody	Baccharis sarathroides
920930	240	RS2	SAEX			0.000027		0.030	0.0000	2.650		woody	Salix exigua
920930	240	RS2	TARA			0.000366		0.413	0.0001	36.550		woody	Tamarix sp?
						0.000000		0.000	0.0000				
920711	246	GB	SPCO	7	2665.257	0.005957	0.0267	0.224	0.0012	595.701	22.351%	grass-perennial	Sporobolus contractus
920711	246	GB	BASA			0.003825		0.144	0.0008	382.473	77.649%	woody	Baccharis sarathroides
920711	246	GB	BASL			0.004060		0.152	0.0008	405.959		woody	Baccharis salicifolia
920711	246	GB	SAEX			0.000486		0.018	0.0001	48.610		woody	Salix exigua
920711	246	GB	SAGO			0.000374		0.014	0.0001	37.426		woody	Salix goodingii
920711	246	GB	TARA			0.011947		0.448	0.0024	1194.708		woody	Tamarix sp?
920711	246	GB	TESE			0.000004		0.000	0.0000	0.380		woody	Tessaria sericia
						0.000000		0.000	0.0000				
9310??	246	GB1	BRRU	8	779.121	0.000007	0.0078	0.001	0.0000	0.691		grass-annual	Bromus rubens
9310??	246	GB1	GA			0.000000		0.000	0.0000	0.016		grass-annual	
9310??	246	GB1	CYDA			0.000768		0.099	0.0002	76.810	83.627%	grass-perennial	Cynodon dactylon
9310??	246	GB1	SPCO			0.005747		0.738	0.0011	574.747		grass-perennial	Sporobolus contractus
9310??	246	GB1	UDS			0.000023		0.003	0.0000	2.270		herbaceous	
9310??	246	GB1	BASL			0.001242		0.159	0.0002	124.164	15.991%	woody	Baccharis salicifolia
9310??	246	GB1	ENFA			0.000004		0.001	0.0000	0.393		woody	Encelia farinosa
9310??	246	GB1	TARA			0.000000		0.000	0.0000	0.031		woody	Tamarix sp?
						0.000000		0.000	0.0000				
921001	246	OHW	LATR	2	3298.088	0.001808	0.0330	0.055	0.0004	180.838		unknown	xphyte
921001	246	OHW	PRGL			0.031173		0.945	0.0062	3117.250	94.517%	woody	Prosopis glandulosa
						0.000000		0.000	0.0000				
920711	246	RS	GP	5	1220.864	0.000023	0.0122	0.002	0.0000	2.310	40.455%	grass-perennial	
920711	246	RS	PHAU			0.004916		0.403	0.0010	491.590		grass-perennial	Phragmites australis
920711	246	RS	BASL			0.000063		0.005	0.0000	6.330	59.545%	woody	Baccharis salicifolia
920711	246	RS	TARA			0.006925		0.567	0.0014	692.533		woody	Tamarix sp?
920711	246	RS	TYPHA			0.000281		0.023	0.0001	28.102		woody	
						0.000000		0.000	0.0000				
940926	254	GB DSofT	BASL	3	1179.794	0.002320	0.0118	0.197	0.0005	232.038	100.000%	woody	Baccharis salicifolia
940926	254	GB DSofT	SAEX			0.007636		0.647	0.0015	763.643		woody	Salix exigua
940926	254	GB DSofT	TARA			0.001841		0.156	0.0004	184.113		woody	Tamarix sp?
						0.000000		0.000	0.0000				

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940926	254	GB USofT	SAEX	2	1009.826	0.009780	0.0101	0.969	0.0020	978.017	100.000%	woody	Salix exigua
940926	254	GB USofT	TARA			0.000318		0.031	0.0001	31.809		woody	Tamarix sp?
						0.000000		0.000	0.0000				
940927	254	GB UT	BASL	5	7489.926	0.071570	0.0749	0.956	0.0143	7156.972	100.000%	woody	Baccharis salicifolia
940927	254	GB UT	SAEX			0.000147		0.002	0.0000	14.695		woody	Salix exigua
940927	254	GB UT	TARA			0.002188		0.029	0.0004	218.765		woody	Tamarix sp?
940927	254	GB UT	TESE			0.000429		0.006	0.0001	42.946		woody	Tessaria sericia
940927	254	GB UT	TYPHA			0.000565		0.008	0.0001	56.549		woody	
						0.000000		0.000	0.0000				
920712	254	GB1	BASL	3	172.272	0.000697	0.0017	0.405	0.0001	69.715	100.000%	woody	Baccharis salicifolia
920712	254	GB1	SAEX			0.000123		0.072	0.0000	12.340		woody	Salix exigua
920712	254	GB1	TARA			0.000902		0.524	0.0002	90.217		woody	Tamarix sp?
						0.000000		0.000	0.0000				
931016	254	GB1	BASAL	3	1448.251	0.003130	0.0145	0.216	0.0006	313.005	100.000%	woody	Baccharis salicifolia
931016	254	GB1	SAEX			0.005888		0.407	0.0012	588.844		woody	Salix exigua
931016	254	GB1	TARA			0.005464		0.377	0.0011	546.402		woody	Tamarix sp?
						0.000000		0.000	0.0000				
931016	254	GB1or2	COCA	3	660.999	0.000000	0.0066	0.000	0.0000	0.031		herbaceous-annu	Conyza canadensis
931016	254	GB1or2	SAEX			0.002724		0.412	0.0005	272.392	99.995%	woody	Salix exigua
931016	254	GB1or2	TARA			0.003886		0.588	0.0008	388.576		woody	Tamarix sp?
						0.000000		0.000	0.0000				
920110	254	GB2	SAEX	2	9.434	0.000053	0.0001	0.558	0.0000	5.263	100.000%	woody	Salix exigua
920110	254	GB2	TARA			0.000042		0.442	0.0000	4.170		woody	Tamarix sp?
						0.000000		0.000	0.0000				
920712	254	GB3-LT	MUHLY	7	855.886	0.000021	0.0086	0.002	0.0000	2.080	3.722%	grass-perennial	Muhlenbergia
920712	254	GB3-LT	MUPO			0.000298		0.035	0.0001	29.780		grass-perennial	Muhlenbergia porteri
920712	254	GB3-LT	BASL			0.003299		0.385	0.0007	329.867	96.278%	woody	Baccharis salicifolia
920712	254	GB3-LT	SAEX			0.000217		0.025	0.0000	21.707		woody	Salix exigua
920712	254	GB3-LT	TARA			0.004572		0.534	0.0009	457.151		woody	Tamarix sp?
920712	254	GB3-LT	TESE			0.000082		0.010	0.0000	8.230		woody	Tessaria sericia
920712	254	GB3-LT	TYPHA			0.000071		0.008	0.0000	7.070		woody	
931017	254	UT	BASAL	4	1246.388	0.009646	0.0125	0.774	0.0019	964.602	100.000%	woody	Baccharis salicifolia
931017	254	UT	SAEX			0.000227		0.018	0.0000	22.667		woody	Salix exigua
931017	254	UT	TARA			0.002433		0.195	0.0005	243.254		woody	Tamarix sp?
931017	254	UT	TESE			0.000159		0.013	0.0000	15.865		woody	Tessaria sericia
						0.000000		0.000	0.0000				
920712	259	GB UT	BASL	2	1493.593	0.009045	0.0149	0.606	0.0018	904.474	100.000%	woody	Baccharis salicifolia
920712	259	GB UT	TARA			0.005891		0.394	0.0012	589.119		woody	Tamarix sp?
						0.000000		0.000	0.0000				
920712	259	RS	JUNCUS SP#1	4	286.791	0.000033	0.0029	0.011	0.0000	3.270	1.140%	herbaceous-perennial	
920712	259	RS	AGST			0.000019		0.007	0.0000	1.940	0.676%	grass-perennial	Agrostis stolonifera
920712	259	RS	BASL			0.001572		0.548	0.0003	157.170	98.183%	woody	Baccharis salicifolia
920712	259	RS	TARA			0.001244		0.434	0.0002	124.412		woody	Tamarix sp?

HUALAPAI TRIBE VEGETATION MONITORING PROJECT
MARSH SUMMARY

includes live plants only
# of spp= # of species censused within plots
this # includes unknowns as seperate species
BA= basal area

GROWTH-FORM CATEGORIES

WOODY (shrubs, trees, cattails)
herbaceous-perennial
grass-perennial
other: includes all non-perennials; unknown dicot seedlings; all

DATE	MILE	total area(m^2) censused	# of spp	#spp/m^2	total BA/marsh (cm^2	total BA/m^2	BA/category	%of total B	%of area census	growth-form categor
fall '92	172	82	40	0.488	1895.682	0.0023	548.792	28.950%	0.067%	grass-perennial
							209.931	11.074%	0.026%	herbaceous-perennia
							999.935	52.748%	0.122%	woody
							137.024	7.228%	0.017%	other
931110	172	82	28	0.341	1237.495	0.0015	187.498	15.151%	0.023%	grass-perennial
							233.913	18.902%	0.029%	herbaceous-perennia
							777.301	62.812%	0.095%	woody
							38.783	3.134%	0.005%	other
941003	172	49	21	0.429	587.739	0.0012	51.043	8.685%	0.010%	grass-perennial
							156.349	26.602%	0.032%	herbaceous-perennia
							378.2	64.348%	0.077%	woody
							2.147	0.365%	0.000%	other
920827	194	231	68	0.294	9006.355	0.0039	1604.581	17.816%	0.069%	grass-perennial
							414.27	4.600%	0.018%	herbaceous-perennia
							6296.997	69.917%	0.273%	woody
							690.507	7.667%	0.030%	other
931111	194	232	59	0.254	16332.3	0.0070	1389.081	8.505%	0.060%	grass-perennial
							356.964	2.186%	0.015%	herbaceous-perennia
							14328.95	87.734%	0.618%	woody
							257.305	1.575%	0.011%	other
941004	194	58	29	0.500	1493.257	0.0026	231.241	15.486%	0.040%	grass-perennial
							59.415	3.979%	0.010%	herbaceous-perennia
							1184.938	79.353%	0.204%	woody
							17.663	1.183%	0.003%	other
931113	213	48	14	0.292	637.011	0.0013	75.202	11.805%	0.016%	grass-perennial
							0	0.000%	0.000%	herbaceous-perennia
							537.731	84.415%	0.112%	woody
							24.078	3.780%	0.005%	other
941005	213	58	9	0.155	1141.646	0.0020	93.493	8.189%	0.016%	grass-perennial
							0	0.000%	0.000%	herbaceous-perennia
							1046.385	91.656%	0.180%	woody
							1.768	0.155%	0.000%	other
920928	228	16	18	1.125	2599.583	0.0162	2367.997	1.480%	1.480%	grass-perennial
							116.042	0.073%	0.073%	herbaceous-perennia

DATE	MILE	total area(m^2) censused	# of spp	#spp/m^2	total BA/marsh (cm^2	total BA/m^2	BA/category	%of total B	%of area census	growth-form categor
							98.135	0.061%	0.061%	woody
							17.4087	0.6697%	0.011%	other
931013	228	24	13	0.542	333.865	0.0014	63.311	0.026%	0.026%	grass-perennial
							120.920	0.050%	0.050%	herbaceous-perennia
							133.431	0.056%	0.056%	woody
							16.2028	4.8531%	0.007%	other
940925	228	23	10	0.435	1137.704	0.0049	80.982	0.035%	0.035%	grass-perennial
							105.408	0.046%	0.046%	herbaceous-perennia
							950.269	0.413%	0.413%	woody
							1.0446	0.0918%	0.000%	other
920929	234	14	5	0.357	681.563	0.0049	261.390	0.187%	0.187%	grass-perennial
							414.824	0.296%	0.296%	herbaceous-perennia
							0.785	0.001%	0.001%	woody
							4.5639	0.6696%	0.003%	other
920930	239	14	5	0.357	240.734	0.0017	5.036	0.004%	0.004%	grass-perennial
							167.211	0.119%	0.119%	herbaceous-perennia
							0	0	0.000%	woody
							68.4871	28.4492%	0.049%	other
920930	241	15	8	0.533	488.076	0.0033	13.165	0.009%	0.009%	grass-perennial
							429.487	0.286%	0.286%	herbaceous-perennia
							44.693	0.030%	0.030%	woody
							0.7304	0.1497%	0.000%	other
9310	241	24	11	0.458	405.737	0.0017	23.452	0.010%	0.010%	grass-perennial
							307.342	0.128%	0.128%	herbaceous-perennia
							66.743	0.028%	0.028%	woody
							8.1996	2.0209%	0.003%	other
940926	241	28	10	0.357	1528.369	0.0055	313.020	0.112%	0.112%	grass-perennial
							1118.352	0.399%	0.399%	herbaceous-perennia
							70.136	0.025%	0.025%	woody
							26.8608	1.7575%	0.010%	other
921001	249	30	17	0.567	271.121	0.0009	39.672	0.013%	0.013%	grass-perennial
							128.724	0.043%	0.043%	herbaceous-perennia
							75.876	0.025%	0.025%	woody
							26.8488	9.9029%	0.009%	other
931015	249	90	20	0.222	1037.571	0.0012	387.216	0.043%	0.043%	grass-perennial
							73.851	0.008%	0.008%	herbaceous-perennia
							474.952	0.053%	0.053%	woody
							101.5520	9.7875%	0.011%	other

DATE	MILE	total area(m^2) censused	# of spp	#spp/m^2	total BA/marsh (cm^2	total BA/m^2	BA/category	%of total B	%of area census	growth-form categor
940926	249	83	16	0.193	2375.462	0.0029	528.997	0.064%	0.064%	grass-perennial
							108.534	0.013%	0.013%	herbaceous-perennia
							1641.121	0.198%	0.198%	woody
							96.8098	4.0754%	0.012%	other

APPENDIX I. AVIAN STUDIES DATA SUMMARY

Table 1. Raw data summary: Numbers of nesting or potentially nesting individuals detected by study site along the Colorado River between National Canyon and Pearce Ferry, Arizona, 1993. Data generated using the absolute count census technique and summarized using the maximum detections method.

	Number of individuals detected: 1993							
	Study site number							
Species	1	2	3	4	5	6	7	8
Mourning Dove	1.3	0.3	0.8	1.6	0.2	0.6	-	2.4
Black-chinned Hummingbird	1.7	3.0	3.8	1.1	0.6	1.8	0.3	2.6
Ladder-backed Woodpecker	-	-	-	-	-	-	-	2
Ash-throated Flycatcher	1.3	1.8	1.3	1.5	-	1.4	-	4.6
Bewick's Wren	2	4	2	6	8	16	6	46
Marsh Wren	-	-	-	-	-	-	-	2
Blue-gray Gnatcatcher	2	6	8	6	6	10	4	34
Northern Mockingbird	-	-	2	-	-	-	-	-
Crissal Thrasher	-	-	-	-	-	-	-	2
Phainopepla	-	-	4	-	-	-	-	-
Bell's Vireo	-	14	20	10	12	34	12	104
Lucy's Warbler	12	4	8	8	6	12	4	14
Yellow Warbler	2	4	2	4	16	26	4	32
Common Yellowthroat	-	2	-	2	10	22	4	46
Yellow-breasted Chat	-	4	-	6	10	14	6	42
Summer Tanager	-	2	-	-	2	4	-	2
Blue Grosbeak	-	-	2	2	-	2	2	18
Lazuli Bunting	-	-	-	2	-	-	-	2
Song Sparrow	-	-	-	6	12	16	6	76
Great-tailed Grackle	0.3	1.3	-	0.1	1.4	1.4	-	0.4
Brown-headed Cowbird	-	-	0.3	0.3	-	2.0	-	10.2
Hooded Oriole	-	-	-	-	2	4	-	-
House Finch	-	1.5	1.0	1.3	0.2	1.2	-	13.0
Lesser Goldfinch	-	2.5	1.3	0.6	2.4	5.4	0.8	4.8
Total individuals/site	22.6	50.4	56.5	58.5	88.8	173.8	49.1	460.0
Size of each study site (ha) for comparison	4.6	3.0	11.6	2.3	2.2	7.1	3.4	47.1

NOTE: Study sites are designated as follows: 1 = National Canyon, 2 = Parashant Canyon, 3 = Granite Park, 4 = RM 243L, 5 = Spencer Canyon, 6 = Quartermaster Canyon, 7 = Waterfall Rapids, and 8 = Tincanebits Canyon. Dashes indicate the species was not detected during the 1993 field season.

Table 2. Raw data summary: Numbers of nesting or potentially nesting individuals detected by study site along the Colorado River between National Canyon and Pearce Ferry, Arizona, 1993. Data generated using the absolute count census technique and summarized using the mean detections method.

	Mean number individuals ± SD: 1993			
	Study site number			
Species	1	2	3	4
Mourning Dove	1.3±0.9	0.3±0.4	0.8±0.8	1.6±1.1
Black-chinned Hummingbird	1.7±0.5	3.0±1.2	3.8±0.8	1.1±1.4
Ladder-backed Woodpecker	-	-	-	-
Ash-throated Flycatcher	1.3±0.9	1.8±0.4	1.3±0.9	1.5±0.5
Bewick's Wren	1.3±0.9	2.5±0.9	0.5±0.9	3.3±2.2
Marsh Wren	-	-	-	-
Blue-gray Gnatcatcher	2.0±0.0	4.5±0.9	6.0±1.4	3.5±1.7
Northern Mockingbird	-	-	1.0±1.0	-
Crissal Thrasher	-	-	-	-
Phainopepla	-	-	3.5±0.9	-
Bell's Vireo	-	13.0±1.7	18.0±1.4	6.8±1.7
Lucy's Warbler	10.0±1.6	3.5±0.9	5.5±1.7	6.0±1.7
Yellow Warbler	1.3±0.9	2.5±0.9	1.0±1.0	2.0±1.7
Common Yellowthroat	-	0.5±0.9	-	0.5±0.9
Yellow-breasted Chat	-	3.5±0.9	-	5.0±1.0
Summer Tanager	-	2.0±0.0	-	-
Blue Grosbeak	-	-	1.0±1.0	2.0±0.0
Lazuli Bunting	-	-	-	0.5±0.9
Song Sparrow	-	-	-	2.5±2.4
Great-tailed Grackle	0.3±0.4	1.3±2.2	-	0.1±0.3
Brown-headed Cowbird	-	-	0.3±0.4	0.3±0.7
Hooded Oriole	-	-	-	-
House Finch	-	1.5±0.5	1.0±1.0	1.3±1.0
Lesser Goldfinch	-	2.5±2.1	1.3±1.7	0.6±0.7
Sum of means	19.2	42.4	45.0	38.6
Mean ± SD number of individuals detected/survey	19.3±0.5	42.3±3.5	44.8±3.8	35.8±8.1
Number of species detected	8	14	14	17
Size of each study site (ha) for comparison	4.6	3.0	11.6	2.3

NOTE: Study sites are designated as follows: 1 = National Canyon, 2 = Parashant Canyon, 3 = Granite Park, 4 = RM 243L, 5 = Spencer Canyon, 6 = Quartermaster Canyon, 7 = Waterfall Rapids, and 8 = Tincanebits Canyon. Dashes indicate the species was not detected during the 1993 field season.

Table 2 (continued). Raw data summary: Numbers of nesting or potentially nesting individuals detected by study site along the Colorado River between National Canyon and Pearce Ferry, Arizona, 1993. Data generated using the absolute count census technique and summarized using the mean detections method.

	Mean number individuals ± SD: 1993			
	Study site number			
Species	5	6	7	8
Mourning Dove	0.2±0.4	0.6±0.8	-	2.4±2.7
Black-chinned Hummingbird	0.6±0.8	1.8±1.2	0.3±0.5	2.6±1.2
Ladder-backed Woodpecker	-	-	-	0.8±1.0
Ash-throated Flycatcher	-	1.4±0.8	-	4.6±1.4
Bewick's Wren	4.8±2.7	11.6±3.4	2.3±2.7	26.8±13.2
Marsh Wren	-	-	-	0.4±0.8
Blue-gray Gnatcatcher	2.8±2.0	4.8±3.5	2.7±1.5	24.4±5.7
Phainopepla	-	-	-	-
Northern Mockingbird	-	-	-	-
Crissal Thrasher	-	-	-	0.4±0.8
Bell's Vireo	10.0±1.3	28.0±4.9	10.0±2.0	89.6±8.9
Lucy's Warbler	3.6±1.5	5.6±3.4	2.0±1.6	6.4±4.8
Yellow Warbler	13.2±1.6	16.8±5.0	2.0±1.6	23.6±7.3
Common Yellowthroat	8.8±1.0	12.8±6.0	1.7±1.4	35.2±8.2
Yellow-breasted Chat	9.5±0.9	11.3±2.5	3.7±1.4	35.6±5.3
Summer Tanager	0.8±1.0	2.0±1.8	-	0.4±0.8
Blue Grosbeak	-	0.4±0.8	0.3±0.7	6.4±6.9
Lazuli Bunting	-	-	-	0.4±0.8
Song Sparrow	5.2±4.3	10.4±4.6	2.3±2.4	66.4±5.7
Great-tailed Grackle	1.4±1.7	1.4±2.3	-	0.4±0.8
Brown-headed Cowbird	-	2.0±0.9	-	10.2±2.3
Hooded Oriole	0.8±1.0	1.6±1.5	-	-
House Finch	0.2±0.4	1.2±1.2	-	13.0±7.2
Lesser Goldfinch	2.4±1.6	5.4±2.9	0.8±0.9	4.8±1.6
Sum of means	64.3	119.1	28.1	354.8
Mean ± SD number of individuals detected/survey	62.8±5.6	115.0±16.0	28.2±5.0	354.6±28.0
Number of species detected	15	18	11	21
Size of each study site (ha) for comparison	2.2	7.1	3.4	47.1

NOTE: Study sites are designated as follows: 1 = National Canyon, 2 = Parashant Canyon, 3 = Granite Park, 4 = RM 243L, 5 = Spencer Canyon, 6 = Quartermaster Canyon, 7 = Waterfall Rapids, and 8 = Tincanebits. Dashes indicate the species was not detected during the 1993 field season.

Table 3. Raw data summary: Numbers of nesting or potentially nesting individuals detected by study site along the Colorado River between National Canyon and Pearce Ferry, Arizona, 1994. Data generated using the absolute count census technique and summarized using the maximum detections method.

Species	Number of individuals detected: 1994							
	Study site number							
	1	2	3	4	5	6	7	8
Gambel's Quail	-	0.1	-	-	-	-	-	-
Mourning Dove	-	-	0.7	0.8	0.3	0.1	-	2.6
Western Screech-Owl	-	-	-	-	-	-	-	2
Black-chinned Hummingbird	1.0	3.4	4.8	2.6	1.6	2.5	0.3	2.0
Costa's Hummingbird	-	-	0.2	0.3	0.1	-	-	-
Ladder-backed Woodpecker	2	2	-	2	2	2	2	2
Ash-throated Flycatcher	0.7	2.8	0.5	1.1	0.1	2.1	0.1	1.7
Kingbird sp.	-	-	-	-	-	0.3	-	-
Bewick's Wren	2	8	6	4	6	20	4	24
Blue-gray Gnatcatcher	6	6	8	10	4	10	6	38
Northern Mockingbird	-	-	2	-	-	-	-	-
Crissal Thrasher	-	-	-	-	-	-	2	2
Phainlopepla	2	2	4	-	-	-	2	-
Bell's Vireo	2	16	20	12	18	32	10	112
Lucy's Warbler	14	12	22	16	6	12	4	20
Yellow Warbler	2	4	2	2	20	16	6	42
Common Yellowthroat	2	4	-	-	12	22	8	50
Yellow-breasted Chat	-	4	4	6	10	20	6	54
Summer Tanager	-	2	-	-	2	-	-	2
Blue Grosbeak	-	2	4	2	2	4	-	8
Indigo Bunting	-	-	-	-	-	-	-	2
Song Sparrow	-	2	-	10	12	14	6	78
Great-tailed Grackle	1.0	0.1	0.3	0.6	1.0	-	-	0.1
Brown-headed Cowbird	-	0.3	0.5	-	0.1	2.3	0.3	6.6
Hooded Oriole	-	2	-	-	-	2	2	-
House Finch	2.3	1.0	1.3	1.0	1.0	1.4	0.8	6.9
Lesser Goldfinch	-	-	1.8	1.4	3.0	2.6	-	6.7
Total individuals/site	37.0	73.7	82.1	71.8	101.2	165.3	59.5	462.6
Size of each study site (ha) for comparison	4.6	3.0	11.6	2.3	2.2	7.1	3.4	47.1

NOTE: Study sites are designated as follows: 1 = National Canyon, 2 = Parashant Canyon, 3 = Granite Park, 4 = RM 243L, 5 = Spencer Canyon, 6 = Quartermaster Canyon, 7 = Waterfall Rapids, and 8 = Tincanebits Canyon. Dashes indicate the species was not detected during the 1994 field season.

Table 4. Raw data summary: Numbers of nesting or potentially nesting individuals detected by study site along the Colorado River between National Canyon and Pearce Ferry, Arizona, 1994. Data generated using the absolute count census technique and summarized using the mean detections method.

	Mean number individuals ± SD: 1994			
	Study site number			
Species	1	2	3	4
Gambel's Quail	-	0.1±0.3	-	-
Mourning Dove	-	-	0.7±0.7	0.8±0.7
Western Screech-Owl	-	-	-	-
Black-chinned Hummingbird	1.0±1.0	3.4±1.9	4.8±3.5	2.6±1.1
Costa's Hummingbird	-	-	0.2±0.4	0.3±0.4
Ladder-backed Woodpecker	0.7±0.9	0.3±0.7	-	0.5±0.9
Ash-throated Flycatcher	0.7±0.5	2.8±0.4	0.5±0.8	1.1±0.8
Kingbird sp.	-	-	-	-
Bewick's Wren	0.7±0.9	3.8±2.1	1.3±2.2	1.5±1.3
Blue-gray Gnatcatcher	2.0±2.3	4.3±1.6	5.3±1.9	6.3±1.9
Northern Mockingbird	-	-	1.0±1.0	-
Crissal Thrasher	-	-	-	-
Phainopepla	0.3±0.7	0.8±1.0	2.0±1.6	-
Bell's Vireo	0.7±0.9	14.3±2.5	18.0±2.3	9.5±2.2
Lucy's Warbler	9.3±2.7	7.3±2.4	11.7±6.7	11.0±3.5
Yellow Warbler	0.3±0.7	1.3±1.4	0.3±0.7	0.5±0.8
Common Yellowthroat	1.3±0.9	1.0±1.4	-	-
Yellow-breasted Chat	-	3.0±1.0	4.0±0.0	4.7±0.9
Summer Tanager	-	0.3±0.7	-	-
Blue Grosbeak	-	0.3±0.7	4.0±0.0	0.5±0.8
Indigo Bunting	-	-	-	-
Song Sparrow	-	0.3±0.7	-	5.5±2.4
Great-tailed Grackle	1.0±1.8	0.1±0.3	0.3±0.5	0.6±1.7
Brown-headed Cowbird	-	0.3±0.7	0.5±0.8	-
Hooded Oriole	-	0.3±0.7	-	-
House Finch	2.3±1.4	1.0±1.1	1.3±0.5	1.0±1.0
Lesser Goldfinch	-	-	1.8±2.6	1.4±1.4
Sum of means	20.3	45.0	57.7	47.8
Mean ± SD number of individuals detected/survey	20.3±8.6	41.5±3.6	52.5±10.6	46.5±9.9
Number of species detected	12	19	17	16
Size of each study site (ha) for comparison	4.6	3.0	11.6	2.3

NOTE: Study sites are designated as follows: 1 = National Canyon, 2 = Parashant Canyon, 3 = Granite Park, 4 = RM 243L, 5 = Spencer Canyon, 6 = Quartermaster Canyon, 7 = Waterfall Rapids, and 8 = Tincanebits Canyon. Dashes indicate the species was not detected during the 1994 field season.

Table 4 (continued). Raw data summary: Numbers of nesting or potentially nesting individuals detected by study site along the Colorado River between National Canyon and Pearce Ferry, Arizona, 1994. Data generated using the absolute count census technique and summarized using the mean detections method.

	Mean number individuals ± SD: 1994			
	Study site number			
Species	5	6	7	8
Gambel's Quail	-	-	-	-
Mourning Dove	0.3±0.7	0.1±0.3	-	2.6±3.5
Western Screech-Owl	-	-	-	0.3±0.7
Black-chinned Hummingbird	1.6±1.0	2.5±3.0	0.3±0.7	2.0±1.4
Costa's Hummingbird	0.1±0.3	-	-	-
Ladder-backed Woodpecker	0.3±0.7	0.5±0.9	0.3±0.7	0.9±1.0
Ash-throated Flycatcher	0.1±0.3	2.1±1.8	0.1±0.3	1.7±0.9
Kingbird sp.	-	0.3±0.7	-	-
Bewick's Wren	4.0±1.4	14.5±3.7	2.0±1.7	19.7±2.2
Blue-gray Gnatcatcher	2.3±1.6	6.0±1.7	2.5±2.2	28.9±5.2
Northern Mockingbird	-	-	-	-
Crissal Thrasher	-	-	0.5±0.9	0.6±0.9
Phainopepla	-	-	0.3±0.7	-
Bell's Vireo	13.5±2.6	29.8±1.6	8.3±1.2	97.1±13.6
Lucy's Warbler	4.3±1.2	5.5±3.4	2.3±0.7	10.6±5.8
Yellow Warbler	16.5±4.0	12.5±3.1	2.8±2.4	29.1±10.6
Common Yellowthroat	6.5±3.4	14.5±3.1	2.5±2.8	41.7±5.8
Yellow-breasted Chat	8.0±1.6	16.3±2.4	4.3±1.4	42.0±9.4
Summer Tanager	0.3±0.7	-	-	0.6±0.9
Blue Grosbeak	0.3±0.7	1.0±1.4	-	2.6±3.5
Indigo Bunting	-	-	-	0.3±0.7
Song Sparrow	8.8±2.4	8.3±3.8	2.5±2.0	67.7±12.2
Great-tailed Grackle	1.0±2.0	-	-	0.1±0.3
Brown-headed Cowbird	0.1±0.3	2.3±2.3	0.3±0.4	6.6±4.4
Hooded Oriole	-	0.5±0.5	0.3±0.7	-
House Finch	1.0±1.1	1.4±1.5	0.8±1.3	6.9±3.7
Lesser Goldfinch	3.0±3.0	2.6±1.4	-	6.7±4.7
Sum of means	72.0	120.7	30.1	368.7
Mean ± SD number of individuals detected/survey	68.1±11.0	117.6±10.0	28.6±8.2	356.3±30.3
Number of species detected	19	18	16	20
Size of each study site (ha) for comparison	2.2	7.1	3.4	47.1

NOTE: Study sites are designated as follows: 1 = National Canyon, 2 = Parashant Canyon, 3 = Granite Park, 4 = RM 243L, 5 = Spencer Canyon, 6 = Quartermaster Canyon, 7 = Waterfall Rapids, and 8 = Tincanebits Canyon. Dashes indicate the species was not detected during the 1994 field season.

Table 5. Nest heights above ground (cm) for birds detected nesting in riparian vegetation along the Colorado River from National Canyon to Tincanebits Canyon (rm 166-265), April to June, 1993-1994. N = sample size.

Species	N	Minimum	Mean ± SD	Maximum
Black-chinned Hummingbird	5	160	208 ± 33	250
Bewick's Wren	1	50	50	50
Blue-gray Gnatcatcher	9	110	352 ± 140	550
Phainopepla	1	180	180	180
Bell's Vireo	27	35	160 ± 70	350
Lucy's Warbler	6	150	204 ± 53	310
Yellow Warbler	2	160	430 ± 270	700
Common Yellowthroat	8	2	50 ± 38	130
Yellow-breasted Chat	12	150	225 ± 66	350
Song Sparrow	6	105	152 ± 34	190
Total Nests	77	-	-	-

Table 6. Nest substrate plants used by birds nesting in riparian vegetation as compared to nest substrate availability as a percentage of total vegetation volume (tvv) and live tvv along the Colorado River from National Canyon to Tincanebits Canyon (rm 166-265), April to June, 1993-1994. a dash indicates no nests were found. Tvv values used were weighted mean values for each nest substrate plant species (mean value at all sites combined weighted by the size of each site).

Nest Substrate Plants	Number of nests by bird species[1]										Total	% of Total	%	% of Live
	BH	BW	BG	P	BV	LW	YW	CY	YC	SS	Nests	Nests	TVV	TVV
Tamarisk	3	1	5	-	18	7	-	2	10	5	51	65.4	67.8	67.0
Cattail	-	-	-	-	-	-	-	5	-	1	6	7.7	4.0	2.9
Honey mesquite	-	-	-	1	4	-	-	-	-	-	5	6.4	2.6	2.8
Baccharis sp.	1	-	-	-	2	-	-	-	2	-	5	6.4	9.2	8.7
Catclaw acacia	-	-	4	-	-	-	-	-	-	-	4	5.1	0.8	0.7
Goodding's willow	-	-	-	-	1	-	2	-	-	-	3	3.8	3.1	3.6
Arrowweed	-	-	-	-	1	-	-	-	-	-	1	1.3	3.1	3.1
Coyote willow	-	-	-	-	-	-	-	1	-	-	1	1.3	4.1	4.7
Hackberry	-	-	-	-	1	-	-	-	-	-	1	1.3	0.9	1.0
Long-leaf brickellbush	1	-	-	-	-	-	-	-	-	-	1	1.3	0.1	0.1
Total nests	5	1	9	1	27	7	2	8	12	6	78	100.0	95.7	94.6

[1] Bird species codes as follows: BH = Black-chinned Hummingbird, BW = Bewick's Wren, BG = Blue-gray Gnatcatcher, P = Phainopepla, BV = Bell's Vireo, LW = Lucy's Warbler, YW = Yellow Warbler, CY = Common Yellowthroat, YC = Yellow-breasted Chat, and SS = Song Sparrow.