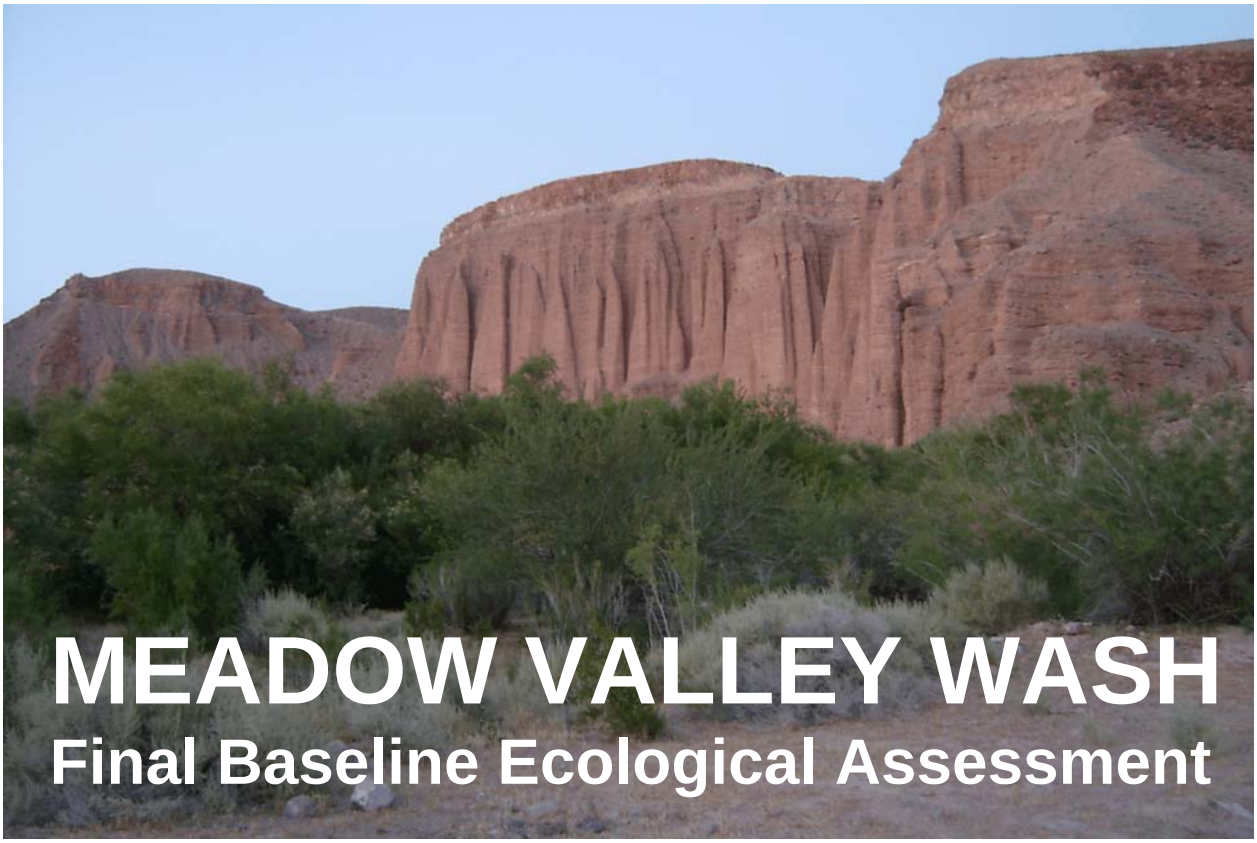

MEADOW VALLEY WASH
Final Baseline Ecological Assessment

Submitted to:
Lincoln County
P.O. Box 685
Pioche, Nevada 89045

Submitted by:
BIO-WEST, Inc.
1063 West 1400 North
Logan, Utah 84321

March 2005

Providing Context-Sensitive Environmental Services Since 1976

PREFACE ON MAP AND DATA AVAILABILITY

The Meadow Valley Wash Baseline Ecological Assessment was funded through a matching grant from the United States Department of Interior, U.S. Fish and Wildlife Service (USFWS) under Section 6 of the Endangered Species Act. The matching participants were Lincoln County and Clark County. As part of the assessment, an extensive array of GIS data and maps were prepared and submitted to Lincoln County, Clark County and the U.S. Fish and Wildlife Service in both hard bound and digital versions. The maps and graphics included the following material.

1. *Three Band Digital Rectified Images, Meadow Valley Wash and Clover Creek.* This is the 3-band imagery captured in October 2003 for both Clover Creek and Meadow Valley Wash.

2. *Meadow Valley Wash Baseline Ecological Assessment, Atlas of Classified Vegetation, Meadow Valley Wash and Clover Creek.* This is the original vegetation classification based on the imagery. The classification was subsequently aggregated into vegetation types.

3. *Meadow Valley Wash Baseline Ecological Assessment, Woody Riparian Vegetation Comparison, 1976 and 2003.* This is the digital GIS data containing the rectified 1976 aerial photos and a shapefile of the change in vegetation between these 1976 photos and the 2003 digital imagery.

4. *MSHCP Covered Species, Historic Sightings in Relation to Current Habitat*. This data set depicts historic occurrence of all MSHCP Covered Species in relation to the delineated suitable habitat (6 maps approximately 22"x36" each).

5. *Meadow Valley Wash Baseline Ecological Assessment, Comprehensive Vegetation Typing and Southwestern Willow Flycatcher Habitat*. This atlas depicts all of the vegetation typing, suitable and potential Southwestern willow flycatcher habitat, and private lands.

Because of the large size and complexity of the graphics and maps, it was not practicable to include this full array with the current report.

One DVD is included in the back cover of the report containing the *Meadow Valley Wash Baseline Ecological Assessment, Comprehensive Vegetation Typing and Southwestern Willow Flycatcher Habitat*. The DVD contains readable files showing all vegetation, and Southwestern willow flycatcher habitat in relation to land ownership. The scale is 1:24,000. The base for this map set is the 2003 aerial 3 band imagery. An index map is included for location reference as well as a legend explaining symbols.

All other data sets, as enumerated above, are available for review at the offices and locations presented on the following page.

Review Locations of Maps and Graphics

Lincoln County
Grants Administration Office
1 Main Street
Pioche, Nevada

Clark County
Department of Air Quality and Environmental Management
500 South Grand Central Parkway
Las Vegas, Nevada

U.S. Fish and Wildlife Service
Southern Nevada Field Office
4701 N. Torrey Pines Drive
Las Vegas, Nevada

Bureau of Land Management
Caliente Field Station
1400 South Front Street
Caliente, Nevada

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INTRODUCTION

Within the arid Southwest, the desert riparian ecosystem supports a diverse array of wildlife species, many of which are restricted to the limited habitat components supported by local hydrology. The desert riparian system has historically provided essential habitat components for species, particularly avian species, that have limited distribution or are experiencing population declines across their range. The Meadow Valley Wash of southeastern Nevada comprises a variable desert riparian ecosystem punctuated by diverse geologic, hydrologic, and anthropogenic conditions that have affected the amount, distribution, and structure of the differing riparian vegetation within the system. The vegetation type, distribution, and structural characteristics have, subsequently, determined available wildlife habitat within Meadow Valley Wash.

In Nevada, both Clark County and Lincoln County (Counties) incorporate environmental conservation – including sustainability of vulnerable ecosystems, resources, and species – into their long-term planning. One such environmental strategy is the development of the Meadow Valley Wash Conservation Plan as prescribed in the Clark County Multiple Species Habitat Conservation Plan (Clark County 2000) and the Southeastern Lincoln County Multiple Species Habitat Conservation Plan (Lincoln County 2003). The Meadow Valley Wash Conservation Plan requires an assessment of baseline ecological characteristics of Meadow Valley Wash that will be used to identify and prioritize conservation actions and activities for "covered" species identified in the Multiple Species Habitat Conservation Plans (MSHCPs), with particular emphasis on southwestern willow flycatcher (*Empidonax traillii extimus*) (SWWFC). The Southeastern Lincoln County MSHCP defines covered species as Federally listed and proposed threatened or endangered species, Federal candidate species, and State-listed sensitive species (Lincoln County 2003). The Clark County MSHCP states that covered species are currently Federally listed threatened or endangered species or those species that may become so in the future (Clark County 2000). The covered species of concern in the Meadow Valley Wash Conservation Plan were restricted to those potentially occurring in the Meadow Valley Wash riparian communities. In October 2003 the Counties contracted BIO-WEST, Inc., of Logan, Utah, to prepare the baseline ecological assessment (Study) of Meadow Valley Wash. The project was funded through a matching grant from the United States Department of Interior, U.S. Fish and Wildlife Service (USFWS) under Section 6 of the Endangered Species Act.

The goal of the Study was to characterize and evaluate riparian communities within Meadow Valley Wash in order to identify riparian sites that could be protected, enhanced, or restored in compliance with the MSHCPs. The Study focused primarily on the identification of suitable habitat and potentially suitable habitat for covered species, with particular emphasis on the SWWFC. Such identification can then be used by the Counties to define and prioritize conservation actions and activities in Meadow Valley Wash.

The Study defined the current condition of riparian communities in Meadow Valley Wash and compared recent and historical riparian conditions with the riparian conditions inventoried in the field. Suitable habitat for covered species was evaluated based on riparian vegetation composition

and structure, habitat patch size, presence of surface water, and other elements that appeared to affect a covered species' affinity for a habitat patch. Riparian conditions were assessed not only for suitable habitat, but also for habitat patches that could potentially reach suitable conditions for covered species, specifically for SWWFC. Suitable habitat for SWWFC was also evaluated for the presence of specific threats or stressors – existing land uses, or hydrologic conditions that could affect riparian conditions and reduce the suitability of the habitat for SWWFC.

STUDY AREA

Meadow Valley Wash drains a substantial portion of southeast Nevada, extending a total of about 110 miles in a general north-south direction from a northern origin in the Wilson Creek Range of eastern Lincoln County to a southern confluence with the Muddy River in Clark County. The drainage originates in the Great Basin physiographic region, but after approximately 30 miles it enters the Mojave Desert physiographic region and continues through the Mojave Desert to its confluence with the Muddy River. Provencher et al. (2003) identified Meadow Valley Wash as ecologically significant, because it is the only remaining corridor of bird migration in Southeastern Nevada between the Mojave Desert and Great Basin with a large portion of native riparian vegetation.

The specific area (Figure 1) for the Study (Study Area) was comprised of approximately 85 miles of the lower-elevation portion of the Meadow Valley Wash main channel that extends through the area covered by the Southeastern Lincoln County MSHCP and the Clark County MSHCP. Approximately 70 miles of the Study Area (82%) are within Lincoln County, and 15 miles (18%) are within Clark County. The Study Area included the general floodplain of Meadow Valley Wash from about 1 mile north of the City of Caliente, Nevada (T4S R67E NE 1/4 NW 1/4, Section 5), to the confluence of Meadow Valley Wash and Muddy River immediately east of Glendale, Nevada (T15S R66E NW 1/4 NE 1/4 Section 2). The elevation grades from 4,434 feet above sea level at the northern Study Area terminus to 1,520 feet above sea level at the confluence with the Muddy River at the southern terminus. The Study Area is primarily within the Mojave Desert, although the northern section through the Rainbow Canyon to Caliente is transitional to the Great Basin.

The terrain within the Study Area is a series of canyons and open valleys dependent upon the underlaying geology. South of Caliente Meadow Valley Wash enters Rainbow Canyon, which cuts through about 600 feet of volcanic rock (tuffaceous rocks, welded tuffs, and thin rhyolite flows) for approximately 20 miles down to Elgin, Nevada (Averett 1995). The volcanic tuffs and rhyolite, with multiple, thin basalt overlying beds, continue south and open rapidly just north of Leith, Nevada. From Leith to past Carp, Nevada, the terrain consists of Tertiary and Quarternary gravels (Averett 1995). The open valley continues south from Leith for approximately 10 miles, then it constricts into a canyon again near Carp. From Carp south to Rox, Nevada, the terrain is primarily a canyon, although it is broader and generally less confining than Rainbow Canyon. South of Rox the terrain is primarily alluvium valley.

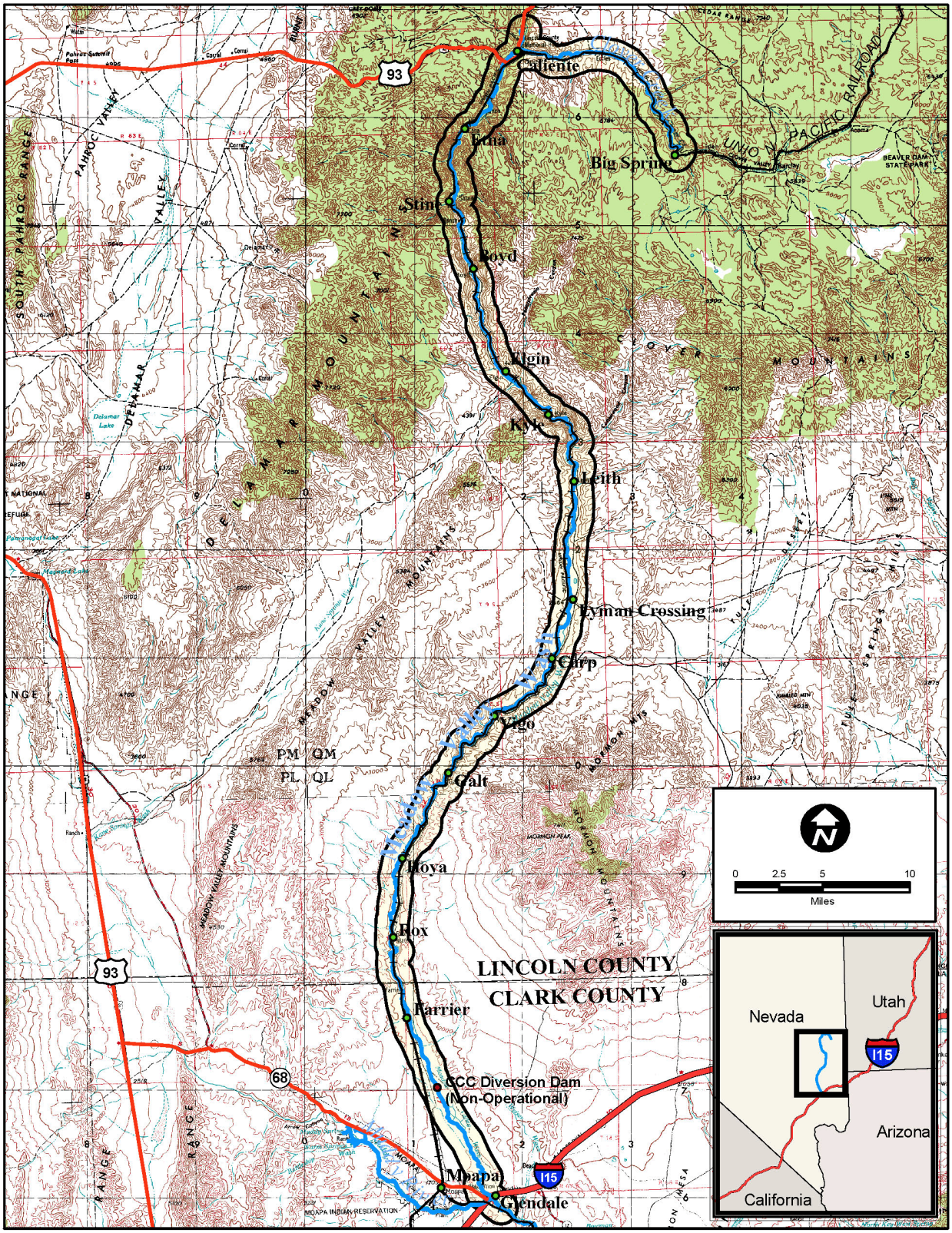

Figure 1. Meadow Valley Wash Study Area.

In general, the water in Meadow Valley Wash is from precipitation falling in the mountains, although ground water discharge through sporadic spring seeps can contribute locally to the flow. On average, Meadow Valley Wash in the Mojave Desert portion receives 4-6 inches of rain annually, while the northern portion in the Great Basin receives 8-14 inches of rain annually (Provencher et al. 2003). Flash flooding has been described frequently for Meadow Valley Wash between Caliente and Rox, and catastrophic flood events have been noted, primarily during the first half of the 1900s (Averett 1995).

Above the Study Area, Meadow Valley Wash is perennial from its source to Caliente (Averett 1995). Within the Study Area, Provencher et al. (2003) described Meadow Valley Wash as perennial from Caliente to Elgin but intermittent further south, depending on where the bedrock interfaces with the alluvium. However, Averett (1995) considered Meadow Valley Wash perennial down through Leith where it sank into the alluvium. From this point downstream to just north of Carp, Averett (1995) considered Meadow Valley Wash ephemeral and described the flow as mostly perennial to the confluence with the Muddy River. This description is historic, based on early 20th century observations, and indicates that flows within Meadow Valley Wash have substantially decreased over the past 50 years or more (Provencher et al. 2003).

Active mining occurred throughout Meadow Valley Wash, but it was most prevalent north of Pioche, Nevada (Provencher et al. 2003). Few mining operations are currently active. By the mid 19th century, year-long livestock ranching activities became common (Provencher et al. 2003). Farms and ranches were established in Meadow Valley Wash south of Caliente during the mid-to-late 1880s, and peak farming and ranching activities occurred through the first half of the 20th century (Averett 1995). Many of the ranches and farms within Meadow Valley Wash between Caliente and Carp are no longer active; approximately 30 ranches were purchased by the Federal government in the late 1930s under the Land Utilization Program (Averett 1995). Remaining ranches continue to pasture livestock and raise crops, primarily alfalfa, but they are limited due to water availability. Railroad development began near the turn of the 20th century, and the rail line through Meadow Valley Wash from Moapa, Nevada, on the south to Caliente on the north became an integral section of the Union Pacific Railroad (UPRR) transcontinental system during the early 20th century (Averett 1995). The UPRR continued east from Caliente through Clover Creek, Nevada, one of the primary tributaries of Meadow Valley Wash, and continued north to Salt Lake City, Utah. The Union Pacific Railroad induced the development of towns within Meadow Valley Wash including Caliente, Elgin, Leith, and Carp (Averett 1995, Provencher et al. 2003). The railroad has also had a substantial effect on the geomorphology, hydraulics, and subsequent vegetation communities within Meadow Valley Wash by disconnecting the floodplain from the river and through dredging operations (Provencher et al. 2003).

Within the Study Area, as with the general Meadow Valley Wash, land ownership is predominantly public, primarily managed by the U.S. Department of the Interior, Bureau of Land Management (BLM). The overall Meadow Valley Wash is approximately 97 percent public lands with the remaining 3 percent privately owned, principally along Meadow Valley Wash (Provencher et al. 2003). Within the area between Caliente and Moapa, public land ownership is approximately 92 percent with the remaining 8 percent privately owned, again primarily along Meadow Valley Wash.

In addition to the primary Study Area, vegetation classification was conducted for the lower 13.7 miles of Clover Creek from its confluence with Meadow Valley Wash at Caliente upstream to approximately 1 mile northeast of Big Springs, Nevada (T5S R68E NW 1/4 NE 1/4 Section 11). Clover Creek is considered an important perennial tributary of Meadow Valley Wash (Provencher et al. 2003).

METHODS

The methods employed in the Study were based on those proposed in the contractor's contractual scope of work. These methods were reviewed and approved by the Technical Review Team after the initial vegetation mapping was completed for the Study.

Mapping Vegetation Resources

Fundamental to the Study was the identification and classification of the existing vegetation components within the Meadow Valley Wash floodplain where hydrogeomorphologic conditions potentially support the desert riparian ecosystem. A verification of existing vegetation components, including species identification and spatial distribution, permitted determination of vegetation communities or types, delineation of specific riparian communities, and eventual identification of current suitable habitat for the SWWFC and other covered species. Vegetation mapping was accomplished through acquisition of high-resolution aerial imagery, accurate field verification, vegetation classification, and aggregation of the vegetation into discrete blocks based on species dominance. Riparian characteristics were identified through an intensive field inventory.

Aerial Imagery

High-resolution, digital 3-band, multispectral imagery was acquired so that a width of approximately 3,300 feet at approximately 1.6-foot pixel resolution would cover the entire Meadow Valley Wash floodplain. The imagery was acquired for the complete 85 miles of the Meadow Valley Wash Study Area, as well as the 13.7 miles of Clover Creek from approximately Big Springs to the confluence with Meadow Valley Wash. The imagery was acquired over a 2-day period, on September 25-26, 2003. Sky conditions were clear and cloudless, and images were captured on three narrow spectral bands centered in the green, red, and near-infrared portions of the electromagnetic spectrum.

Prior to flights, a standard reflectance panel was established at the Mesquite, Nevada, airport. Voltages from the panel were sampled and stored in a data logger every minute. The voltages were related to radiance through calibration equations. The data were used in the absolute calibration of the acquired imagery.

Approximately 450 individual three-band images were obtained. The images were radiometrically calibrated to radiance using relationships of image digital numbers to radiance. The image pixels were then transformed into reflectance using measurements of incoming irradiance conducted concurrently with the flights. The images were calibrated in terms of reflectance and corrected for variation in incoming solar radiation throughout the flight period. Calibration also permitted the classification of large mosaics covering long reaches of Meadow Valley Wash with the same signature file. Finally, calibration ensured that the present data set could be compared with future image acquisition. The individual 3-band images were then rectified through a rubber-sheeting technique to 1:24,000 U.S. Geological Survey (USGS) digital orthophoto quadrangles (DOQs) using common control points visible in both sets of imagery. The rectified images were then mosaicked along the flight lines to form larger image strips for the reaches of Meadow Valley Wash.

Imagery acquisition method specifics are presented in the supplemental vegetation classification report for the Study (Neale and Jayanthi 2004). The supplemental report, as well as the digital files of all individual images and mosaics, were delivered to Lincoln and Clark Counties as components of the Study's products.

Vegetation Classification

After mosaics of the rectified imagery were completed for both Meadow Valley Wash and Clover Creek, the rectified imagery was printed at 1:6,000 scale onto tabloid pages, resulting in a 73-page atlas, which was laminated and bound for field use. A field visit to obtain ground-verified identification of vegetation was conducted between December 5-14, 2003.

Initially, the ground team conducted an overview of the entire Study Area to determine the complexity of the vegetation and allocate the remaining ground-truthing effort based on riparian habitat considerations. Following the overview, 514 discrete sample sites were visited. At each location, the vegetation type or surface type was noted and demarked on the field maps as discrete polygons. In addition, 1,356 points were identified as to the specific plant species. In Clover Creek and the upper portions of Meadow Valley Wash, the leaves of the riparian vegetation were mostly senesced and dropped, making discrete species identification difficult for problematic taxons such as willows (*Salix* sp.). As a result, the initial field determination for some of these taxons was reviewed and revised during the subsequent field evaluations of riparian conditions.

A total of 53 surface types were identified during the field visit. Five of the types were architectural and included railroad, roof, quarry, shadow, and lawn. Another six types were related to bare soils and surface water. The remaining 43 types were vegetation species or aggregations of species.

The calibrated image mosaics were classified using supervised classification techniques. The ground-truth data were used to identify several occurrences for each different vegetation type. Supervised signature extraction techniques were used to extract spectral signatures representing the different surface and vegetation types in the calibrated images. For each spectral class, an area-of-interest polygon was produced for the pixels used in the signature. The spectral signatures of these polygons were extracted, and a transformed divergence statistical analysis was conducted to study

the separability of the signatures. Signatures with significant overlapping spectral characteristics were either dropped and retrained, or they were merged if they were totally inseparable and represented the same type. It was necessary to extract several spectral classes representing one vegetation type in order to capture the variability in reflectance and signatures resulting from varying vegetation density and health, as well as bidirectional reflectance. Once the signature set was finalized, the image mosaic was classified according to vegetation or surface type.

The final classification was statistically analyzed and the results were good, with all accuracies above 90 percent. The accuracy assessment was conducted by dividing the entire Study Area into five large reaches, one Clover Creek reach and four Meadow Valley Wash reaches. Within each Study Area reach, 100 random points were assigned to the classified image and compared with the verified ground-truth data for each point.

Specifics of the vegetation classification methods are presented in the supplemental vegetation classification report for the Study (Neale and Jayanthi 2004). The supplemental report and the digital files of the classified mosaics were delivered to the Counties as components of the Study's products.

Final Vegetation and Land Typing

The supervised vegetation classification became the final product for the Clover Creek reach of the Study Area and resulted in 52 classes. However, the supervised vegetation classification was reappraised to better describe vegetation and land-use types within the Meadow Valley Wash floodplain. In some cases, the preliminary vegetation types identified through the supervised classification were not relevant, because (1) they were subcomponents of a more inclusive type, (2) they did not occur in sufficient density to compose discrete types, or (3) they did not occur within the floodplain of Meadow Valley Wash. In addition, subsequent field investigations identified and described additional types that were not included in the initial classifications.

Based on a review of the supervised vegetation classification, a literature review, and subsequent field investigations, a final classification system for the Study Area was developed in accordance with the National Vegetation Classification in Nevada, which was produced by the Nevada Natural Heritage Program (NNHP) (NNHP 2001). The classification system was also designed to fit within the framework of The Nature Conservancy and Natureserve ecological community classification (Grossman et al. 1998, NatureServe 2004). However, Meadow Valley Wash vegetation has not been classified strictly using the NNHP hierarchy. The NNHP classification of upland plant communities is more detailed than what is feasible within the scope of this Study, yet it is not detailed enough for the diverse riparian plant communities in the Study Area. In addition, some of the prevalent plant communities in the Study Area are not found in the NNHP classification system. Finally, there are no keys or detailed descriptions of some of the Alliances and Associations in the NNHP classification, which makes it difficult to classify vegetation based on the NNHP system alone.

Most of the upland plant communities defined for the Study are equivalent to what is called an "Alliance" in the NNHP classification, while most of the riparian types are equivalent to the more detailed "Associations." In order to reflect habitat criteria for important animal species, a determination was made to use slightly different classification terminology for this Study. Also, the employed classification could not be definitively correlated to the NNHP classification system in all cases. Therefore, the more general term "vegetation types" was used for vegetation categories and "land types" was used for those categories dominated by human activities and where plant composition is secondary or nonexistent.

The riparian classification of vegetation in Nevada is an ongoing process, and the NNHP classification is not complete. For instance, there are no red willow (*Salix laevigata*) plant communities in the NNHP classification; however, it is an important vegetation type in the Study Area. Tamarisk (*Tamarix ramosissima*) vegetation types are also absent in the NNHP classification, but they need to be included in this Study since they are a major component of the current desert riparian ecosystem. The Riparian Forest/Tamarisk Woodland Mix vegetation type is important to separately identify in the Study Area because undesirable tamarisk mix with more desirable native riparian species. This vegetation type can indicate areas of regeneration of Freemont cottonwood (*Populous freemontii*) and willows within this plant community or, conversely, the future loss of the native community; therefore, important information could be lost by using the NNHP classification, which would classify this plan community into another Association. The vegetation type classification used here also differs from the NNHP in classifying the Freemont cottonwood type as a forest and not a woodland. This brings the current classification in accordance with the habitat requirements of Hink and Ohmart (1984) for determining suitable SWWFC habitat. Freemont Cottonwood Forests, in their full expression within the Study Area, are indeed forests and not woodlands: they have a dense canopy, are over 40 feet high, and have diverse, dense understory vegetation.

As a result of the reappraisal, the vegetation and land types were reduced from the 52 types defined during the supervised classification to 41 vegetation and land types appropriate for the Study Area. Table 1 identifies the final vegetation and land types used in this Study. See Appendix A for a description of each of the 41 vegetation and land types.

Vegetation Aggregation

Once final vegetation types were established, the vegetation was consolidated into spatial blocks dominated by a specific vegetation type. Aggregating the vegetation into discrete polygons based on the dominant vegetation type was the method used to identify and segregate the individual plant communities within the Study Area.

Prior to aggregation, the classified data were in a raster format with a pixel resolution of 1.6 feet and, as such, each pixel was individually classified with discrete vegetation values. The individual pixels were converted into polygons with common boundaries using Arc/Info 8.1. These polygons were built from groups of contiguous pixels with the same vegetation value and thus were homogeneous in vegetation type.

Table 1. Meadow Valley Wash Baseline Ecological Assessment and Nevada Natural Heritage Program Vegetation Classification Equivalencies.

VEGETATION TYPE/LAND TYPE	NNHP VEGETATION TYPE[a]	INTERNATIONAL CLASSIFICATION[b]
Alluvium	Unconsolidated material sparse vegetation	Unconsolidated material sparse vegetation
Arrowweed Shrubland	none	Arrow-weed Seasonally Flooded Shrubland
Bare Soil	Boulder, gravel, cobble, or talus; sparse vegetation	Boulder, gravel, cobble, or talus; sparse vegetation
Bulrush Marsh	several[c]	several
Burnt or Dead Tamarisk Woodland	none	none
Bush Seepweed Shrubland	Shrubby Seepweed Shrubland	Shrubby Seepweed Shrubland
Cattail Marsh	Broadleaf Cattail Marsh	Broadleaf Cattail Marsh
Coyote Willow Shrubland	Coyote Willow / Mesic Forbs Shrubland	Sandbar Willow Shrubland
Creosote Bush Shrubland	Creosotebush Shrubland Alliance	Creosotebush Shrubland Alliance
Desert Willow Shrubland	Chilopsis Linearis Shrubland	Chilopsis linearis Shrubland
Developed Lands	none	none
Fremont Cottonwood Forest	Fremont Cottonwood Temporarily Flooded Forest Alliance	Fremont Cottonwood Temporarily Flooded Forest Alliance
Gambel Oak Shrubland	none	Gambel Oak Shrubland Alliance
Greasewood Shrubland	Black Greasewood Shrubland	Black Greasewood Shrubland
Knapweed Meadow	none	none
Mesquite Shrubland	Western Honey Mesquite Shrubland	Western Honey Mesquite Shrubland
Mixed Canyon Shrubland	several	several
Mixed Desert Shrubland	several	several
Mixed Grassland	several	several
Mixed Marsh	several	several
Mixed Wet Meadow	several	several
Open Water	none	none
Pasture/Agricultural Lands	none	none

VEGETATION TYPE/LAND TYPE	NNHP VEGETATION TYPE[a]	INTERNATIONAL CLASSIFICATION[b]
Quailbush Shrubland	(Lens-fruit Saltbush, Cattle-spinach) Shrubland	(Lens-fruit Saltbush, Cattle-spinach) Shrubland
Quarry	none	none
Rabbitbrush Shrubland	Rubber Rabbitbrush Shrubland Alliance	Rubber Rabbitbrush Shrubland Alliance
Railroad/Road	none	none
Red Willow Forest	none	Polished Willow Temporarily Flooded Woodland Alliance
Red Willow Shrubland	none	Polished Willow Temporarily Flooded Woodland Alliance
Riparian Forest	several	several
Riparian Forest/Tamarisk Woodland Mix	none	none
Russian Thistle Meadow	none	none
Sagebrush Shrubland	Basin Big Sagebrush Shrubland	Basin Big Sagebrush Shrubland
Saltgrass Grassland	Inland Saltgrass Saline Prairie	Inland Saltgrass Saline Prairie
Screwbean Shrubland	none	American Screwbean Shrubland
Seep Willow Shrubland	Seep-willow Intermittently Flooded Shrubland Alliance	Seep-willow Intermittently Flooded Shrubland Alliance
Shadscale Shrubland	Shadscale Shrubland Alliance	Shadscale Shrubland Alliance
Sparsely Vegetated/ Disturbed Lands	Unconsolidated material sparse vegetation	Unconsolidated material sparse vegetation
Tamarisk Woodland	none	none
Water Cress/Duck Weed Marsh	none	none
Wolfberry Shrubland	none	none

[a] NNHP 2001.
[b] Grossman 1998, NatureServe 2004.
[c] There are several plant associations or alliances that would fit within this category. In some cases the plant type may not fit into any described associations because there is not a particular dominant plant species.

This exercise resulted in a vast array of homogeneously segregated polygons throughout the Study Area. The polygons ranged in size from less than 2 square feet to more than 2 million square feet. The number of polygons generated was too vast and unwieldy to evaluate as discrete vegetation and land types. In addition, it was evident that many of the generated homogeneous polygons were

much too small to support breeding SWWFC or other covered species. Previous studies have shown that SWWFC require a minimum patch size for successful occupation and breeding, and previous investigators have indicated that habitat patches for the SWWFC need to be of a minimum size. As reported in Finch and Stoleson (2000), minimum patch size appeared to range from about 1.5 acres in the Grand Canyon (Sogge et al. 1997a) to 0.25 acre for the Rio Grande (Cooper 1997). The SWWFC Recovery Plan (USFWS 2002) identifies a minimum patch size of 0.25 acre for suitable habitat. At a January 2004 meeting of the Technical Review Team, a discussion of minimum patch size concluded with concurrence that the 0.25-acre size was applicable to Meadow Valley Wash. Subsequently, the classified vegetation types were consolidated into polygons with a minimum size of 0.25 acre.

The vegetation aggregation entailed dissolution of polygons less than 0.25 acre into the larger of the adjacent polygons. As such, vegetation heterogeneity replaced the homogeneous vegetation classification as mosaics of small vegetation types were incorporated into the larger polygons. Such mosaics were compatible with the SWWFC Recovery Plan that describes the habitat characteristics for the species as an aggregate of dense patches often interspersed with small openings, open water, or shorter/sparser vegetation, creating a mosaic that is not uniformly dense (USFWS 2002).

The process required conversion of the classified imagery to a GRID format in Arc/Info 8.1 and then conversion to polygon coverage. Polygons equal to or less than 0.25 acre were selected in ArcPlot, and all polygons less than 0.25 acre (minimum mapping unit) were removed. These small polygons were essentially merged with neighboring polygons that had the largest shared border. This generalized the original classification and made it more manageable in a geographic information system (GIS). The end result was the delineation of 1,747 distinct vegetation polygons equal to or greater than 0.25 acre within Meadow Valley Wash. The aggregation classification was further refined during the On-site Riparian Inventory, described below, with the end result of a final 1,183, distinct vegetation polygons verified and delineated.

After several iterations of polygon and database edits, the Microsoft Access® database was exported to a database table and permanently joined to the GIS shapefile based on the vegetation attributes. The join was made permanent. All subsequent calculations and analyses were based on the GIS shapefile of aggregated vegetation polygons. The GIS shapefile was delivered to the counties as components of the Study's products.

On-site Riparian Inventory

Field Methods

The on-site riparian inventory was conducted during the last week in May and the first week in June. The on-site inventory was timed to coincide with the expected breeding chronology of SWWFC. In general, SWWFC arrive on their breeding grounds during May, initiate nest building in the second half of May, and lay eggs from the end of May through June (Sogge et al. 1997b). Although the Study was not a census or survey of breeding SWWFC, performing the inventory when the birds

were potentially present for breeding permitted a description of habitat components actually available when breeding SWWFC initiated nesting. These habitat components included the attributes known to be of importance in selecting breeding sites and include vegetation structure, density, and presence of surface water.

The field investigators included a botanist, a wildlife biologist, and a wetland specialist. Approximately 230 field hours were spent visiting the vegetation polygons delineated for Meadow Valley Wash during the vegetation classification phase. No on-site evaluation of Clover Creek vegetation was conducted as part of the Study.

Observations were made by walking through each woody riparian community. Where communities were extensive in length (> 0.25 mile), ground inspections were conducted at spaced linear intervals of the community. In many of the tamarisk communities, it was not possible to walk through the extremely dense interior. All pertinent vegetation composition, structure, and density components, as well as specific habitat variables, were recorded for each riparian community. The riparian vegetation and habitat components are described below. A copy of the data sheet used is attached as Appendix B.

Before the on-site inventory, the final aggregated vegetation classification for Meadow Valley Wash was printed at 1:6,000 scale onto tabloid paper resulting in an atlas of 61 map pages that were laminated and bound for field use. The base map for the field atlas was the ortho-rectified digital imagery obtained in October 2003. The atlas contained all 1,747 vegetation polygons delineated during the aggregation classification process described above. The atlas included delineated boundaries for each vegetation polygon and a Vegetation Identification Number for each polygon that corresponded to the vegetation type.

Each of the 1,747 delineated vegetation polygons were visually inspected to verify the vegetation classification as to vegetation type and boundaries. Where necessary, vegetation boundaries were redrawn in the field on the atlas to better delineate homogenous vegetation types. This resulted in incorporating additional contiguous areas dominated by the same vegetation type or separating areas of greater than 0.25 acre into distinct polygons where it could be determined that the dominating vegetation type differed from that originally classified. Vegetation types, where appropriate, were revised on the field data sheets. Field verification resulted in splitting some polygons and combining others so that the final field-verified vegetation polygons totaled 1,183. The field revisions of polygon boundaries were digitized into the GIS on-screen at 1:2,000 by splitting and merging polygons. Vegetation Identification Numbers were also changed and created accordingly, in order to match with changed or new polygons in the field. All other attributes were changed and updated in the separate Microsoft Access database.

Information obtained for upland vegetation polygons was confined to verification of vegetation type and boundaries. Detailed information was obtained only for those vegetation polygons in the Meadow Valley Wash floodplain determined to be riparian plant communities. Riparian plant communities were defined as the classified vegetation polygons (discrete plant communities) occurring adjacent to or near Meadow Valley Wash where the vegetation type is so influenced by,

and dependent upon, surface or subsurface water flows associated with Meadow Valley Wash that the dominant plant species are either facultative or obligate wetland species. The riparian plant communities are potential habitat for riparian covered species, particularly SWWFC.

In Meadow Valley Wash 428 total polygons were originally classified as vegetation types dominated by riparian plants. On-site investigations refined these polygons to 398 discrete riparian plant communities. To the extent practicable, each of these 398 riparian plant communities were investigated and described, based primarily on characteristics determined to be important measures of habitat suitability for SWWFC.

Access to Sites

The objective of the field investigation was to verify the classification and boundaries of each vegetation polygon in Meadow Valley Wash and inventory each of the riparian plant communities. However, actual on-site inventories were predicated on access to private lands. Although Meadow Valley Wash is consists mostly of public lands, there are some extensive private land holdings, especially adjacent to the wash. Every private land owner was contacted and asked permission for access. Where access to private lands was not specifically granted, no on-site inventory was conducted. A total of 118 vegetation polygons occurred on inaccessible private lands. This accounted for approximately 1,520 acres in Lincoln County and 117 acres in Clark County.

In Lincoln County, there were 16 private parcels (out of 82) to which access was denied. Thirteen (13) of these parcels belonged to one land owner and totaled approximately 1,465 acres. In Clark County, there were 40 private parcels (out of 316) to which access was denied. Thirty-eight (38) of these parcels (approximately 111 ac) belonged to one land owner, the same large land owner who denied access to Lincoln County parcels.

In general, verification of vegetation types and polygon boundary delineations were not affected by lack of access as these parameters could be described from adjacent public lands. In only one instance was the vegetation type on a polygon (0.65 acre) that was unable to be verified. However, inventory of attributes was problematic for riparian plant communities that could not be physically accessed. In some cases, the small size and/or open structure of the unaccessible riparian plant community permitted data collection from adjacent accessible lands or from vertical vantage points. Also, riparian communities sometimes extended over both accessible and non-accessible lands. In these instances, the riparian inventory was conducted on the accessible lands and extrapolated over the entire polygon.

Where access was prohibited and specific riparian components remained undetermined, they were so recorded on the data sheets. A total of 58 riparian communities occurred on private lands where access was denied. Of these, 36 riparian communities remained undetermined as to requisite habitat components for SWWFC and other covered species. These unevaluated riparian communities totaled approximately 92 acres, which was less than 6 percent of the private lands that could not be accessed.

Riparian Vegetation Structure and Density

The riparian evaluation used a vegetation community and structure classification system based on methods created by the Middle Rio Grande Biological Survey (Hink and Ohmart 1984). Hink and Ohmart (1984) conducted exhaustive biological analyses, including a classification of vegetation communities and structure in the riparian zone. In addition, their inventory of wildlife correlated bird and mammal abundance with vegetation types, making this system valuable for determining the wildlife value of vegetation types. For the current riparian evaluation, the Hink and Ohmart (1984) methods were modified as necessary to focus on parameters specific for Meadow Valley Wash.

The Hink and Ohmart (1984) coding system consisted of species codes for the canopy layer, species codes for the understory layer, and a number code signifying the height of the canopy and density of the understory.

Plant species were recorded according to the relative abundance of the species cover within the canopy and the understory layers. Up to four species were recorded for each layer, with each species having 25 percent or greater relative abundance. Plant species dominance (or relative abundance) was determined by visual estimation. Tree and shrub height, as well as overall plant cover, were determined by visual estimates.

Riparian classifications were defined and coded as follows.

Multiple-Story Communities

Type 1

Tall trees with well developed understory. Tall or mature to mixed-aged trees (>40 ft) with canopy covering greater than 24 percent of area of the community (polygon) and understory layer (0-20 ft) covering greater than 24 percent of area of the community (polygon). Substantial foliage exists in all height layers.

- YES Type 1 with understory visually considered dense enough between 0-15 feet to support SWWFC nesting over greater than 74 percent of total aerial vegetation cover, and patch size is about 30 feet wide or greater.
- NO Type 1 with a sparse, clumpy, or patchy understory without sufficient density between 0-15 feet to support SWWFC nesting, but not sparse enough to be a Type 2.

Type 2

Tall trees with little or no understory. Tall or mature trees (>40 ft) with canopy covering greater than 24 percent of area of the community (polygon) and understory layer (0-20 ft) with less than 25 percent of area of the community (polygon). Majority of vegetation over 30 feet.

Type 3
Intermediate-sized trees with dense understory. Intermediate sized trees (20-40ft) with canopy covering greater than 24 percent of area of the community (polygon) and understory layer (0-20 ft) covering greater than 24 percent of the area of the community (polygon). Substantial foliage between 0-30 feet.

YES Type 3 with understory visually considered dense enough between 0-15 feet to support SWWFC nesting over greater than 74 percent of total aerial vegetation cover, and patch size is about 30 feet wide or greater.

NO Type 3 with a sparse, clumpy, or patchy understory without sufficient density between 0-15 feet to support SWWFC nesting, but not sparse enough to be a Type 4.

Type 4
Intermediate-sized trees with little or no understory. Intermediate-sized trees (20-40 ft) with canopy covering greater than 24 percent of the area of the community (polygon) and an understory layer covering less than 25 percent of the area of the community (polygon). Majority of foliage between 15-30 feet.

Single-Story Communities

Type 5
Stands with dense shrubby growth. Understory layer only 0-20 feet high covering greater than 24 percent of area of the community. Majority of vegetation between 0 and 15 feet. Stands where there is a significant amount of foliage between 5-15 feet (this distinguishes Type 5 from Type 6).

YES Type 5 with understory visually considered dense enough between 0-15 feet to support SWWFC nesting over greater than 74 percent of total aerial vegetation cover, and patch size is about 30 feet wide or greater.

NO Type 5 where the cover is sparse, clumpy, or patchy, but not sparse enough to be a Type 6 or OP (see below).

Type 6
Very young and low growth. Young understory layer (0-5 ft) covering greater than 24 percent of community (polygon). Majority of foliage between 0-5 feet. If there is less than 25 percent of area covered, the type is OP (see below).

Other Types (Non-woody)

Other non-woody vegetation types were identified as follows:

- CAT – Cattail
- WM – Wet Meadow
- MS – Marsh with cattail, rush, or other permanent marsh vegetation
- OW – Open Water
- OP – Open Area (vegetation <25% aerial coverage)

Other Community Attributes

In addition to vegetation composition, structure, and density, other attributes were inventoried and recorded for each riparian community. These attributes included those related to requisite habitat variables for covered species, community health and stability, possible threats or stressors to community health, and incidental observations.

Habitat Variables for Covered Species

Presence of Water

The presence of surface water or saturated soils at or near breeding sites appears to be a necessary component for SWWFC breeding habitat (Finch and Stolleson 2000). The ground inventory identified either presence or absence of saturated soils or surface water within the discrete riparian community or within 125 feet of the community. If present, surface water was further identified as still or flowing water.

Flowing water was further described in general categories of run, riffle, and pool. Since long reaches of flowing water could occur adjacent to or within one riparian community, the flowing water category was generalized for the entire reach through the discrete riparian community. The determination of run, riffle, or pool was done with the intent of identifying available habitat for the desert sucker (*Catostomus clarki utahensis*) and the Meadow Valley speckled dace (*Rhinicthys osculus* spp. [unamed]). Generalization of flowing water habitat could not effectively identify specific areas of riffle, run, or pool habitat. Thus, no specific habitat parameters for sensitive fish species could be ascertained for this Study. However, the presence of surface water in May-June was assumed to provide a good indication of reaches that likely support a fishery.

Tree Snags and Cavities

Tree snags and cavities were recorded when observed within riparian communities. Tree snags and cavities provide nesting habitat for Lucy's warbler (*Vermivora luciae*) and, in conjunction with vegetation composition, structure, and density, can define this habitat (Lincoln County 2003).

Mistletoe

Phainopepla (*Phainopepla nitens*) habitat is selected on the availability of the desert mistletoe (*Phoradendron californicum*) that parasitizes woody leguminous shrubs and trees (Chu and Walsberg 1999). Phainopepla rely almost exclusively on the mistletoe berries as its main diet during

winter and spring residency in desert systems (Chu and Walsberg 1999). Identification of desert mistletoe provided strong indication of available phainopepla habitat.

Community Health and Stability

Additional information on the general health and stability of each woody riparian community was obtained by recording extensive signs of older growth, new shoots, general degradation, dead branches, and seral stage. Observations of community health and stability provided opportunities to further investigate the likelihood of environmental stresses and threats to riparian health.

Threats and Stressors

Threats and stressors are those activities or processes that potentially affect the vegetation composition, structure, density, and health of a riparian community. Potential threats and stressors were identified based on those enumerated for the desert riparian ecosystem by the Clark County MSHCP (Clark County 2000) and subsequently refined to include only those threats and stressors likely to be influential within Meadow Valley Wash. The threats and stressors used for the current Study are provided below with the relevant threat as identified in the Clark County MSHCP included in parentheses.

1. Habitat degradation through fire and fire management (Threat 301).
2. Excessive OHV/Recreation use (Threats 401 and 403).
3. Excessive grazing (Threats 703 and 1304).
4. Land use conversion (Threats 1101 and 1304).
5. Stream channelization (Threat 1301).
6. Change in water flows (quantity, quality, seasonality) (Threats 1302 and 1303).
7. Spring/seep diversion and modification, groundwater pumping (Threats 1401, 1402, 1403).
8. Introduction and competition of exotic species such as tamarisk, fan palm (Threat 1501).
9. Population decreases due to parasitic species (e.g., brown-headed cowbird [*Molothrus ater*]) (Threat 1502).

Incidental Data

Incidental observations were recorded that could potentially have a bearing on riparian development, suitability of the habitat for SWWFC, or community threats were recorded. These observations included presence of beaver (water availability), sightings of individual SWWFC (habitat suitability confirmation), and sightings of brown-headed cowbirds.

GIS Data Analysis of Riparian Communities

SWWFC

Riparian habitat variables inventoried in the field were the basis for evaluating discrete riparian polygons as SWWFC habitat.

Suitable Habitat

The riparian habitat evaluation was based on the "suitability" of the habitat for attracting SWWFC and maintaining breeding pairs. The definition of SWWFC suitable habitat was synthesized from the SWWFC Recovery Plan (USFWS 2002) and refined for this project as follows.

SWWFC Suitable Habitat

Suitable habitat for SWWFC is woody riparian vegetation stands, either trees or shrubs, that appear to have all the components necessary for the species to establish territories and/or nest. Woody riparian vegetation may be dominated by native vegetation or by exotic tamarisk. The primary components of suitable habitat include: (1) a stand, or patch size, of 0.25 acre or greater; (2) a vegetation width of more than about 30 feet; (3) a dense canopy; (4) dense interior vegetation from ground level up to about 15 feet, or dense patches interspersed with openings; and (5) surface water or saturated soils present within the stand or within 125 feet of the stand. Suitable habitat may be unoccupied for any one of a multitude of reasons.

To determine which of the riparian polygons were suitable habitat for SWWFC, the GIS database was queried for the following attributes. A riparian polygon was considered SWWFC suitable habitat, if it met each of the following criteria.

Vegetation Type. The vegetation type (dominant vegetation composition) of the riparian polygon was one of the following 11 types of woody riparian vegetation.

Arrowweed Shrubland	Freemont Cottonwood Forest	Riparian Forest/Tamarisk Woodland Mix
Burnt or Dead Tamarisk	Red Willow Forest	
Coyote Willow Shrubland	Red Willow Shrubland	Seepwillow Shrubland
Desert Willow Shrubland	Riparian Forest	Tamarisk Woodland

Vegetation Structure and Density. The riparian polygon was identified as a structure type 1, 3, or 5, as defined under the Hink and Ohmart (1984) system, and valued as a "Yes" as to density components as described above (Riparian Vegetation Structure and Density section).

Availability of Water. Surface water or saturated soils occurred within the riparian polygon or within 125 feet of the stand.

Patch Size. Through the delineation process of polygons as defined above, all vegetation polygons are at least 0.25 acre in size. A defined value of "Yes" under the modified Hink and Ohmart (1984) system used for the Study implies a habitat width of more than about 30 feet.

GIS Entry

The set of attributes that met all of the above criteria was then codified as a separate value within the GIS database (shapefile) and labeled FC (flycatcher) = Yes. Querying the GIS database for FC = Yes then identified all riparian vegetation polygons considered SWWFC suitable habitat.

SWWFC Potential Habitat

In some cases the woody riparian vegetation polygons do not currently have all the components necessary for SWWFC to establish territories and/or reproduce, but the polygons do have the vegetation composition, patch size, and basic vegetation structure to potentially develop into SWWFC suitable habitat, especially if management objectives are designed to promote suitable habitat development. Potential habitat occurs where the floodplain conditions, sediment characteristics, and hydrological setting provide potential for development of dense riparian vegetation. The definition of SWWFC potential habitat is synthesized from the SWWFC Recovery Plan (USFWS 2002) and further refined for this project as follows.

SWWFC Potential Habitat-Type A

This type of woody riparian vegetation stands have the patch size, vegetation structure, and density needed for SWWFC to establish territories and/or nesting but do not have surface water or saturated soils present or within 125 feet of the stand. If surface water or saturated soils were present during breeding season, the stands would contain all the components deemed necessary for SWWFC to establish territories and/or nesting (suitable habitat).

GIS Entry

To determine which of the riparian polygons were potential habitat-Type A, the GIS database was queried for the same attributes as for SWWFC suitable habitat. Where the criteria could be met for each of the attributes described for SWWFC suitable habitat, except for the presence of surface water or saturated soils within the polygon or within 125 feet of the stand, the polygon was defined as SWWFC potential habitat-Type A. The set of polygons that met these criteria were then codified as a separate value within the GIS database (shapefile) and labeled Pot_A. Querying the GIS database for Pot_A = Yes then identified all riparian vegetation polygons considered SWWFC potential habitat-Type A.

SWWFC Potential Habitat-Type B

Woody riparian vegetation stands that have the patch size and vegetation structure needed for SWWFC to establish territories and/or nesting but do not have the interior vegetation density (from the ground level up to about 15 feet) considered necessary to attract and maintain breeding birds are considered Type B potential habitat. Surface water or saturated soils may or may not be present. Lack of hydrologic connectivity, ecological characteristics, or anthropogenic stressors may be affecting the development of sufficient interior density.

To determine which of the riparian polygons were SWWFC potential habitat-Type B, the GIS database was queried for the same attributes as for SWWFC suitable habitat. A riparian polygon was considered SWWFC potential habitat-Type B, if it met each of the following criteria.

Vegetation Type. The vegetation type (dominant vegetation composition) of the riparian polygon was one of the types of woody riparian vegetation described for SWWFC suitable habitat.

Vegetation Structure and Density. The riparian polygon was identified as a structure Type 1, 3, or 5 as defined under the Hink and Ohmart (1984) system, and valued as a "No" as to density components, as described above (Riparian Vegetation Structure and Density section).

GIS Entry

The set of polygons that met these criteria were then codified as a separate value within the GIS database (shapefile) and labeled Pot_B. Querying the GIS database for Pot_B = Yes then identified all riparian vegetation polygons considered SWWFC potential habitat- Type B.

SWWFC Potential Habitat-Type C

Type C potential habitat consists of woody riparian vegetation stands that have the patch size to support establishment of SWWFC territories and/or nesting. However, neither the canopy nor the interior vegetation densities are sufficient to attract and maintain breeding birds. Surface water or saturated soils occur within the stand or within 125 feet of the stand. Ecological characteristics may preclude eventual development of vegetation structure and density to attract and maintain breeding SWWFC. Anthropogenic stressors could be affecting the development of vegetation components.

To determine which of the riparian polygons were SWWFC potential habitat-Type C, the GIS database was queried for the same attributes as for SWWFC suitable habitat. A riparian polygon was considered SWWFC potential habitat-Type C, if it met each of the following criteria.

Vegetation Type. The vegetation type (dominant vegetation composition) of the riparian polygon was one of the types of woody riparian vegetation described for SWWFC suitable habitat.

Vegetation Structure and Density. The riparian polygon was identified as a structure Type 2, 4, or 6 as defined under the Hink and Ohmart (1984) system, as described above (Riparian Vegetation Structure and Density section).

Availability of Water. Surface water or saturated soils occurred within the riparian polygon or within 125 feet of the stand.

GIS Entry

The set of polygons that met these criteria were then codified as a separate value within the GIS database (shapefile) and labeled Pot_C. Querying the GIS database for Pot_C = Yes then identified all riparian vegetation polygons considered SWWFC potential habitat- Type C.

Stressed Habitat

SWWFC suitable habitat may be subjected to anthropogenic activities that threaten the current ecological development and stability of a riparian stand. Continued stress may threaten the viability of the stand as suitable breeding habitat through a change in vegetation structure, density, or surface water availability. However, with site-specific management, the stands will likely continue to maintain the components necessary for SWWFC occupation.

SWWFC potential habitat may also be subjected to anthropogenic activities that affect the ability of a riparian stand to naturally develop the vegetation structure and density necessary to support breeding SWWFC. Stressed potential habitat could have the appropriate hydrological and ecological characteristics to develop into suitable habitat if not for one or more major stressors and may require active abatement of stressors in order to become suitable.

Stressors that may be preventing regenerating and restorable habitats from becoming suitable include the following anthropogenic activities.

Land Stressors

Land stressors were considered anthropogenic activities associated with land activities that were identified and recorded as a threat or stressor based on observations as described below.

Habitat degradation through fire and fire management. Recent fire has substantially changed the vegetation structure and density of the canopy and understory.

Excessive Off-highway Vehicle (OHV)/Recreation use. Evidence of substantial amount of tracking by vehicles that have degraded vegetation or slope stability. Other indicators include paths that may have been cut to expedite off-highway vehicle (OHV) use through the riparian corridor, and excessive evidence of camping.

Excessive grazing. The substantial signs of livestock use included overgrazed forbs and grasses, noticeable grazed shrub or tree line, and/or substantial livestock spoor within the riparian stand. No wild horses or burros were identified within the Study Area. However, the BLM one has identified 2 Horse Management Areas (HMA) between approximately Caliente and Elgin that border on the Meadow Valley Wash. The Clover Mountains HMA is on the east and currently contains approximately 40 wild horses. The Delamar Mountains HMA is on the west and contains approximately 50 wild horses. Access to the wash is limited in the Rainbow Canyon and thus minimal wild horse use of the wash occurs. Although 2 other HMAs occur further south of Rainbow Canyon, no year-long populations currently exist within them. Historically, horses from these HMAs were known to frequent the Meadow Valley Wash in the vicinity of Carp.

Land use conversion. This stressor includes evidences of a moderately recent conversion of land from a natural community to an agricultural, mining, or urban use and was recorded as "development."

Hydrologic Stressors

Hydrologic stressors were considered anthropogenic activities associated with manipulation of surface water that were identified in the field and recorded as a threat or stressor based on observations as described below.

Channelization. The natural channel of Meadow Valley Wash had been noticeably modified through bank modifications and/or dredging with the express purpose of flow conveyance and flood control. Channelization may also have occurred as a result of geomorphic processes.

Channel downcutting. The natural channel of Meadow Valley Wash has been noticeably entrenched as a result of channel modifications including channelization so that a hydrologic disconnection with the adjacent riparian area is probable.

Water Diversion. This stressor was identified as of a point of water diversion upstream of a riparian stand where water flow in Meadow Valley Wash is noticeably decreased. Water is removed from the main channel of Meadow Valley Wash and transferred out of the riparian corridor primarily for irrigation of upland pastures.

Spring or Seep Diversion. This stressor consists of a channelized diversion from a flowing spring or seep that changes the hydrologic connection of the spring to an adjacent riparian stand.

Ecological Stressors

Ecological stressors potentially occurring within the Study Area primarily include invasion of exotic species that can substantially change the structure and composition of a riparian community, and the presence of parasitic species that substantially affect the viability of a local population.

The primary exotic species invading the area is tamarisk. However, because this exotic species does provide breeding habitat for SWWFC (USFWS 2002), the invasion was not considered as an independent stressor. The primary parasitic species of concern to the SWWFC within the Study Area is the brown-headed cowbird. Although an attempt was made to record any incidental brown-headed cowbird observations, the Study was not designed as a census or survey for this species.

Other Covered Species

Vegetation variables and structural components recorded in the field provided the basis for identifying suitable habitat for other covered species. A vegetation stand that appeared to have all the components necessary for a specific covered species to establish territories and/or reproduce was considered suitable habitat. Delineation of suitable habitat for the other covered species was a secondary objective of the Study.

Yellow-billed Cuckoo (Coccyzus americanus)

Yellow-billed cuckoos are restricted to riparian areas in the western United States that are commonly comprised of a mixture of mature cottonwood and willow (Clark County 2000). Nests are commonly constructed in dense willow understories in riparian forests. Yellow-billed cuckoos most often occupy habitat patches greater than 100 acres in size with a width of greater than 650 feet (Laymon and Halterman 1989). For the Study, yellow-billed cuckoo suitable habitat was defined by the following criteria.

- Vegetation Type is Fremont Cottonwood Forest, Red Willow Forest, Riparian Forest, or Riparian Forest/Tamarisk Woodland Mix.

- Vegetation Structure Type is 1, 2, 3, or 4. These vegetation types indicate forested stands.

- Vegetation polygons are greater than 50 acres and 350 feet wide. Total habitat patch size was delineated based on a composite of adjacent polygons that met the criteria for vegetation type and vegetation structure type so that contiguous polygons with these attributes are greater than 50 acres and 350 feet wide. Since yellow-billed cuckoos may utilize habitat less

than 100 acres in size, the minimum patch size was reduced by 50 percent. The isolated desert riparian ecosystem of Meadow Valley Wash limits available habitat in the region and can possibly be more attractive at a smaller patch size.

Bell's Vireo (Vireo bellii)

Breeding habitat for Bell's vireo is comprised of dense, low, shrubby vegetation, often near water (Clark County 2000). These habitat variables are consistent with the vegetation structure and density determined for SWWFC, as is the presence of surface water. Therefore, Bell's vireo suitable habitat was defined as all woody riparian vegetation types with a vegetation structure of Type 1, 3, or 5, with high density from ground level to about 15 feet, and with surface water within 125 feet of the vegetation stand.

Blue Grosbeak (Guiraca caerulea)

Blue grosbeak habitat requirements include low tree density, reduced canopy cover, medium-sized trees, and low shrub density (James 1971). Vegetation types used for breeding within Meadow Valley Wash include mesquite, tamarisk, as well as forest and stream edges (Clark County 2000). Other vegetation types used for breeding include willow, cottonwood, and ash with an understory of riparian shrubs (Lincoln County 2003). For the Study, blue grosbeak suitable habitat was defined as Desert Willow Shrubland, Freemont Cottonwood, Red Willow Forest, Red Willow Shrubland, Riparian Forest, Riparian Forest/Tamarisk Woodland Mix, Screwbean Mesquite Shrublands, and Seep Willow Shrublands that have a vegetation structure of Type 4 or 6.

Summer Tanager (Piranga rubra)

Summer tanagers breed in riparian woodlands that include cottonwood, willow, mesquite, and tamarisk (Clark County 2000). Robinson (1996) found eastern populations occupying open deciduous woods. For the Study, summer tanager suitable habitat was defined as riparian woodlands or forests comprised of large- to medium-sized trees with an open understory as presented below.

- Vegetation type is Desert Willow Shrubland, Fremont Cottonwood Forest, Red Willow Forest, Riparian Forest, Riparian Forest/Tamarisk Woodland Mix, or Tamarisk Woodland.

- Vegetation Structure Type is 1, 2, 3, or 4. These vegetation types indicate forested or woodland stands.

- Vegetation density is not sufficient for SWWFC habitat. By definition, Vegetation Type 2 and Type 4 have an open understory. Defining Vegetation Type 1 and Type 3 as in sufficient SWWFC habitat eliminates a dense understory from these vegetation structure types.

Phainopepla (Phainopepla nitens)

Phainopepla occupy desert habitats in winter between September and May, breeding in these winter habitats from February through April (Chu and Walsberg 1999). Phainopepla occur in woody riparian stands, often dominated by leguminous shrubs and trees. The key element in selecting breeding habitat appears to be the presence of the desert mistletoe, relying on the berries of the

mistletoe as its main diet (Chu and Walsberg 1999). Therefore, phainopepla suitable habitat was defined as woody riparian vegetation with the presence of mistletoe in the vegetation stand.

Lucy's Warbler (Vermivora luciae)

Lucy's warbler occur in large dense mature riparian mesquite stands where they locate nests under large pieces of loose bark of the older mesquite (Lincoln County 2003). In addition, they use snags in other trees and cavities in large cottonwoods, and will utilize tamarisk, if native trees are not available (Lincoln County 2003). They avoid stands with a dense shrub understory.
For the Study, Lucy's warbler suitable habitat was defined as follows.

- Vegetation type is Desert Willow Shrubland, Fremont Cottonwood Forest, Mesquite Shrubland, Red Willow Forest, Riparian Forest, Riparian Forest/Tamarisk Woodland Mix, Screwbean Mesquite Shrubland, or Tamarisk Woodland.

- Understory vegetation is not dense enough to support SWWFC, thus eliminating dense shrub understory.

- Tree cavities and tree snags were observed within the vegetation stand.

Arizona Southwestern Toad (Bufo microscaphus microscaphus)

The Arizona southwestern toad migrates between nonbreeding terrestrial habitats and breeding pools. It inhabits a wide variety of upland habitats and ranges up to 500 feet from water (Clark County 2000). The toad uses creek pools with moderate to low gradient and shallow water. The Arizona southwestern toad does not depend on rainfall for breeding but breeds directly in streams and shallow ponds. Its eggs are deposited on the bottom of shallow, quiet waters among gravel, leaves and sticks, mud, or clean sand (USFS 2004). With breeding restricted to shallow, quiet waters, Arizona southwestern toad suitable habitat for this Study was defined as riparian vegetation types containing still water. These vegetation types include Open Water, Bulrush Marsh, Cattail Marsh, Mixed Marsh, or Water Cress/Duck Weed Marsh. In addition, if still surface water was recorded within a vegetation stand, the polygon was considered suitable Arizona southwestern toad habitat.

Historic Data Acquisition

An attempt was made to obtain pertinent information that could help determine historic riparian extent and conditions, and habitat suitability for covered species. Historic information was obtained through agency file searches and document acquisition, oral interviews, and historic aerial photo interpretation.

Agency Documentation

To obtain historical information and historic occurrences of species, phone conversations and office visits were conducted with Federal and State agency contacts, The Nature Conservancy, the San

Bernandino County Museum, and university researchers. The purpose of this effort was to obtain records of the occurrence of an individual species, habitat descriptions, vegetation descriptions, and other information that could be incorporated into the GIS to provide a historical comparison with the Study's riparian evaluation. Most of the information obtained was in hard-copy report format, although pertinent GIS information was obtained from the Nevada Heritage Program. While much of this information was gathered through phone contacts, visits to agency offices in Las Vegas, Ely, and Caliente allowed an indepth examination of agency files and records to obtain pertinent information. Information obtained ranged from site-specific occurrences of species to general descriptions of Meadow Valley Wash. References for this information are provided in the References Cited section. Table 2 lists information sources and a brief summary of the information obtained.

Oral Interviews

A component of the Study was personal interviews with current, long-term residents of Meadow Valley Wash regarding past environmental conditions within the Study Area. The complete Oral History Report is presented as Appendix C of this report.

A total of 16 interviews was conducted and nearly 23 hours of discussions recorded. The interviews were conducted over two separate sessions (15-21 December 2003 and 31 March-5 April 2004). Some interviews involved multiple family members, bringing the total number of participants to 21. Of the 21 participants, 9 were residents from Caliente, 9 lived in Moapa, 1 lived in Logandale, Nevada, 1 lived in Overton, Nevada, and 1 lived at the Moapa Indian Reservation. The people interviewed represented a wide range of professions and interests, thereby providing a broad range of remembered information. The participants also represented a wide range of ages; the oldest participant was born in 1913 and the youngest in 1953.

Questions for the interviews were directed at conditions concerning water levels, flooding events, vegetation and vegetation changes, animal occurrence, climate differences, and other changes perceived over time.

Several challenges were encountered that limited the usefulness of the information derived from the oral histories. First, many former residents within the Study Area who would have been excellent resources have died, moved, or were not available for interviews. Second, the very nature of human memory was a challenge for recovering historical information about the environment. Developing environmental oral histories requires people to remember and describe the mundane backdrop behind the events of their lives, which is difficult for most people to recall. Third, the size of (more than 80 miles of Meadow Valley Wash) and remoteness of the Study Area limited the inhabited areas. Currently, most of the population lives at either the northern end of the Study Area (Caliente) or towards the southern end (Moapa Valley). Historically, more people lived throughout the Study Area. However, even during the height of railroad, agricultural, and ranching development, people were still relatively isolated and tended to keep to local, small communities. As such, they have familiarity with only local portions of the Study Area.

Table 2. Historic information and sources.[a]

ENTITY	CONTACT	INFORMATION
Nevada Division of Wildlife	Cris Tomlinson	Bird survey reports.
	Jim Heinrich	Fish occurrence information, primarily for Clark County.
	Jon Sjoberg	Fish survey reports.
	Brian Hobbs	Fish survey reports.
	Ralph Phenix	GIS occurrence information for summer tanager, phainopepla, and Arizona southwestern toad.
Nevada Natural Heritage Program	Eric Miskow	Heritage Program GIS shapefiles and metadata for bird, toad, and fish occurrences.
Nevada Division of Water Rights		Existing water rights for basin.
U.S. Bureau of Land Management Las Vegas Office	Jackie Gratton	Map containing bird occurrence information for area immediately north of Moapa. Resource management plan documents.
	Kristen Murphy	Draft Habitat Management Plan with general existing conditions.
U.S. Bureau of Land Management Caliente Office	Shirley Johnson	Riparian inventories and grazing allotment datasheets and photographs. Also provided access to 1976 aerial photos (complete set of Study Area), which have been digitized and are available on CD.
	Bill Smith	Photographs (from the 1990s) of various locations along wash used to help familiarize BIO-WEST field staff.
U.S. Bureau of Land Management Ely Office	Gary Medlyn	1999 Desert Tortoise Habitat Management Plan/FEIS, 1941 range survey report, 1985 rangeland program summary update. Also provided 1964 groundwater report prepared by Nevada Department of Conservation and Natural Resources and Caliente resource management plan documents.
Natural Resources Conservation Service Caliente Office	Rick Orr, Jim Potts, Corry Lyttle	Lincoln County Soil Survey (1:24000 maps). Accompanied BIO-WEST staff for drive along Meadow Valley Wash from Caliente to below Elgin providing flood history and other observations.
Natural Resources Conservation Service Las Vegas Office	Jarrod Edmunds	1973 Virgin River soil survey, which includes Clark County portion of Meadow Valley Wash (1:24000 maps).
The Nature Conservancy	Bruce Lund	Bird occurrence information, including Christmas bird counts, results of bird surveys performed for The Nature Conservancy, and data sheets for SWWFC surveys. Copy of groundwater assessment report prepared for recent power plant proposal.
U.S. Bureau of Reclamation	Theresa Olsen	SWWFC surveys performed by San Bernandino County Museum since 1996.
U.S. Environmental Protection Agency	David Bradford	Arizona southwestern toad journal articles that included occurrence information.
North Georgia College and State University	Terry Schwaner	Arizona southwestern toad occurrence locations.

[a]Additional contacts were made with entities that did not have pertinent or available information, including the Union Pacific Railroad, the Red Rock Audobon Society in Las Vegas, the Great Basin Bird Observatory, two University of Nevada-Las Vegas and University of Nevada Reno researchers, and two private consulting firms.

Aerial Photo Interpretation

The 1976 black-and-white rectified photography was obtained from the BLM, Caliente Field Office. Only hard copies of the photos were available. These were subsequently scanned and digitized. The digitized 1976 aerial photos were then overlaid with the 2003 multi-spectral imagery obtained for the Study. Because of the coarse resolution of the 1976 aerial photos, it was difficult to interpret all vegetation types. Consequently, only woody vegetation could be interpreted fairly accurately.

Areas with changes in woody vegetation over the time period were identified and delineated at 1:4,800 (1" = 400') with a minimum mapping unit of about 0.25 acre. This information is to be used as a coarse indication of changes in woody vegetation over the period.

Current vegetation was intersected by historic vegetation using the Geoprocessing Wizard in ArcMap (ArcInfo) 8.1. This resultant polygon shapefile showed changes from 1976 to 2003 by delineating areas that were bare soil in the historical (1976) photography and have been replaced by specific types of woody vegetation in the current (2003) imagery. The intersected layer specified what kind of vegetation change occurred in each polygon, since it captured the attributes of the current vegetation. The assumption was made that the vegetation type had not changed between 1976 and the present. This may not be completely accurate, as there is continuing invasion by the exotic tamarisk as well as ecological processes and hydrological events that have caused changes to the vegetation type. However, it is believed that general changes can be identified and provide an indication of vegetational change over time. Meadow Valley Wash is dynamic and subject to stochastic hydrologic events including flooding, local scouring, and changes in hydrologic controls. Between 1978 through 1980 peak flow events at the Caliente gaging station were approximately 2,400 cubic feet per second (cfs), while peak flow in 1995 was approximately 1900 cfs. Normal flows at Caliente are typically between about 1 and 10 cfs with a 2-year flood magnitude of about 300 cfs. In addition, land management activities including livestock management and tamarisk removal, such as those currently implemented by BLM within the Study Area, have likely enhanced non-invasive woody riparian vegetation growth.

Hydrologic Evaluation

A final component of the Study involved evaluating the hydrologic conditions within the riparian vegetation communities present along Meadow Valley Wash to provide a general understanding of hydrologic connectivity in relation to riparian conditions. The complete Hydrologic Report is presented as Appendix D of this report.

Reaches and Transect Surveys

Within the Study Area, Meadow Valley Wash was divided into eight large-scale reaches with generally similar channel pattern, valley width, land use, and streamflow characteristics. Because the Study Area spans more than 80 miles of stream length, it was not feasible to develop a complete longitudinal profile (slope) map of the entire Study Area within the scope of this Study. Similarly,

it was not feasible to comprehensively classify each individually homogeneous stream segment using a system such as the Rosgen classification (Rosgen 1994). Instead, the reach breaks that were established simply represent large-scale differences in overall geomorphic setting and dominant land use. Table 3 lists the general characteristics of each reach.

Table 3. General characteristics of Study reaches.

REACH	VALLEY WIDTH	CHANNEL PATTERN	STREAMFLOW	LAND USE
CA	wide	single-threaded	flowing	urban
ET	wide	primarily single-threaded	flowing	grazing/agriculture
UR	moderately wide	primarily single-threaded	generally flowing; loses flow near bottom of reach	some grazing/ agriculture
RC	narrow/ confined	primarily single-threaded	flowing	recreation
RR	moderately wide/ occasionally confined	primarily single-threaded	dry in upstream part; flowing in downstream part	recreation, some agriculture
CW	moderately wide	primarily single-threaded	flowing	recreation
VI	very wide/ unconfined	relatively straight, multi-threaded	dry in upstream part; flowing in downstream part except where diverted	grazing/agriculture
PE	generally very wide/ unconfined with narrower sections at top of reach and near Rox	meandering/ single-threaded in confined sections, otherwise straighter and multi-threaded	alternates between dry and flowing sections	grazing/agriculture, some residential near Glendale at downstream end of reach

In upstream to downstream order, the eight reaches and their abbreviations are:

- Caliente Reach (CA)
- Etna Reach (ET)
- Upper Rainbow Reach (UR)
- Rainbow Canyon Reach (RC)
- Elgin Reach (RR)
- Cottonwood Reach (CW)
- Vigo Reach (VI)
- Rox Reach (PE)

Two transects were surveyed within each of these eight reaches for a total of 16 transects. In each reach, one of the transects was located in an area with relatively high-quality riparian habitat, and the other transect was located in an area with lower-quality/degraded habitat. In general, transects were not placed in portions of reaches that lacked flowing surface water. Rather, the transects representing "degraded" habitat were typically placed in areas that appear to have the potential to

support higher quality riparian conditions but have been degraded by anthropogenic impacts of some sort. Surveys were completed using a Total Station, rod, and prism.

Transect endpoints were permanently monumented by installing rebar (buried to ground level) at each transect endpoint. Each rebar endpoint was capped with metal or yellow plastic and labeled with the reach abbreviation and transect number. Coordinates of each endpoint were obtained using a standard (multi-meter accuracy) GPS unit.

Hydrology

Gage Data

Two USGS gaging stations – one near Caliente/Etna and one near Rox – are located on Meadow Valley Wash within the Study Area (see Appendix D, Figure 1.1). The Caliente gage provides 48 years of daily flow data, while the Rox gage has collected data for a total of about 10 years (Table 4).

Table 4. Meadow Valley Wash gage stations.

GAGE NAME	GAGE NUMBER	PERIOD OF RECORD
Meadow Valley Wash near Caliente, Nevada	09418500	2/1/51-9/30/60, 12/1/64-9/30/83, 10/1/84-present
Meadow Valley Wash near Rox, Nevada	09418700	2/6/87-9/30/94, 10/1/01-present

Flow duration curves were developed using the complete daily flow records for each gage. A log-Pearson Type III flood frequency analysis was completed using peak flow data at the Caliente gage. No flood frequency curve was developed for the Rox gage, because only 7 years of peak flow data are available.

Field Discharge Measurements

At transects with measurable flowing water, discharge was measured using a velocity meter. For some transects, vegetation (cattails or algae) in the channel made it impossible to obtain an accurate measurement directly at the transect; in these cases, discharge was measured slightly upstream of or downstream from the transect where the channel became clear enough to accurately measure discharge.

Hydrologic Associations Analysis

Previous studies of flow regime effects on riparian ecosystems have found that certain vegetation communities are associated with specific depth, frequency, and duration of inundation (Auble et al. 1994). In order to assess the possible relationship of flow regime on riparian communities for Meadow Valley Wash, hydraulic conditions were modeled to determine the range of flows associated with the vegetation type at the transects where vegetation types occupied specific topographic levels. Specifically, calculations were performed using WinXSPRO cross-section analysis software. This software uses inputs of slope and roughness to determine the stage-discharge relationship at a given cross-section (transect).

Water surface or streambed slopes were surveyed in the field at the time of the transect surveys. Low-stage roughness (Manning's "n") values were back-calculated from field-measured discharge and stage values for the transects with measurable streamflow. High-stage roughness values and low-stage values for sites without measurable streamflow were estimated using published Manning's "n" tables (Bedient and Huber 1992). At transects RR2, CW1, and VI1, the back-calculated "n" values were unreasonably high (0.27, 0.20, and 0.53, respectively). At RR2 and CW1, the low-flow stage was likely elevated due to downstream beaver activity. At VI1, which is located in a recently burned area, the unusually high stage at low flow was most likely a function of the thick algae growing in the channel as well as the indefinite elevation of the extremely soft, unconsolidated, "bottomless" silt streambed. For these three transects, a low-stage "n" value of 0.18 was used, which is one of the highest published "n" values for natural channel/floodplain areas.

RESULTS

Meadow Valley Wash Land Ownership

The vast majority of land within the general Meadow Valley Wash is predominantly public, primarily managed by the BLM. Overall, Meadow Valley Wash is approximately 97 percent public lands with the remaining 3 percent privately owned, principally along Meadow Valley Wash (Provencher et al. 2003). Within the general area between Caliente and Moapa, public land ownership is approximately 92 percent with the remaining 8 percent privately owned, again primarily along Meadow Valley Wash. Private lands tend to be concentrated within the Meadow Valley Wash floodplain where surface water and shallow groundwater are more accessible and available. As such, private lands disproportionately fall within the Study Area, comprising approximately 26.4 percent (2,718.9 ac).

Lincoln County

The proportionate distribution of private lands within Lincoln County is consistent with the overall distribution within the Study Area. Private lands comprise approximately 26.4 percent (2,174.6 ac) of the Study Area in Lincoln County. These private lands are predominantly associated with ranching/agricultural land uses, although other uses, such as recreation and residential, occur. The vicinity of Caliente is predominantly comprised of private lands associated with residential and commercial land uses. Private lands in Lincoln County tend to be concentrated in the relatively broad areas of the valley where the floodplain has historically provided accessible surface water or shallow groundwater for agricultural production and railroad operations. Although not limited to these areas, concentrations of private land predominantly occur within the county in vicinity of Caliente, Elgin, Kyle, Lyman Crossing to Carp, Vigo, and the open valley above Rox. Private lands do not occur in the narrow canyon sections of Rainbow Canyon or the narrow canyon between Vigo and north of Rox.

Clark County

As with Lincoln County, the proportionate distribution of private lands within Clark County is consistent with the overall distribution within the Study Area. Private lands comprise approximately 26.2 percent (544.3 ac) of the Study Area in Clark County. Approximately 43.2 percent (235.4 ac) of these private lands consist of sand and gravel mining operations in the northern portion of Clark County. Otherwise, private lands tend to be concentrated near the communities of Moapa and Glendale, and land uses are primarily residential and agricultural.

Meadow Valley Wash Vegetation Types

A total of 1,183 vegetation/land use polygons comprising approximately 10,311 acres was delineated within the Study Area (Table 5). Forty-four (44) vegetation/land use types, were described for the Study Area. Thirty-five (34) of these were vegetation types, and an additional 4 were other natural ground covers (soils or open water). Together, these types comprised approximately 85.7 percent (8,833.20 ac) of the total ground cover within the Study Area. Natural vegetation types account for approximately 78.2 percent (8,064.78 ac) of the total ground cover within the Study Area. Of the remaining 6 types, 4 were anthropogenic land use types (development, agriculture, mining, and transportation) and 2 were incidental (shadows and unknown). The anthropogenic land use types comprised approximately 14.3 percent (1,475.75 ac) of the total ground cover in the Study Area, with the majority (989.07 ac) occurring as pasture/agricultural lands. The incidentals made up less than 0.02 percent of the total cover (1.97 ac).

Table 5. Total vegetation within Meadow Valley Wash.

VEGETATION TYPE/ LAND USE	LINCOLN COUNTY		CLARK COUNTY		TOTAL STUDY AREA	
	Number of Sites	Acres	Number of Sites	Acres	Number of Sites	Acres
Alluvium	13	498.04	3	30.39	16	528.43
Arrowweed Shrubland	28	117.32	0	0.00	28	117.32
Bare Soil	57	212.47	6	4.72	63	217.19
Bulrush Marsh	3	2.06	0	0.00	3	2.06
Burnt or Dead Tamarisk Woodland	13	189.93	19	61.51	32	251.44
Bush Seepweed Shrubland	7	39.51	3	5.62	10	45.13
Cattail Marsh	31	35.49	0	0.00	31	35.49
Coyote Willow Shrubland	3	4.96	0	0.00	3	4.96
Creosote Bush Shrubland	46	310.56	11	281.22	57	591.78
Desert Willow Shrubland	12	41.25	7	24.46	19	65.71
Developed Lands	3	7.81	3	2.11	6	9.92
Exposed Bright Soil	6	12.94	0	0.00	6	12.94
Fremont Cottonwood Forest	90	182.29	0	0.00	90	182.29
Gambel Oak Shrubland	5	9.33	0	0.00	5	9.33
Greasewood Shrubland	33	115.16	0	0.00	33	115.16
Knapweed Meadow	1	10.30	0	0.00	1	10.30
Mesquite Shrubland	3	2.47	12	20.84	15	23.31
Mixed Canyon Shrubland	47	618.52	0	0.00	47	618.52
Mixed Desert Shrubland	41	1,964.05	92	607.70	133	2,571.75
Mixed Grassland	22	181.63	6	29.80	28	211.43
Mixed Marsh	4	5.79	0	0.00	4	5.79
Mixed Wet Meadow	12	119.95	0	0.00	12	119.95
Open Water	6	4.08	6	5.78	12	9.86
Pasture/Agricultural Lands	22	882.97	4	106.10	26	989.07
Quailbush Shrubland	7	6.87	2	1.79	8	8.66
Quarry	0	0.00	2	235.42	2	235.42
Rabbitbrush Shrubland	98	350.36	0	0.00	98	350.36
Railroad/Road	45	220.45	11	20.88	54	241.33
Red Willow Forest	25	52.74	0	0.00	25	52.74
Red Willow Shrubland	4	7.51	0	0.00	4	7.51
Riparian Forest	22	204.94	0	0.00	22	204.94
Riparian Forest/Tamarisk Woodland Mix	10	140.42	1	3.63	9	144.05
Sagebrush Shrubland	26	87.37	0	0.00	26	87.37
Saltgrass Grassland	3	2.43	0	0.00	3	2.43
Screwbean Shrubland	1	1.22	0	0.00	1	1.22
Seep Willow Shrubland	8	16.75	0	0.00	8	16.75
Shadow	1	1.32	0	0.00	1	1.32
Shadscale Shrubland	46	461.28	14	129.46	60	590.74
Sparsely Vegetated/ Disturbed Lands	100	671.78	25	433.13	125	1,104.91
Tamarisk Woodland	65	433.10	28	218.24	93	651.34
Undetermined	1	0.65	0	0.00	1	0.65
Upland Forest	1	6.19	0	0.00	1	6.19
Water Cress/Duck Weed Marsh	2	1.73	0	0.00	2	1.73
Wolfberry Shrubland	1	0.41	0	0.00	1	0.41
TOTALS	**974**	**8,236.40**	**214**	**2,074.52**	**1183**	**10,310.92**

Approximately 80 percent of the total ground cover is within Lincoln County and 20 percent in Clark County, while approximately 82 percent of the polygons occur within Lincoln County and the remaining 18 percent in Clark County. As expected, this distribution pattern is consistent with the proportionate aerial composition of the overall Study Area: 82 percent is within Lincoln County and 18 percent in Clark County. Total vegetated cover mimics these proportions with approximately 79 percent of the natural vegetation occurring in Lincoln County and the remaining 21 percent in Clark County. However, a disproportionate amount of the Sparsely Vegetated/Disturbed Lands (39.2%) occurs in Clark County, indicative of the lower elevation Mojave influence.

A slightly disproportionate amount of anthropogenic land uses occur (approximately 25%) in the Clark County portion of the Study Area. This is primarily because approximately 235 acres of quarry and mined land occur within the Clark County portion of the Study Area. On the other hand, a disproportionate amount of pasture/agricultural lands, approximately 89 percent (882.97 ac), is within Lincoln County.

Riparian Vegetation Types

A total of 18 vegetation types considered dependant upon surface water or groundwater connectivity were delineated within the Study Area. Six (6) of these types are wetland communities that total approximately 167 acres, which is less than 2 percent of the total cover of the Study Area. Most of the wetland communities (approximately 85% or 142.4 ac) occurs within Rainbow Canyon. Additional wetlands, particularly Cattail Marshes, occur within vegetation types that are dominated by woody riparian vegetation types. All of the wetland types occur in Lincoln County.

Woody riparian vegetation types became the focus of the Study, because these vegetation types provide the species composition and vegetative structure and density to support SWWFC and other covered avian species. Twelve (12) woody riparian vegetation types were described for the Study Area (Table 6). Woody riparian vegetation comprises 1,744.18 acres within the Study Area, or approximately 16.9 percent of the total ground cover. The proportionate amount is similar within both Counties. In the Lincoln County portion of the Study Area, woody riparian vegetation is approximately 17.4 percent (1,430.72 ac) of the total ground cover, while in Clark County woody riparian vegetation is approximately 15.1 percent (313.46 ac) of the total ground. Overall, approximately 82 percent of the woody riparian vegetation is in Lincoln County and 18 percent is in Clark County. This distribution pattern is consistent with the proportionate aerial composition of the overall Study Area.

A comparison analysis between the 1976 aerial photographs and the 2003 digital imagery determined that woody riparian vegetation has increased by approximately 229 acres since 1976 (Table 7). Approximately 82 percent of the increase occurred on public lands, with only about 40 acres of the increase noted on private lands. The changes in vegetation over time may be the result of a variety of hydrologic events including flooding, local scouring, and changes in hydrologic controls. Between 1978 through 1980 peak flows at Caliente were approximately 2,400 cubic feet per second (cfs), while peak flow in 1995 was approximately 1900 cfs. Normal flows at Caliente

Table 6. Woody riparian vegetation for Meadow Valley Wash.

VEGETATION TYPE	LINCOLN COUNTY		CLARK COUNTY		TOTAL STUDY AREA	
	Number of Sites	Acres	Number of Sites	Acres	Number of Sites	Acres
NON-INVASIVE VEGETATION						
Arrowweed Shrubland	28	117.32	0	0.00	28	117.32
Bush Seepweed Shrubland	7	39.51	3	5.62	10	45.13
Coyote Willow Shrubland	3	4.96	0	0.00	3	4.96
Desert Willow Shrubland	12	41.25	7	24.46	19	65.71
Fremont Cottonwood Forest	90	182.29	0	0.00	90	182.29
Red Willow Forest	25	52.74	0	0.00	25	52.74
Red Willow Shrubland	4	7.51	0	0.00	4	7.51
Riparian Forest	22	204.94	0	0.00	22	204.94
Seep Willow Shrubland	8	16.75	0	0.00	8	16.75
Subtotals	***199***	***667.27***	***10***	***30.08***	***209***	***697.35***
INVASIVE VEGETATION						
Burnt or Dead Tamarisk Woodland	13	189.93	19	61.51	32	251.44
Riparian Forest/ Tamarisk Woodland Mix	10	140.42	1	3.63	9	144.05
Tamarisk Woodland	65	433.10	28	218.24	93	651.34
Subtotals	***88***	***763.45***	***48***	***283.38***	***134***	***1,046.83***
TOTALS	**287**	**1,430.72**	**58**	**313.46**	**343**	**1,744.18**

are typically between about 1 and 10 cfs with a 2-year flood magnitude is about 300 cfs In addition, land management activities including livestock management and tamarisk removal, such as those currently implemented by BLM, have likely enhanced non-invasive woody riparian vegetation growth and improved the ecological site potential for woody riparian vegetation.

Of the 12 woody riparian vegetation types, 9 types are non-invasive types (see Table 6). Non-invasive vegetation types are those dominated by native vegetation or naturalized vegetation not on the State of Nevada's noxious species list. Three (3) invasive woody riparian vegetation types occur within the Study Area. These 3 vegetation types are dominated by tamarisk or have a substantial tamarisk component.

Table 7. Woody riparian vegetation increase from 1976-2004.

VEGETATION TYPE	LINCOLN COUNTY			CLARK COUNTY			TOTAL STUDY AREA		
	Private Acres	Public Acres	Total Acres	Private Acres	Public Acres	Total Acres	Private Acres	Public Acres	Total Acres
NON-INVASIVE VEGETATION TYPES									
Arrowweed Shrubland	1.26	0.00	**1.26**	0.00	0.00	**0.00**	1.26	0.00	**1.26**
Bush Seepweed Shrubland	0.00	0.16	**0.16**	0.00	0.00	**0.00**	0.00	0.16	**0.16**
Desert Willow Shrubland	1.43	1.15	**2.58**	0.00	0.00	**0.00**	1.43	1.15	**2.58**
Freemont Cottonwood Forest	0.48	27.39	**27.87**	0.00	0.00	**0.00**	0.48	27.39	**27.87**
Red Willow Forest	0.00	0.98	**0.98**	0.00	0.00	**0.00**	0.00	0.98	**0.98**
Red Willow Shrubland	0.00	0.89	**0.89**	0.00	0.00	**0.00**	0.00	0.89	**0.89**
Riparian Forest	0.00	111.90	**111.90**	0.00	0.00	**0.00**	0.00	111.90	**111.90**
Seep Willow Shrubland	0.09	0.83	**0.92**	0.00	0.00	**0.00**	0.09	0.83	**0.92**
Subtotals	***3.26***	***143.30***	***146.56***	***0.00***	***0.00***	***0.00***	***3.26***	***143.3***	***146.56***
INVASIVE VEGETATION TYPES									
Burnt or Dead Tamarisk Woodland	2.61	4.51	**7.12**	0.10	0.02	**0.12**	2.71	4.53	**7.24**
Riparian Forest/ Tamarisk Woodland Mix	0.67	7.03	**7.70**	0.00	0.00	**0.00**	0.67	7.03	**7.70**
Tamarisk Woodland	32.10	31.65	**63.75**	1.52	2.14	**3.66**	33.62	33.79	**67.41**
Subtotals	***35.38***	***43.19***	***78.57***	***1.62***	***2.16***	***3.78***	***37.00***	***45.35***	***82.35***
TOTALS	**38.64**	**186.49**	**225.13**	**1.62**	**2.16**	**3.78**	**40.26**	**188.65**	**228.91**

Lincoln County

Non-invasive Woody Riparian Vegetation Types

Overall, 40.0 percent (697.35 ac) of the woody riparian vegetation types within the Study Area is non-invasive vegetation. Almost all (95.7%) of the non-invasive woody riparian vegetation occurs in Lincoln County (Table 6). Rainbow Canyon segment (between Caliente and Elgin) contains approximately 41.5 percent (289.17 ac) of the non-invasive vegetation types within the Study Area, all of which is on public lands. Of the total non-invasive woody riparian vegetation types in Lincoln County, approximately 31 percent occurs on private land, primarily in the vicinity of Caliente, Kyle,

Carp and Vigo. Two (2) vegetation types make up 55.5 percent of the non-invasive woody riparian vegetation in Lincoln County: Freemont Cottonwood Forest and Riparian Forest. These same two types comprise 81.8 percent (236.40 ac) of the non-invasive woody riparian vegetation in Rainbow Canyon.

The occurrence of the non-invasive woody riparian vegetation in Rainbow Canyon appears to be related to the available surface water and shallow groundwater. Surface water was recorded throughout the general reach between Caliente and Elgin, including Rainbow Canyon, where a predominance of the non-invasive woody riparian vegetation type polygons were delineated. One respondent to the oral history interviews (Appendix C) provided information indicating that this area historically provided surface flow or shallow groundwater. Another area noted as a historic "water zone" in the oral history interviews began north of Kyle and extended south toward Leith. Surface water was also noted in this area during the current Study, and the general area supports a well-developed complex of non-invasive woody riparian vegetation types.

During the oral history interviews, an overwhelming number of the residents believed that, in general, vegetation along the riparian corridor has increased over time (see Appendix C). Some residents stated that much of the change appeared to occur in the mid 1980s with an increase in vegetation stand density. This perception agrees with the comparison analysis between the 1976 aerial photographs and the 2003 digital imagery. Within Lincoln County, woody riparian vegetation appears to have increased by approximately 225 acres, and the vast majority (over 98%) has been on public lands (Table 7). Most of this increase (approximately 60%) was non-invasive woody riparian vegetation in Rainbow Canyon. Within Rainbow Canyon, the increased woody riparian vegetation was most noticeable between Stine, Nevada, and Boyd, Nevada, with an increase of approximately 67 acres. The changes in vegetation over time may be the result of a variety of hydrologic events including flood events that occurred with peak flows between 1978 and 1980 (about 2,400 cfs) and again in 1995 with a peak flow of approximately 1,900 cfs. In addition, management activities such as livestock management and tamarisk removal, such as those currently implemented by BLM throughout Rainbow Canyon, have likely enhanced non-invasive woody riparian vegetation growth and improved the ecological site potential for woody riparian vegetation.

Invasive Woody Riparian Vegetation Types

While Lincoln County contains nearly all of the non-invasive woody riparian vegetation, it amounts to only 46.6 percent of the woody riparian vegetation in the Lincoln County portion of the Study Area. Invasive woody riparian vegetation types account for 763.45 acres in Lincoln County. The invasive woody riparian vegetation types are very limited in Rainbow Canyon, accounting for 2.3 acres. The BLM has an active tamarisk control plan and has been treating public lands in Rainbow Canyon since 1999. Overall, invasive vegetation types are very limited throughout the northern half of the Study Area. Less than 10 acres of invasive woody riparian vegetation types occur between Caliente and Leith, although it should be noted that tamarisk was identified as an invasive species within a number of non-invasive woody riparian vegetation types. Within Rainbow Canyon 18 of the 84 non-invasive woody riparian polygons contained a tamarisk component. Approximately one half (about 395 ac) of the invasive woody riparian vegetation types occur on or adjacent to private lands in Lincoln County.

The majority of the invasive woody riparian vegetation (533.18) in Lincoln County occurs from just north of Lyman Crossing to south of Vigo. Most of this invasive woody riparian vegetation is Tamarisk Woodlands (340.94 ac) and the recently burned tamarisk woodland types in the vicinity of Carp (approximately 190 ac). A large block (107.67 ac) of Riparian Forest/Tamarisk Woodland Mix occurs in the vicinity of Rox, near the southern boundary of Lincoln County, and is half within private lands. This large stand of Riparian Forest/Tamarisk Woodland Mix is a complex mosaic of tamarisk and Freemont cottonwood in the canopy with a dense understory of tamarisk, mesquite (*Prosopis* sp.), red willow, and ash (*Fraxinus* sp.).

Surface water was recorded for the southern half of the Study Area in Lincoln County, particularly in the vicinity of Carp. This is consistent with remembered historic conditions (see Appendix C) where creek water was recalled to rise to the surface again. Woody riparian vegetation types associated with these surface water areas are primarily invasive vegetation types. The invasive tamarisk vegetation types form a large complex in the vicinity of Carp, and it dominates the woody riparian vegetation types through the remainder of Lincoln County. One respondent to the oral history interviews indicated that surface water in the vicinity of Carp dried up by summer. This lack of consistent perennial surface water may have given the competitive advantage to invasive tamarisk communities that could establish better connectivity to stable groundwater sources. The vitality of the invasive communities near Carp may be reflective of the availability of surface water for at least part of each growing season.

Respondents of the oral history interviews consistently recognized the spread and increasing density of tamarisk throughout Meadow Valley Wash (see Appendix C). Interpretation of the responses indicates that tamarisk invaded during the first decades of the 20th century in the vicinity of Leith. One respondent stated that tamarisk became noticeable in this area in 1937. Another resident stated that tamarisk invaded the area around Carp starting about 1945. The comparison analysis between the 1976 aerial photographs and the 2003 digital imagery determined that invasive woody riparian vegetation types (tamarisk) increased by approximately 79 acres during this time frame (Table 7). Approximately 45 percent of this increase occurred on private lands. Most of the increase in invasive vegetation types since 1976 appears to have occurred in the vicinity of Carp and Vigo. Approximately 22 acres of increased tamarisk vegetation types were delineated in the vicinity of Carp; most of this has been recently burned. Approximately 28 acres of increased tamarisk vegetation types were delineated in the vicinity of Vigo.

Clark County

Non-invasive Woody Riparian Vegetation Types

Very little (4.3%) of the non-invasive woody riparian vegetation occurs in Clark County. Non-invasive vegetation types in Clark County are limited to 5.62 acres of Bush Seepweed Shrubland and 24.46 acres of Desert Willow Shrubland (Table 6). The non-invasive riparian vegetation polygons are distributed throughout the Clark County portion of the Study Area. These non-invasive vegetation polygons in Clark County are all less than 7 acres in size. The Desert Willow Shrubland polygons range in size from approximately 0.6 acre to 6.9 acres. The 3 Bush Seepweed Shrubland polygons range in size from approximately 0.3 acre to 3.8 acres. All of the non-invasive woody

riparian vegetation polygons in Clark County, except for one small polygon (1.5 ac) of Bush Seepweed Shrubland, occurs on public lands.

A respondent of the oral history interviews recalled that the brush has increased in density over time, and that the woody vegetation in Clark County portion of Meadow Valley Wash was dominated by mesquite (see Appendix C). In a comparison analysis between the 1976 aerial photographs and the 2003 digital imagery, there does not appear to be any increase in non-invasive woody riparian vegetation types within Clark County (Table 7).

Invasive Woody Riparian Vegetation Types

Invasive woody riparian vegetation types account for the vast majority (90.4%) of the woody riparian vegetation in Clark County (Table 6). The Tamarisk Woodland vegetation type is predominant, comprising 218.24 ac of the total 283.38 acres of invasive woody riparian vegetation types in Clark County. Approximately 28 percent (about 80 ac) of the invasive woody riparian vegetation types occur on private lands in Clark County.

One respondent of the oral history interviews remembered tamarisk starting in the southern portion of Meadow Valley Wash during the 1940s to 1950s (see Appendix C). Respondents indicated that as tamarisk became thicker, removal projects were initiated around Moapa using prison labor, as well as by private land owners. The comparison analysis between the 1976 aerial photographs and the 2003 digital imagery determined that there has been very little change in size of the woody riparian vegetation types in the Clark County portion of the Study Area over the past 27 years (Table 7). The comparison analysis defined a total of 3.8 acres of increased tamarisk vegetation types. Although, as respondents indicated, the density of invasive vegetation stands may have increased. Much of the change in vegetation may have occurred earlier in the 20th century with the initial invasion of tamarisk. As described in the Hydrology Report (see Appendix D), tamarisk is generally better able to survive drought, salinity stress, and rapid water table declines than native willows and cottonwoods. Therefore, tamarisk may be able to grow in areas that lack consistently available surface water flows or have shallow groundwater tables. Study observations suggest that this may be the case in Meadow Valley Wash, where broad, thick tamarisk stands were observed in the lower, dry portions of the Study Area. Water availability is a limiting factor, as the Clark County portion of the Study Area has restricted surface water due to the infiltration of surface flows into valley sediments and irrigation withdrawals. Lack of available surface water and shallow groundwater may limit any substantial increase in overall distribution of woody riparian vegetation in the Clark County portion of the Study Area.

One non-operational Civilian Conservation Corps (CCC) flood control/diversion dam exists 5 miles north of Moapa (T14S R66E Section 5). The dam was evidently one of a series of structures constructed in Meadow Valley Wash during the 1930's to provide flood protection. The small retaining area behind the dam has long since completely filled with sediment. No riparian vegetation types exist immediately behind or below the dam; although Burnt or Dead Tamarisk stands occur within 500 feet above and below the old structure. The presence of the structure is not assumed to have an influence on the tamarisk communities.

Southwestern Willow Flycatcher (SWWFC) Habitat

SWWFC Suitable Habitat

For the Study, SWWFC suitable habitat is defined as woody riparian vegetation stands, either trees or shrubs, that appear to have all the components necessary for SWWFC to establish territories and/or nest. Woody riparian vegetation may be dominated by native vegetation or by exotic tamarisk. The primary components include: (1) a stand, or patch size, of 0.25 acre or greater; (2) a vegetation width of more than about 30 feet; (3) a dense canopy; (4) dense interior vegetation from ground level up to about 15 feet or dense patches interspersed with openings; and (5) surface water or saturated soils present within the stand or within 125 feet of the stand. Suitable habitat may be unoccupied for any of a multitude of reasons.

Overall Study Area

Within the entire Study Area (Table 8) a total of 713.65 acres of woody riparian vegetation types was delineated as SWWFC suitable habitat. This is a substantial amount (40.9%) of the woody riparian vegetation types delineated in the Study Area. The proportionate amount is similar within both Counties. In the Lincoln County portion of the Study Area, SWWFC suitable habitat occurs on approximately 40.3 percent (576.11 ac) of the woody riparian vegetation types, while in Clark County SWWFC suitable habitat occurs on approximately 43.9 percent of the woody riparian vegetation types. Overall, approximately 81 percent of the woody riparian vegetation is in Lincoln County and 19 percent is in Clark County. This distribution pattern is consistent with the proportionate aerial composition of the overall Study Area.

SWWFC suitable habitat was delineated in 65 individual stands comprised of woody riparian vegetation types. These stands range in patch size from approximately 0.4 acre to 133.5 acres. The average stand size is 10.98 acres, and the median size is 2.94 acres.

A comparison analysis between the 1976 aerial photographs and the 2003 digital imagery determined that woody riparian vegetation has increased by approximately 229 acres since 1976 (Table 7). Approximately 181 of these acres (79.0%) have been identified as SWWFC suitable habitat. A large majority (84.0%) of the increase in available SWWFC suitable habitat has occurred on public lands (152 ac).

Non-invasive Vegetation Types

SWWFC suitable habitat was delineated within 7 of the 12 woody riparian vegetation types defined for the Study Area. Five (5) of these types are non-invasive vegetation types; the other 2 types are invasive or semi-invasive vegetation types dominated or co-dominated by tamarisk (Table 8). Non-invasive woody riparian vegetation types only account for approximately 31.5 percent (224.77 ac)of the SWWFC suitable habitat in the Study Area. Two (2) of the non-invasive vegetation types, Red Willow Forest and Riparian Forest, provide a disproportionate amount of the SWWFC suitable habitat (Table 9). While a substantial portion of the available Red Willow Forest (57.6%) provides SWWFC suitable habitat, there are only about 52.7 acres of this vegetation type within the Study Area. Of the non-invasive vegetation types, the Riparian Forest vegetation type appears to provide

Table 8. Southwestern willow flycatcher (SWWFC) suitable habitat by vegetation type in Meadow Valley Wash.

VEGETATION TYPE	PRIVATE LANDS		PUBLIC LANDS		TOTALS BY HABITAT TYPE	
	TOTAL HABITAT (Acres)	STRESSED HABITAT (Acres)	TOTAL HABITAT (Acres)	STRESSED HABITAT (Acres)	TOTAL HABITAT (Acres)	STRESSED HABITAT (Acres)
LINCOLN COUNTY						
Desert Willow	0.00	0.00	0.56	0.00	0.56	0.00
Fremont Cottonwood Forest	9.29	9.00	40.00	19.00	49.29	28.30
Red Willow Forest	10.34	9.96	20.07	20.07	30.41	30.03
Red Willow Shrubland	0.00	0.00	1.67	0.00	1.67	0.00
Riparian Forest	7.30	7.30	135.54	47.27	142.83	54.57
Riparian Forest/ Tamarisk Woodland Mixed	46.15	46.15	83.48	65.81	129.63	111.96
Tamarisk Woodland	123.58	16.77	98.14	32.97	221.72	49.74
Subtotals	***196.66***	***89.47***	***379.45***	***185.13***	***576.11***	***274.60***
CLARK COUNTY						
Riparian Forest/ Tamarisk Woodland Mixed	3.39	0.00	0.24	0.00	3.63	0.00
Tamarisk Woodland	32.01	34.08	101.89	0.00	133.90	34.08
Subtotals	***35.40***	***34.08***	***102.14***	***0.00***	***137.53***	***34.08***
TOTAL STUDY AREA						
Desert Willow	0.00	0.00	0.56	0.00	0.56	0.00
Fremont Cottonwood Forest	9.29	9.29	40.00	19.01	49.29	28.30
Red Willow Forest	10.34	9.96	20.07	20.07	30.41	30.02
Red Willow Shrubland	0.00	0.00	1.67	0.00	1.67	0.00
Riparian Forest	7.30	7.30	135.54	47.27	142.84	54.57
Riparian Forest/ Tamarisk Woodland Mixed	49.54	46.15	83.72	65.81	133.26	111.96
Tamarisk Woodland	155.59	48.22	200.03	35.60	355.62	83.82
TOTALS	**232.06**	**123.55**	**481.59**	**185.13**	**713.65**	**308.68**

Table 9. Southwestern willow flycatcher (SWWFC) suitable habitat compared to overall woody riparian vegetation types in Meadow Valley Wash.

VEGETATION TYPE	SWWF HABITAT (Total Acres)	TOTAL WOODY RIPARIAN VEGETATION (Total Acres)	PERCENT OF WOODY RIPARIAN VEGETATION THAT IS SWWFC HABITAT
NON-INVASIVE VEGETATION TYPES			
Arrowweed	0.00	117.30	0.0%
Bush Seepweed	0.00	45.13	0.0%
Coyote Willow	0.00	4.96	0.0%
Desert Willow	0.56	65.71	0.8%
Fremont Cottonwood Forest	49.29	182.29	27.0%
Red Willow Forest	30.41	52.75	57.7%
Red Willow Shrubland	1.67	7.51	22.2%
Riparian Forest	142.84	204.94	69.7%
INVASIVE VEGETATION TYPES			
Burnt or Dead Tamarisk Woodland	0.00	251.44	0.0%
Riparian Forest/ Tamarisk Woodland Mixed	133.26	144.05	92.5%
Tamarisk Woodland	355.62	651.34	54.6%
TOTALS	**713.65**	**1744.18**	**40.9%**

the best opportunity for supporting SWWFC suitable habitat. The Riparian Forest vegetation type contains most of the non-invasive SWWFC suitable habitat (63.5% or 142.84 ac). Overall, 69.7 percent of the delineated Riparian Forest within the Study Area was determined to be SWWFC suitable habitat (Table 9). SWWFC suitable habitat was delineated in 13 stands of Riparian Forest. The size of the Riparian Forest stands range from approximately 1.0 acre to 45.2 acres. The average stand size is 10.99 acres; while the median size is 4.91acres.

The comparison analysis between the 1976 aerial photographs and 2003 digital imagery determined that woody riparian vegetation has increased SWWFC suitable habitat by approximately 181 acres since 1976. Most (71.3% or 129 acres) of this increase is from non-invasive woody riparian vegetation. All of the increased in non-invasive riparian vegetation types considered SWWFC suitable habitat has been in Lincoln County's Rainbow Canyon.

Invasive Vegetation Types

The majority of SWWFC suitable habitat within the overall Study Area occurs within invasive vegetation types. Approximately 68.5 percent (488.88 ac) of the delineated SWWFC suitable habitat within the Study Area is comprised of invasive or semi-invasive vegetation types (Table 10).

Table 10. Meadow Valley Wash – southwestern willow flycatcher (SWWFC) suitable habitat by invasive vegetation component.

HABITAT TYPE	PRIVATE LANDS (ACRES)			PUBLIC LANDS (ACRES)			TOTAL LANDS (ACRES)		
	Non-invasive Types	Semi-invasive Types	Invasive Types	Non-invasive Types	Semi-invasive Types	Invasive Types	Non-invasive Types	Semi-invasive Types	Invasive Types
LINCOLN COUNTY									
Total Southwestern Willow Flycatcher Suitable Habitat	26.93	46.15	123.58	197.84	83.48	98.14	224.77	129.63	221.72
Stressed Suitable Habitat	26.55	46.15	16.77	86.35	65.81	32.97	112.90	111.96	49.74
CLARK COUNTY									
Total Southwestern Willow Flycatcher Suitable Habitat	0.00	3.39	32.01	0.00	0.24	101.89	0.00	3.63	133.90
Stressed Suitable Habitat	0.00	0.00	31.45	0.00	0.00	2.63	0.00	0.00	34.08
MEADOW VALLEY WASH STUDY AREA									
Total Southwestern Willow Flycatcher Suitable Habitat	26.93	49.54	155.59	197.84	83.72	200.03	224.77	133.26	355.62
Stressed Suitable Habitat	26.55	46.15	48.22	89.35	65.81	35.60	112.90	111.96	83.82

SWWFC suitable habitat occurs within 2 of the 3 invasive woody riparian vegetation types defined for the Study Area (Table 9). No SWWFC suitable habitat was delineated in Burnt or Dead Tamarisk Woodlands. Substantial amounts of both Tamarisk Woodlands and the Riparian Forest/Tamarisk Woodland Mix provide SWWFC suitable habitat (Table 9). Nearly all (92.5%) of the Riparian Forest/Tamarisk Woodland Mix and about half (54.6%) of the Tamarisk Woodlands provide SWWFC suitable habitat. These two vegetation types comprise approximately 45.6 percent of the woody riparian vegetation in the Study Area. SWWFC suitable habitat was delineated in 25 stands of invasive vegetation types (19 stands of Tamarisk Woodland and 6 stands of Riparian Forest/Tamarisk Woodland Mix). The sizes of the invasive vegetation type stands that support SWWFC suitable habitat range from approximately 0.5 acre to 133.5 acres. The average stand size is 19.55 acres while the median size is 0.39 acre.

The dominance of these two vegetation types and their ability to provide SWWFC suitable habitat indicate their importance in the Study Area. Although SWWFC have evolved and bred exclusively in native woody riparian stands, they appear to have responded to the loss and modification of native riparian habitat by using exotic dominated habitats, particularly tamarisk (Sogge and Marshall 2000, USFWS 2002).

The comparison analysis between the 1976 aerial photographs and 2003 digital imagery determined that woody riparian vegetation has increased SWWFC suitable habitat by approximately 181 acres since 1976. Approximately 54 acres of this increase in available SWWFC suitable habitat has been invasive woody riparian vegetation (29.8%).

Relationship to Land Ownership

The majority of SWWFC suitable habitat within the Study Area occurs on public lands and accounts for approximately 67.5 percent (481.59 ac) of the suitable habitat (Table 8). Invasive vegetation types make up most of the SWWFC suitable habitat on public lands (58.9%). Non-invasive woody riparian vegetation types account for approximately 41.1 percent (197.83 ac) of the SWWFC suitable habitat on public lands. This is proportionately larger than found on the Study Area as a whole (31.5 percent). Of the total non-invasive woody vegetation that is SWWFC suitable habitat (224.75 ac), 80.0 percent (197.83 ac) occurs on public land. Very little of the SWWFC suitable habitat that is comprised of non-invasive woody vegetation occurs on private lands.

On the other hand, invasive vegetation types on private lands that are SWWFC suitable habitat are disproportionately high. Approximately 88.4 percent (205.13 ac) of available SWWFC suitable habitat on private lands is invasive woody riparian vegetation dominated by tamarisk or containing a large tamarisk component, whereas invasive woody riparian vegetation types comprise 68.5 percent of the overall SWWFC suitable habitat within the Study Area.

The comparison analysis between the 1976 aerial photographs and 2003 digital imagery determined that woody riparian vegetation has increased SWWFC suitable habitat by approximately 181 acres since 1976. A large majority (84.0%) of this change in available SWWFC suitable habitat has occurred on public lands (152 ac).

Lincoln County

In Lincoln County 576.11 acres of woody riparian vegetation types were recorded as SWWFC suitable habitat. This is approximately 81 percent of the SWWFC suitable habitat within the entire Study Area. This distribution pattern is consistent with the proportionate aerial composition of the overall Study Area, where approximately 80 percent of the total ground cover is within Lincoln County. Overall, 39.0 percent (224.76 ac) of the SWWFC habitat in Lincoln County is comprised of non-invasive woody riparian vegetation types, while 61.0 percent (351.35 ac) is invasive woody riparian vegetation types dominated by tamarisk or with a significant tamarisk component (Table 8).

Non-invasive Vegetation Types

All (100.0%) of the SWWFC suitable habitat within the Study Area that is composed of non-invasive woody riparian vegetation occurs in Lincoln County (Table 8). Nearly all (99.2%) of the non-invasive vegetation types considered SWWFC suitable habitat occur between Caliente and Kyle. Rainbow Canyon segment (south of Caliente to north of Elgin) contains the overwhelming majority (80.8%) of the non-invasive SWWFC suitable habitat (181.64 ac), which occurs in 30 stands. Stand size ranges from approximately 0.4 acre to 45.2 acre, with an average stand size of 6.05 acres and a median of 2.80 acres.

SWWFC suitable habitat occurs in 4 non-invasive vegetation types in Rainbow Canyon: Freemont Cottonwood, Red Willow Forest, Red Willow Shrubland, and Riparian Forest. The Riparian Forest vegetation type composes 74.5 percent of the SWWFC suitable habitat in Rainbow Canyon. Approximately 9.3 acres of Freemont Cottonwood are SWWFC habitat within the immediate vicinity of Caliente.

Two distinct communities consisting of Freemont Cottonwood (13.68 ac) and Riparian Forest (7.45 ac) provide SWWFC suitable habitat in the vicinity of Kyle.

As previously stated, the extensive occurrence of the non-invasive SWWFC suitable habitat woody riparian vegetation in Rainbow Canyon appears to be related to the available surface water and shallow groundwater. Surface water was recorded between Caliente and Elgin, including Rainbow Canyon, where a predominance of the non-invasive woody riparian vegetation type polygons were delineated. Both the historic data and the site investigations indicate available surface water in the vicinity of Kyle, and this area supports a well-developed complex of non-invasive woody riparian vegetation types.

The comparison analysis between the 1976 aerial photographs and 2003 digital imagery determined that non-invasive woody riparian vegetation has increased SWWFC suitable habitat by approximately 129 acres since 1976. All of this increase in non-invasive riparian vegetation types considered SWWFC suitable habitat has been in Rainbow Canyon. The majority (83.4%) of this increase in non-invasive vegetation types considered SWWFC suitable habitat is comprised of the Riparian Forest vegetation type (approximately 114 ac).

Invasive Vegetation Types

While Lincoln County contains nearly all of the non-invasive woody riparian vegetation, it supports only 39.0 percent of the SWWFC suitable habitat in the Lincoln County portion of the Study Area. Invasive woody riparian vegetation types account for 351.35 acres of SWWFC suitable habitat in Lincoln County occurring in 20 separate stands. Stand size ranges from approximately 0.5 acre to133.5 acres, with an average stand size of 17.75 acres and a median of 6.14 acres.

All of the SWWFC suitable habitat that occurs in invasive vegetation types in Lincoln County occurs south of Lyman Crossing. Large stands of SWWFC suitable habitat occur in the vicinity immediately north of Vigo where SWWFC suitable habitat occupies 152.07 acres of invasive vegetation types, primarily Tamarisk Woodland (147.77 ac). The Tamarisk Woodland is interspersed by small stands of non-invasive woody riparian vegetation generally not of sufficient density or structure to provide suitable habitat. Another large block SWWFC suitable habitat (165.85 ac) occurs in the vicinity of Rox. Most of this SWWFC suitable habitat occurs in on large stand (107.67 ac) of Riparian Forest/Tamarisk Woodland Mix in the open valley north of Rox. This large stand has a mosaic of tamarisk and Freemont cottonwood in the canopy with a dense understory of tamarisk, mesquite, red willow, and ash. None of the large stands of Tamarisk Woodland in the vicinity of Carp were defined as SWWFC suitable habitat. Many of the tamarisk stands in this area had been recently burned and do not have the structure or density for nesting

SWWFC. Unburned stands of Tamarisk Woodland in the vicinity of Carp either do not have the vegetative structure and density or do not have surface water in or adjacent to the stands.

The comparison analysis between the 1976 aerial photographs and 2003 digital imagery determined that invasive woody riparian vegetation has increased SWWFC suitable habitat by approximately 51 acres since 1976. Most of this increase (86.8%) is in the Tamarisk Woodland vegetation type (approximately 44 ac). Most of the increase (70.9%) in invasive vegetation types that are SWWFC suitable habitat has occurred in the vicinity of Vigo (about 33 ac).

Stressed SWWFC Suitable Habitat

Stressed SWWFC suitable habitat is suitable habitat subjected to anthropogenic activities that threaten the current ecological development and stability of the riparian stand. Continued stress may threaten the viability of the stand as suitable breeding habitat through a change in vegetation structure or density, or surface water availability.

Of the 576.11 acres delineated as SWWFC suitable habitat in Lincoln County, nearly half (274.60 ac) is currently undergoing anthropogenic stress and includes 34 of the 60 vegetation stands (Table 8 and Table 10).

Stressed Non-Invasive SWWFC Suitable Habitat

Half (50.2% or 112.89 ac) of the non-invasive vegetation types that comprise SWWFC suitable habitat is currently undergoing anthropogenic stress. Stressors were noted on 22 of the 40 stands of non-invasive SWWFC suitable habitat in Lincoln County. Grazing was identified as occurring on 11 of these stands (35.89 total acres). Stress was exacerbated in 4 of these grazed stands (12.99 total acres) by stream channelization or downcutting. Eight (8) of the stands stressed by grazing have a noticeable lack of diverse understory. Development activities were identified on 4 other stands (16.07 total acres). Channelization was observed in, or adjacent to, an additional 7 stands that may be threatening 60.92 acres of non-invasive SWWFC suitable habitat, although only 1 of these stands (8.32 ac) had a noticeable lack of understory diversity.

Rainbow Canyon (south of Caliente to north of Elgin) contains the overwhelming majority (80.8%) of the non-invasive SWWFC suitable habitat (181.64 ac). Anthropogenic stressors were identified in 16 of the 30 stands of SWWFC suitable habitat in Rainbow Canyon and occur on approximately 47.4 percent (86.10 ac) of the SWWFC suitable habitat in Rainbow Canyon. Grazing was identified as occurring on 8 of these stands (27.11 total acres). These 8 grazed stands had a noticeable lack of diverse understory, and 4 of these grazed stands (12.99 ac) were additionally threatened by stream channelization or downcutting. All of the land stress to 4 stands of SWWFC suitable habitat, as noted above, occurred in Rainbow Canyon (16.07 ac). Channelization that may be threatening 42.92 acres of non-invasive SWWFC suitable habitat in Rainbow Canyon was observed in, or adjacent to, an additional 4 stands, although none of these stands had a noticeable lack of understory diversity.

Stressed Invasive SWWFC Suitable Habitat

Close to half (46.0% or 161.71 ac) of the invasive vegetation types that comprise SWWFC suitable habitat is currently undergoing anthropogenic stress. Stressors were noted on 12 of the 20 stands of invasive SWWFC suitable habitat in Lincoln County. Grazing was identified as occurring on all

12 of these stands, while channel downcutting was observed in only 1 of the stands. Three (3) of these stands are diverse Riparian Forest/Tamarisk Woodland Mix vegetation types and, even with the grazing stress, they contained a diverse understory. The remaining 9 stands were the Tamarisk Woodland vegetation type, and the density of the tamarisk most likely precluded substantial effects on the interior of these stands.

Relationship to Land Ownership

The majority of SWWFC suitable habitat within the Lincoln County occurs on public lands and accounts for approximately 65.9 percent (379.45 ac) of the SWWFC suitable habitat in Lincoln County (Table 8). Non-invasive vegetation types make up 52.1 percent of the SWWFC suitable habitat on public lands (197.83 ac), and invasive vegetation types make up 47.9 percent (181.62 ac). Of the total non-invasive woody vegetation that is SWWFC suitable habitat in Lincoln County (224.77 ac), 80.0 percent (197.83 ac) occurs on public land.

Very little of the SWWFC suitable habitat that is comprised of non-invasive woody vegetation occurs on private lands in Lincoln County. Non-invasive SWWFC suitable habitat was identified on 3 separate private parcels and totaled 15.82 acres, with an additional 11.1 acres owned by the City of Caliente or occurring adjacent to public roads.

Invasive SWWFC suitable habitat vegetation types on private lands in Lincoln County is disproportionately high. Approximately 86.3 percent (169.73 ac) of the available SWWFC suitable habitat on private lands in Lincoln County is comprised of invasive woody riparian vegetation dominated by tamarisk or containing a large tamarisk component, whereas invasive woody riparian vegetation types comprise 61.0 percent of the overall SWWFC suitable habitat within the Lincoln County.

Non-invasive SWWFC suitable habitat was identified on 10 separate private parcels.

The comparison analysis between the 1976 aerial photographs and the 2003 digital imagery determined that woody riparian vegetation has increased SWWFC suitable habitat in Lincoln County by approximately 156 acres since 1976. A large majority (82.0%) of this change in available SWWFC suitable habitat has occurred on public lands (128 ac).

Stressed SWWFC Suitable Habitat on Public Lands

Of the 379.45 acres delineated as SWWFC suitable habitat on public lands in Lincoln County, about 48.7 percent (185.13 ac) is currently undergoing anthropogenic stress (Table 8). Grazing was identified as occurring on 17 stands (approximately 122 ac). All of the 9 stands comprised of invasive woody riparian vegetation types, approximately 95 acres were identified as grazed. The other 8 stands, comprised of non-invasive vegetation types (approximately 27 ac), are located in Rainbow Canyon and were described previously. Development activities were identified on 2 stands of non-invasive woody riparian vegetation types (approximately 10 ac). Channelization, observed in or adjacent to an additional 7 stands, may be threatening approximately 54 acres of non-invasive SWWFC suitable habitat.

Stressed SWWFC Suitable Habitat on Private Lands

Of the 196.66 acres delineated as SWWFC suitable habitat on private lands in Lincoln County, about 45.5 percent (89.47 ac) are currently undergoing anthropogenic stress (Table 8). Grazing was identified as occurring on 7 of the 10 stands (approximately 75 ac). The stands comprised of invasive woody riparian vegetation types (approximately 64 ac) were identified as grazed, while grazing was also identified on 3 of the non-invasive woody riparian vegetation types (approximately 11 ac). Development activities were identified on 3 stands of non-invasive woody riparian vegetation types (approximately 14 ac). Channelization was observed in or adjacent to only 1 stand, and development activities were noted on this private land.

Seven of the 13 private parcels with SWWFC suitable habitat were identified as having stressors.

Clark County

In Clark County, 137.53 acres of woody riparian vegetation types were defined as SWWFC suitable habitat (Table 8). This is approximately 19 percent of the SWWFC suitable habitat within the entire Study Area. This distribution pattern is consistent with the proportionate aerial composition of the overall Study Area, where approximately 19 percent of the total ground cover is within Clark County. The SWWFC suitable habitat in Clark County occurs entirely within invasive vegetation types dominated by tamarisk (Tamarisk Woodland) or with a significant tamarisk component (Riparian Forest/Tamarisk Woodland Mix).

In Clark County SWWFC suitable habitat occurs on only 7 stands. Stand size ranges from approximately 0.6 acre to 99.8 acres, with an average stand size of 23.97 acres and a median of 10.07 acres.

Almost all of the SWWFC suitable habitat in Clark County is concentrated in two large complexes of Tamarisk Woodland vegetation type; both are located in the southern half of the Clark County portion of the Study Area. A complex is defined as a group of connected vegetation stands with attributes that meet habitat criteria. One complex is east of Moapa and is 99.82 acres of homogenous tamarisk. This complex appears to have developed in conjunction with some limited surface water and shallow groundwater. The second complex is at the southern terminus of the Study Area. Three (3) stands of Tamarisk Woodland comprise 33.49 acres that have developed at the confluence with the Muddy River where surface water appears to be perennial. This complex includes a more diverse understory with a mesquite co-dominance. One stand (3.39 ac) of Riparian Forest/Tamarisk Woodland Mix provides SWWFC suitable habitat at the northern boundary of Clark County. This stand continues north into Lincoln County for an additional 6.54 acres. This stand is co-dominated by tamarisk and coyote willow (*Salix exigua*), with an understory of coyote willow.

The comparison analysis between the 1976 aerial photographs and 2003 digital imagery determined that invasive woody riparian vegetation has increased SWWFC suitable habitat by only about 2.5 acres since 1976. As previously described under the Woody Riparian Vegetation section, the Clark County portion of the Study Area has limited surface water due to the infiltration of surface flows into valley sediments and irrigation withdrawals. Lack of available surface water and shallow groundwater may limit any substantial increase in overall distribution of woody riparian vegetation in the Clark County portion of the Study Area.

Stressed SWWFC Suitable Habitat

Stressed SWWFC suitable habitat is the suitable habitat subjected to anthropogenic activities that threaten the current ecological development and stability of the riparian stand. Continued stress may threaten the viability of the stand as suitable breeding habitat through a change in vegetation structure or density, or surface water availability.

Of the 137.53 acres in Clark County delineated as SWWFC suitable habitat, only 34.08 acres (24.8%) are currently undergoing anthropogenic stress. Stressors were identified in 4 of the 6 stands of SWWFC suitable habitat in Clark County (Table 8 and Table 10). While grazing was identified as a common stressor in Lincoln County, no grazing was noted within any SWWFC suitable habitat in Clark County. Channelization and downcutting were identified in or adjacent to 2 stands of SWWFC suitable habitat, and water diversion was observed within 1 additional stand. Development activities were noted within 2 stands, one of which was also threatened by channelization. Stressors were not observed within the 1 large (99.82 ac) Tamarisk Woodland complex east of Moapa or in the Riparian Forest/Tamarisk Woodland Mix at the northern border of Clark County.

Relationship to Land Ownership

The majority of SWWFC suitable habitat within the Clark County occurs on public lands and accounts for approximately 74.3 percent (102.14 ac) of the SWWFC suitable habitat in the County (Table 8). SWWFC suitable habitat occurs on 14 parcels of private lands for a total of 35.40 acres.

The comparison analysis between the 1976 aerial photographs and 2003 digital imagery determined that invasive woody riparian vegetation has increased SWWFC suitable habitat by only about 2.5 acres since 1976, of which 2.1 acres are is on public lands.

Stressed SWWFC Suitable Habitat

All 34.08 acres of stressed SWWFC suitable habitat in Clark County occur on private lands and are described under the Clark County Stressed SWWFC Habitat section. Stressed SWWFC suitable habitat was identified on 11 of the 14 parcels with SWWFC suitable habitat.

SWWFC Potential Habitat

For the Study SWWFC potential habitat is defined as the woody riparian vegetation stands that do not currently have all the components necessary for SWWFC to establish territories and/or reproduce but do have the vegetation composition, patch size, and the basic vegetation structure that could potentially develop into SWWFC suitable habitat in the future, especially if management objectives are designed to promote suitable habitat development. Potential habitat occurs where floodplain conditions, sediment characteristics, and hydrological setting provide potential for development of dense riparian vegetation.

Overall, SWWFC potential habitat comprises 692.22 acres within the Study Area (Table 11), which is approximately 39.7 percent of the total woody riparian vegetation within the Study Area. The proportional distribution of potential habitat between Lincoln County (80%) and Clark County

Table 11. Meadow Valley Wash – summary of southwestern willow flycatcher (SWWFC) potential habitat.

HABITAT TYPE	PRIVATE LANDS (ACRES)	PUBLIC LANDS (ACRES)	TOTAL LANDS (ACRES)
LINCOLN COUNTY			
Total Southwestern Willow Flycatcher Potential Habitat	208.42	348.27	556.69
Potential Habitat-Type A	6.02	5.88	11.90
Potential Habitat-Type B	181.81	302.24	484.05
Potential Habitat-Type C	20.59	40.15	60.74
CLARK COUNTY			
Total Southwestern Willow Flycatcher Potential Habitat	25.00	110.54	135.54
Potential Habitat-Type A	3.85	0.03	3.88
Potential Habitat-Type B	21.15	110.51	131.66
Potential Habitat-Type C	0.00	0.00	0.00
MEADOW VALLEY WASH STUDY AREA			
Total Southwestern Willow Flycatcher Potential Habitat	233.42	458.81	692.22
Potential Habitat-Type A	9.87	5.91	15.78
Potential Habitat-Type B	202.96	412.74	615.70
Potential Habitat-Type C	20.59	40.15	60.74

(20%) mimics the aerial distribution of ground cover between the Counties. Potential habitat occurs more frequently (66.3%) on public lands where it totals 458.81 acres (Table 11). Most (71.4%) of the potential habitat is comprised of invasive vegetation types dominated by tamarisk or with a significant tamarisk component (Table 12). As expected, almost all (96.2%) of the potential habitat in non-invasive vegetation types occurs in Lincoln County (Table 12).

Three (3) types of SWWFC potential habitat were determined based on vegetation structure and density, as well as the presence of water. These 3 types have been arbitrarily labeled Potential Habitat Type A, Potential Habitat Type B, and Potential Habitat Type C.

Potential Habitat-Type A

Potential habitat Type A is comprised of woody riparian vegetation stands that have the patch size, vegetation structure, and density needed for SWWFC to establish territories and/or nest, but do not have surface water or saturated soils present or within 125 feet of the stand. If surface water or saturated soils were present during breeding season, the stands would contain all the components deemed necessary for SWWFC to establish territories and/or nest (suitable habitat).

Of all three types of potential habitat Type A is the least common occurring on just 15.78 acres (Table 10). Type A habitat was identified in only 5 stands, 4 stands in Lincoln County and 1 stand in Clark County. Two (2) of these 5 stands are non-invasive vegetation types: one in upper Rainbow Canyon and the other near Elgin (Table 13). Both of these stands are on public land. In general, the locations of these 2 stands of SWWFC potential habitat are isolated from the immediate active

Table 12. Meadow Valley Wash – southwestern willow flycatcher (SWWFC) potential habitat by invasive vegetation component.

HABITAT TYPE	PRIVATE LANDS (ACRES)			PUBLIC LANDS (ACRES)			TOTAL LANDS (ACRES)		
	Non-invasive Types	Semi-invasive Types	Invasive Types	Non-invasive Types	Semi-invasive Types	Invasive Types	Non-invasive Types	Semi-invasive Types	Invasive Types
LINCOLN COUNTY									
Total Southwestern Willow Flycatcher Potential Habitat	42.45	5.67	160.31	147.86	5.11	195.30	190.31	10.78	355.61
Stressed Potential Habitat	35.43	5.67	158.56	103.08	5.11	191.45	138.51	10.78	350.01
CLARK COUNTY									
Total Southwestern Willow Flycatcher Potential Habitat	0.00	0.00	25.00	7.42	0.00	103.12	7.42	0.00	128.12
Stressed Potential Habitat	0.00	0.00	21.05	7.42	0.00	103.09	7.42	0.00	124.14
MEADOW VALLEY WASH STUDY AREA									
Total Southwestern Willow Flycatcher Potential Habitat	42.45	5.67	185.31	155.28	5.11	298.42	197.73	10.78	483.73
Stressed Potential Habitat	35.43	5.67	179.61	110.50	5.11	294.54	145.93	10.78	474.15

floodplain of Meadow Valley Wash either by distance (800-1,000 ft) and/or roads or railroad barriers. The 2 stands are approximately 0.5 acre and 3 acres in size, respectively. Stand development is believed to have resulted from shallow groundwater and seep discharge from slopes or road/railroad fill.

The other 3 stands are comprised of invasive vegetation types and occur on private land. Two (2) of these stands are Tamarisk Woodland and isolated from the immediate active floodplain of Meadow Valley Wash either by distance (400-800 ft) and/or by road or railroad barriers. Both occur in the southern half of Lincoln County. The third stand is within the immediate, active Meadow Valley Wash floodplain in Clark County and approximately 4 acres in size. This stand has an overstory of burnt or dead tamarisk and live tamarisk, and an understory of desert willow and tamarisk.

Table 13. Meadow Valley Wash southwestern willow flycatcher (SWWFC) potential habitat – Type A.

VEGETATION TYPE	PRIVATE LANDS		PUBLIC LANDS		TOTAL VEGETATION TYPE	
	TOTAL HABITAT (ACRES)	STRESSED HABITAT (ACRES)	TOTAL HABITAT (ACRES)	STRESSED HABITAT (ACRES)	TOTAL HABITAT (ACRES)	STRESSED HABITAT (ACRES)
LINCOLN COUNTY						
Coyote Willow Shrubland	0.00	0.00	0.41	0.41	0.41	0.41
Fremont Cottonwood Forest	0.00	0.00	2.99	2.99	2.99	2.99
Tamarisk Woodland	6.02	4.34	2.48	2.48	8.50	6.82
Subtotals	***6.02***	***4.34***	***5.88***	***5.88***	***11.90***	***10.22***
CLARK COUNTY						
Burnt/Dead Tamarisk Woodland	3.85	0.00	0.03	0.00	3.88	0.00
TOTAL STUDY AREA						
Burnt/Dead Tamarisk Woodland	3.85	0.00	0.03	0.00	3.88	0.00
Coyote Willow Shrubland	0.00	0.00	0.41	0.41	0.41	0.41
Fremont Cottonwood Forest	0.00	0.00	2.99	2.99	2.99	2.99
Tamarisk Woodland	6.02	4.34	2.48	2.48	8.50	6.82
TOTALS	9.87	4.34	5.91	5.88	15.78	10.22

Potential Habitat-Type B

Potential habitat Type B is comprised of woody riparian vegetation stands that have the patch size and the vegetation structure needed for SWWFC to establish territories and/or nest, but do not have the interior vegetation density from the ground level up to 15 feet considered necessary to attract and maintain breeding birds. Surface water or saturated soils may or may not be present. Lack of hydrologic connectivity, ecological characteristics, or anthropogenic stressors may be affecting the development of sufficient interior density.

Type B is the most common SWWFC potential habitat, occurring on 112 stands (615.70 ac) of the Study Area (Table 10). Stand size ranges from approximately 0.3 acre to 75.2 acres, with an average stand size of 5.50 acres and a median of 2.04 acres. Non-invasive vegetation types make up approximately 21.7 percent (133.88 ac) of the Type B potential habitat in the Study Area. All of the non-invasive Type B potential habitat, except for 7.42 acres of Desert Willow Shrublands, is located in Lincoln County (Table 14).

Table 14. Meadow Valley Wash southwestern willow flycatcher (SWWFC) potential habitat – Type B.

VEGETATION TYPE	PRIVATE LANDS		PUBLIC LANDS		TOTAL VEGETATION TYPE	
	TOTAL HABITAT (ACRES)	STRESSED HABITAT (ACRES)	TOTAL HABITAT (ACRES)	STRESSED HABITAT (ACRES)	TOTAL HABITAT (ACRES)	STRESSED HABITAT (ACRES)
LINCOLN COUNTY						
Coyote Willow	0.31	0.31	4.24	4.24	4.55	4.55
Desert Willow	8.86	8.86	0.93	0.93	9.79	9.79
Fremont Cottonwood Forest	0.06	0.06	36.09	27.46	36.15	27.52
Red Willow Forest	0.00	0.00	5.72	5.72	5.72	5.72
Red Willow Shrubland	5.84	5.84	0.00	0.00	5.84	5.84
Riparian Forest	5.70	0.00	48.44	24.09	54.14	24.09
Seep Willow Shrubland	1.09	1.09	9.18	8.41	10.27	9.50
Burnt or Dead Tamarisk Woodland	112.97	112.97	76.96	76.06	189.93	189.03
Riparian Forest/Tamarisk Woodland Mixed	5.67	5.67	5.11	5.11	10.78	10.78
Tamarisk Woodland	41.36	41.36	115.57	112.62	156.93	153.98
Subtotals	***181.86***	***176.16***	***302.24***	***264.64***	***484.10***	***440.80***
CLARK COUNTY						
Desert Willow	0.00	0.00	7.42	7.42	7.42	7.42
Burnt or Dead Tamarisk Woodland	1.72	1.72	50.19	50.19	51.91	51.91
Tamarisk Woodland	19.43	19.33	52.90	48.39	72.33	67.72
Subtotals	***21.15***	***21.05***	***110.51***	***106.00***	***131.66***	***127.05***
TOTAL STUDY AREA						
Coyote Willow	0.31	0.31	4.24	4.24	4.55	4.55
Desert Willow	8.86	8.86	8.35	8.35	17.21	17.21
Fremont Cottonwood Forest	0.06	0.06	36.09	27.46	36.15	27.52
Red Willow Forest	0.00	0.00	5.72	5.72	5.72	5.72
Red Willow Shrubland	5.84	5.84	0.00	0.00	5.84	5.84
Riparian Forest	5.70	0.00	48.44	24.09	54.14	24.09
Seep Willow Shrubland	1.09	1.09	9.18	8.41	10.27	9.50
Burnt or Dead Tamarisk Woodland	114.69	114.69	127.15	126.25	241.84	240.94
Riparian Forest/Tamarisk Woodland Mixed	5.67	5.67	5.11	5.11	10.78	10.78
Tamarisk Woodland	60.79	60.69	168.47	161.01	229.26	221.70
TOTALS	**203.01**	**197.21**	**412.75**	**370.64**	**615.76**	**567.85**

Surface water or saturated soils, a necessary component of SWWFC suitable habitat, occur on 47 of the 112 stands of Type B potential habitat (265.76 total ac). As such, these 47 stands have a very good potential of developing into SWWFC suitable habitat. Thirty-four (34) of these 47 stands (217.88 ac) of Type B potential habitat with surface water present were observed to have stressors that may be inhibiting their potential to develop into SWWFC habitat. Grazing and stream channelization are the most common stressors, occurring either individually or together on 25 stands. Other common stressors included recent fire (occurring on 10 stands, primarily in Tamarisk Woodlands), land developments (occurring on 8 stands), and OHV use (identified on 6 stands).

Surface water or saturated soils was not observed on the remaining 65 stands of Type B potential habitat (349.94 total ac). In addition to the lack of surface water, 25 of these 65 stands (246.21 total ac) were observed to have stressors that may inhibit the potential to develop into SWWFC habitat. Grazing is the most common stressor, occurring either individually or together on 17 of these 25 stands. The next most common stressor, OHV use, was observed occurring on 9 of the stands. As expected, channelization and water diversions were not common stressors, since there was no surface water present in the Meadow Valley Wash channel.

Lincoln County

Most (78.6%) of the Type B potential habitat occurs in Lincoln County (484.10 total ac). Type B potential habitat was identified in 78 stands of woody riparian vegetation. Stand size ranges from approximately 0.3 acre to 75.2 acres, with an average stand size of 6.21 acres and a median of 2.07 acres. Except for 7.42 acres of Desert Willow Shrubland, all of the non-invasive Type B potential habitat occurs in Lincoln County. Invasive vegetation types dominate the composition of Type B potential habitat in Lincoln County (73.9%), occurring on a total of 357.64 acres (Table 13). Invasive vegetation types support Type B potential habitat on 47 stands. Stand size ranges from approximately 0.3 acre to 75.2 acres, with an average stand size of 7.61 acres and a median of 1.58 acres.

Private Lands -Type B Potential Habitat

Type B potential habitat occurs on 181.86 acres of private lands in Lincoln County and is located on 14 separate private parcels, including land owned by the City of Caliente. Thirty-two (32) stands of Type B potential habitat occur on private lands are greater than 0.25 acre, the minimum patch size for SWWFC suitable habitat. Other stand fragments exist on private lands, but they are residual parts of stands occurring on adjacent public lands or private parcels. These stand fragments account for less than 1 acre, indicating that most stands of Type B potential habitat on private lands are of sufficient size to support SWWFC.

Non-invasive woody vegetation types that comprise Type B potential habitat occur on only 21.86 acres and are located on 7 different private parcels in Lincoln County. Non-invasive Type B habitat occurs in 10 stands greater than 0.25 acre, the minimum patch size for SWWFC suitable habitat. Smaller stands exist on private lands, but they are residual parts of stands occurring on adjacent public lands or other private parcels. These residual parts total less than 0.2 acre, indicating that most stands of Type B potential habitat on private lands are of sufficient size to support SWWFC.

Surface water or saturated soils, a necessary component of SWWFC suitable habitat, occur on 7 of the 10 stands (12.51 ac) of non-invasive Type B potential habitat on private lands in Lincoln County. These 7 stands are located on 4 different private parcels, including land owned by the City of Caliente (approximately 6.2 ac). Five (5) of the 7 stands (6.81 ac) were identified as having stressors. Most of the stressed habitat occurred within the City of Caliente where land development and the channelized stream threaten these stands and their potential development as SWWFC suitable habitat. One (1) substantial stand of Desert Willow Shrubland in the vicinity of Kyle was noted as having a water diversion occurring on, or adjacent to, the stand. This water diversion could affect SWWFC suitable habitat.

Most (87.8%) of the Type B potential habitat on private land in Lincoln County is composed of invasive woody vegetation types that occur on 160 acres. Invasive Type B potential habitat occurs on 10 different private parcels in Lincoln County. Invasive Type B habitat occurs in 22 stands greater than 0.25 acre, the minimum patch size for SWWFC suitable habitat. Smaller stands exist on private lands, but they are residual parts of stands occurring on adjacent public lands or other private parcels. These residual parts total less than 0.4 acre, indicating that most stands of invasive Type B potential habitat on private lands are of sufficient size to support SWWFC.

On Lincoln County private lands the vast majority of the invasive Type B potential habitat are dominated by tamarisk, of which 112.97 acres are in stands that have been previously burned or treated. These stands are now showing a regeneration of tamarisk in the understory with structure and density approaching that necessary for SWWFC suitable habitat. Because tamarisk is generally better able to survive drought, salinity stress, and rapid water table declines, lack of surface water has not precluded development of the vegetation structure and increasing density that has the potential to develop into SWWFC habitat. Surface water or saturated soils were observed within only 8 stands of the invasive vegetation types comprising Type B potential habitat (45.23 total ac).

Other than the lack of surface water at 14 of the invasive Type B potential habitat on private lands and the evidence of fire within Tamarisk Woodland stands, grazing was the only stressor observed. Grazing occurred within 1 large stand (75.19 ac) of Burnt or Dead Tamarisk Woodland north of Carp.

Public Lands -Type B Potential Habitat

Public lands support the majority (62.4%) of Type B potential habitat in Lincoln County (302.24 total ac). As with the private lands in Lincoln County, invasive vegetation types comprise the majority of Type B potential habitat on public lands, accounting for 65.4 percent of the Type B potential habitat (197.64 total ac) (Table 13).

Non-invasive woody vegetation types that comprise Type B potential habitat occur on 104.60 acres of public land in Lincoln County. Non-invasive Type B potential habitat occurs in 27 stands that range in size from approximately 0.3 acre to 16.8 acres. Almost all of the non-invasive Type B potential habitat occurs in Rainbow Canyon or in the general vicinity of Kyle.

Rainbow Canyon contains 51.31 acres (49.1%) of the non-invasive Type B potential habitat on public land in Lincoln County. This non-invasive Type B potential habitat occurs in 12 stands ranging in size from approximately 2.0 acre to 17.5 acres. Surface water occurs within each of these 12 stands, and they all have well-developed canopies and diverse understories. Stressors were noted in 9 of these stands (46.64 total ac). Stream channelization was the most common stressor, occurring adjacent to 6 stands of non-invasive Type B potential habitat. Land development was observed on 4 stands, and grazing was identified as a stressor on 3 stands. A combination of these stressors exists on 4 stands.

The area from approximately 2 miles upstream of Kyle to about 3 miles below Kyle contains most (50.5%) of the remaining acreage (52.83 ac or 49.1%) of the non-invasive Type B potential habitat on public land in Lincoln County. In this area non-invasive Type B potential habitat occurs in 14 stands ranging in size from approximately 0.5 acre to 16.7 acres. Surface water occurs within, or adjacent to, 10 of these stands. This is consistent with information obtained during oral history interviews (see Appendix C), where this area was noted as a historic "water zone" that began north of Kyle and extended south toward Leith. Stressors were noted in 6 of the 10 stands where water was present. Grazing (4 stands) and stream channelization/downcutting (3 stands) were the most common stressors, occurring together on 3 stands. Other stressors include land development (1 stand), fire (1 stand), and OHV use (1 stand). The only stressor that did to not occur in conjunction with other stressors was OHV use. Other than the lack of surface water, the only stressor recorded on any of the remaining 4 stands of non-invasive Type B potential habitat in the vicinity of Kyle was a water diversion adjacent to a 0.9-acre stand of Desert Willow Shrubland. This stand is part of a larger stand (totaling 9.79 ac) that occurs primarily on private land.

Most (65.4% or 197.64 ac) of the Type B potential habitat on public land in Lincoln County is composed of invasive woody vegetation types. This invasive Type B potential habitat occurs on 35 stands ranging in size from approximately 0.3 acre to 46.2 acres. One smaller stand (0.1 ac) was delineated, but this stand is a residual part of an adjacent stand of Burnt or Dead Tamarisk Woodland occurring on an adjacent private parcel.

Type B potential habitat that is composed of invasive vegetation types occurs throughout Lincoln County; however, this habitat is most concentrated in the area between Lyman Crossing and just below Carp, where approximately 69.1 percent of the invasive Type B is found (136.57 total ac). In this area Tamarisk Woodland (13 stands) comprises 60.24 acres, ranging in size from 0.3 acre to 46.2 acres. Burnt or Dead Tamarisk Woodland (10 stands) comprises 76.33 acres, ranging in size from 0.4 acre to 26.5 acres. The stands of Burnt or Dead Tamarisk Woodland are now showing a regeneration of tamarisk in the understory with structure and density approaching that necessary for SWWFC suitable habitat.

Surface water within Meadow Valley Wash was observed in this general area of Carp. This is consistent with remembered historic conditions (see Appendix C) where creek water was recalled to rise to the surface. Surface water was observed within Meadow Valley Wash within or adjacent to 11 of the 23 stands of invasive Type B potential habitat in the vicinity of Carp. Standing surface water was noted in 2 additional stands. As expected, the most frequently observed stressor within

the Type B potential habitat in the vicinity of Carp is fire. Fire affected 11 stands, 6 of which had water present. Grazing was recorded on 5 stands, 4 of which had water present. These 2 stressors were observed in conjunction on only 2 stands of Tamarisk Woodland.

Invasive Type B potential habitat exists on 12 additional stands (61.07 total ac) of invasive woody riparian vegetation on public land throughout Lincoln County. These stands are primarily in the reach south of Carp running to the south of Vigo, although 3 small stands occur in Rainbow Canyon and 3 others are north of Rox. Stand sizes range from 0.3 acre to 29.5 acres.

Clark County

Clark County supports Type B potential habitat for SWWFC in about the same proportion as its overall proportion of the overall aerial coverage-about 21 percent. All most all (94.4% or 124.24 ac) of the Type B potential habitat in Clark County is composed of invasive woody riparian vegetation types (Table 13). Within Clark County Type B potential habitat was identified in 34 stands. Two of these stands are comprised of a non-invasive vegetation type (Desert Willow Shrubland) and total 7.42 acres. Sixteen (16) stands are Burnt or Dead Tamarisk Woodland (51.91 ac), and 16 stands are Tamarisk Woodland (72.33 ac). Stand sizes range from approximately 0.3 acre to 20.4 acres, with an average stand size of 3.87 acres and a median of 1.82 acres.

Private Lands -Type B Potential Habitat

Type B potential habitat occurs on 21.15 acres of private land in Clark County and is located on 15 separate private parcels. For the most part, the stands on these private parcels are portions of 5 larger stands occurring on adjacent public land or continuing through adjacent private parcels. When divided based on parcel ownership, 15 stands greater than 0.25 acre were delineated, the minimum patch size for SWWFC suitable habitat. Nine other stand fragments exist on private lands, but they are residual parts of stands occurring on adjacent public lands. These stand fragments account for less than 0.6 acre.

All of the Type B potential habitat on private land in Clark County is composed of invasive woody vegetation types. All of the Type B habitat is Tamarisk Woodland, except for 1 stand (1.62 ac) of Burnt or Dead Tamarisk Woodland. Surface water was present on 9 different private parcels that support Type B potential habitat (13.54 total ac). These parcels all occur near the Muddy River confluence where water flow is perennial. The stream channel within these 9 parcels was observed to be channelized and downcut. Channelization is considered a stressor within these stands of Type B potential habitat. Six (6) other private parcels supported Type B potential habitat, and did not have surface water present. These parcels were scattered throughout Clark County. Grazing was the only stressor recorded, occurring on 1 stand of Tamarisk Woodland immediately downstream of the Muddy River confluence and south of Interstate 15.

Public Lands -Type B Potential Habitat

Public lands support most (83.9% or 110.51 ac) of the Type B potential habitat in Clark County. Invasive vegetation types dominate the Type B potential habitat on public lands in Clark County, accounting for 93.3 percent (103.09 ac) of the Type B potential habitat (Table 13).

Non-invasive woody vegetation types that comprise Type B potential habitat occur on only 2 stands within the central portion of Clark County – 1 stand of 5.40 acres and another of 2.02 acres. Surface water was not identified within 125 feet of either stand. In addition to the lack of surface water, channelization was identified as a stressor on the larger stand of Desert Willow Shrubland.

Tamarisk Woodland (14 stands, 52.90 ac) and Burnt or Dead Tamarisk vegetation types (15 stands, 50.19 ac) comprise the invasive vegetation types that support Type B potential habitat on public lands in Clark County. The invasive Type B potential habitat occurs on stands ranging in size from approximately 3.0 to 24.4 acres. Although these invasive Type B potential habitat stands exist throughout the Clark County portion of the Study Area, they are more prevalent in the central and southern portions of the county. Surface water was identified as present on, or adjacent to, only 4 stands. These stands total 8.78 acres of Tamarisk Woodland vegetation and occur between Moapa and Glendale.

Stressors were observed in all but 2 stands (4.51 ac) of the invasive Type B potential habitat on public lands in Clark County. Grazing was identified on 8 different stands, generally within the central part of the Clark County portion of the Study Area. Another stressor, OHV use, was also recorded on 8 additional stands, most of which are in the vicinity of Moapa and Glendale. Stream channelization was noted as a stressor on 4 other stands of Type B potential habitat in the vicinity of Moapa and Glendale.

Potential Habitat-Type C

Type C potential habitat is comprised of woody riparian vegetation stands that have the patch size to support SWWFC territories and/or nesting. However, neither the canopy nor the interior vegetation density is sufficient to attract and maintain breeding birds. Surface water or saturated soils occur within the stand or within 125 feet of the stand. Ecological characteristics may preclude eventual development of the vegetation structure and density necessary to attract and maintain breeding SWWFC. Anthropogenic stressors could be affecting the development of vegetation components.

Type C potential habitat occurs only in Lincoln County on 60.74 acres (Table 10). Type C potential habitat is almost exclusively composed of non-invasive vegetation; only 1 small stand (0.29 ac) is composed of invasive vegetation (Tamarisk Woodland) (Table 15). The other 37 stands are composed of non-invasive vegetation types. Individual stand sizes are modestly sized, ranging from approximately 0.3 acre to 12.63 acres, with an average stand size of 1.60 acres and a median of 0.82 acre. Most of the Type C habitat is composed of Freemont Cottonwood Forest (20 stands, 35.40 ac), Red Willow Forest (9 stands, 11.21 ac), and Riparian Forest (3 stands, 7.97 ac) (Table 14). These forest vegetation types generally are mature and have open understories. Type C potential habitat occurs throughout most of the Lincoln County portion of the Study Area, from south of Caliente to Vigo. No Type C potential habitat occurs south of the general Vigo area, even though surface water was observed in the Rox area. Most (66.1%) of the Type C potential habitat is on public lands.

Table 15. Meadow Valley Wash southwestern willow flycatcher potential habitat (SWWFC) – Type C.

VEGETATION TYPE	PRIVATE LANDS		PUBLIC LANDS		TOTAL LANDS	
	TOTAL HABITAT (Acres)	STRESSED HABITAT (Acres)	TOTAL HABITAT (Acres)	STRESSED HABITAT (Acres)	TOTAL HABITAT (Acres)	STRESSED HABITAT (Acres)
LINCOLN COUNTY						
Desert Willow Shrubland	0.00	0.00	2.62	2.25	2.62	2.25
Freemont Cottonwood Forest	14.56	13.24	20.84	13.47	35.40	26.79
Red Willow Forest	3.16	3.16	8.05	8.05	11.21	11.21
Riparian Forest	2.60	2.60	5.38	4.69	7.98	7.29
Seep Willow Shrubland	0.27	0.27	2.97	0.37	3.24	0.64
Tamarisk Woodland	0.00	0.00	0.29	0.29	0.29	0.29
Subtotal	***20.59***	***19.27***	***40.15***	***29.12***	***60.74***	***48.39***
CLARK COUNTY						
None.						
TOTAL STUDY AREA						
Desert Willow Shrubland	0.00	0.00	2.62	2.25	2.62	2.25
Freemont Cottonwood Forest	14.56	13.24	20.84	13.47	35.40	26.79
Red Willow Forest	3.16	3.16	8.05	8.05	11.21	11.21
Riparian Forest	2.60	2.60	5.38	4.69	7.98	7.29
Seep Willow Shrubland	0.27	0.27	2.97	0.37	3.24	0.64
Tamarisk Woodland	0.00	0.00	0.29	0.29	0.29	0.29
TOTALS	**20.59**	**19.27**	**40.15**	**29.12**	**60.74**	**48.39**

Private Lands-Type C Potential Habitat

Type C potential habitat occurs on only 20.59 acres of private lands comprised of 7 separate private parcels, including the land owned by the City of Caliente. All of the Type C potential habitat is composed of non-invasive vegetation types. The Type C potential habitat occurs on 12 stands within these 7 parcels. These 12 stands are each greater than 0.25 acre, the minimum patch size for SWWFC suitable habitat. Other stand fragments exist on private lands, but they are residual parts of stands occurring on adjacent public lands or adjacent private parcels. These stand fragments account for about 0.1 acre, indicating that most stands of Type C potential habitat on private lands are of sufficient size to support SWWFC. Stand sizes range from approximately 0.5 acre to 4.0 acres.

Most of the Type C potential habitat on private lands occurs immediately north of Kyle in one complex of Freemont Cottonwood Forest that comprises 11.54 acres and is connected on 3 private

parcels by Type C potential habitat on adjacent public lands. In the vicinity of Caliente, 4 stands of forest vegetation types provide Type C potential habitat on 7.84 acres.

Stressors were identified on 5 of the 7 private parcels, 3 of which were observed with more than one type of stressor. Grazing was noted on 6 stands of Type C potential habitat occurring on 4 parcels of private lands, including land in the City of Caliente. Land development activities were observed on 3 private parcels, and OHV use was identified on 2 private parcels. Stressors that may affect hydrologic connectivity (stream channelization, downcutting, and water diversions) were observed only on City of Caliente land.

Public Lands-Type C Potential Habitat

Public lands support the majority (66.1% or 40.15 ac) of the Type C potential habitat, which occurs on 31 stands. Of the Type C potential habitat on public lands, non-invasive vegetation types comprise all but 1 stand (0.29 ac), which is a Tamarisk Woodland composed of a tall tamarisk overstory.

Non-invasive woody vegetation types that comprise Type C potential habitat occur on 39.86 acres of public land in Lincoln County. Non-invasive Type C habitat occurs in 30 stands that range in size from approximately 0.4 acre to 5.0 acres. Most (70.3%) of the non-invasive Type C potential habitat occurs in Rainbow Canyon. Smaller, scattered stands occur primarily in the general vicinity of Kyle.

Rainbow Canyon contains 28.04 acres of the Type C potential habitat occurring on public lands. These 28.04 acres occur on 20 stands ranging in size from approximately 0.4 acre to 4.5 acres. Stressors were noted on 16 of these stands (21.64 ac). Grazing was the most common stressor observed, occurring on 15 of these stands (16.95 ac). Hydrologic modifications (stream channelization, downcutting, or water diversions) were identified on, or adjacent to, 10 stands (15.42 ac). Nine (9) of these hydrologically modified stands were also grazed. Land development was observed on 3 stands, and OHV use was identified on 2 stands. Land development and OHV use occurred in conjunction with grazing and/or hydrologic modification.

Type C potential habitat comprises 11 stands throughout the remaining part of Lincoln County (12.09 ac). Six (6) of these stands are composed of forest vegetation types. The others are composed of Desert Willow Shrubland (2 stands), Seep Willow Shrubland (2 stands), and Tamarisk Woodland (1 stand). Stressors were identified on 7 of these 11 stands (7.46 ac). Hydrologic modifications were identified as stressors on 3 stands. Grazing , OHV use, and land development were noted on 2 stands each, while recent fire was noted in one small stand of Seep Willow Shrubland. On 2 stands OHV use occurred in conjunction with other stressors.

Documented Historic Observations of SWWFC

A review of available documentation identified 6 confirmed observations of the SWWFC within the Study Area. Additionally, 12 other observations at census points did not record the species as present at those sites. Seventeen (17) of the 18 observations were made during point surveys

conducted from1998 through 2001 by the San Bernadino County Museum under contract with the U.S. Bureau of Reclamation. One additional record was obtained as part of the BLM study conducted by USR Corporation (USR 2001). This record of SWWFC presence was not dated and is only documented as historic. The records varied in precision of location from latitude-longitude seconds to latitude-longitude minutes. However, the precision was enough to generally locate the area of observation.

The other 5 documented observations of SWWFC occurred in Rainbow Canyon. All of the confirmed observations occurred within or adjacent to SWWFC suitable habitat or Type B potential habitat.

The first confirmed observation was made in 1999 on city-owned land immediately north of Highway 93. The sighting occurred in or adjacent to delineated Type B potential SWWFC habitat. SWWFC suitable habitat is located less than 0.5 mile south of the observation location. The record indicated that the bird was a migrant.

Two confirmed observations were made in the same approximate location in 1998 and 1999, approximately 7.3 miles south of Caliente and 1.2 miles north of Stine. The sightings occurred close to a Riparian Forest vegetation type (5.41 ac) that was delineated as Type B potential habitat. The vegetation description in the record is similar to the vegetation description for this stand of Riparian Forest. A stand of Freemont Cottonwood Forest (4.91 ac) delineated as SWWFC suitable habitat is located approximately 0.5 mile south of the location of 2 observations.

Another discrete, confirmed occurrence was documented at Stine in 1998. This observation occurred within a complex of SWWFC suitable habitat (19.64 total ac) composed of 3 stands of Freemont Cottonwood Forest and 1 stand of Riparian Forest. The observed bird was described as actively nesting.

The fifth documented observation occurred between Stine and Boyd. The observation was made in 1998, and the documentation described the sighting as "historical nesting." This sighting occurred within a large stand of Riparian Forest (29.88 ac) delineated as SWWFC suitable habitat. No positive sightings occurred at 4 other census points (1998-2001) within approximately the same location with no positive sightings.

Additionally, 11 separate driving/pedestrian transects were surveyed throughout the Study Area by the Nevada Division of Wildlife (NDOW) and by The Nature Conservancy (TNC). Three (3) transects were surveyed by NDOW between the years 2000 and 2002. Eight (8) transects were surveyed by TNC between the years 2000 and 2002. Because these transects were long and linear, sightings could not be definitively located. Only NDOW had a confirmed observation, which occurred on the linear transects. This sighting occurred between May and August 2002. The general location of this sighting was near the Lincoln-Clark County line, most likely in an 18-acre complex of Riparian Forest/Tamarisk Woodland Mix that has been delineated as SWWFC suitable habitat. It is interesting to note that the transect on which this observation occurred is adjacent the location of the historic sighting (URS 2001).

Other Covered Species

Several additional species of concern are known to occur along the Meadow Valley Wash. Some of these species are covered under the Clark County's MSHCP and permit, which include provisions for implementing conservation actions that will benefit these species. Additionally, as part of Lincoln County's habitat conservation planning process, effects to these species of concern must be considered to ensure that potential impacts resulting from proposed planning and permitting actions are understood and addressed. This section presents existing data on occurrence and habitat for these species within the Study Area.

Table 16 presents a summary of identified habitat within the Study Area for these covered species.

Table 16. Other covered species habitat in Meadow Valley Wash.

SPECIES	LINCOLN COUNTY			CLARK COUNTY			TOTAL STUDY AREA		
	Private Acres	Public Acres	Total Acres	Private Acres	Public Acres	Total Acres	Private Acres	Public Acres	Total Acres
AVIAN SPECIES									
Yellow-billed cuckoo	46.15	206.50	**252.65**	0.00	0.00	**0.00**	46.15	206.50	**252.65**
Summer tanager	69.14	231.21	**300.35**	22.74	43.81	**66.55**	91.88	275.02	**366.90**
Bell's vireo	196.66	379.45	**576.11**	35.40	102.13	**137.53**	232.06	481.58	**713.64**
Lucy's warbler	12.83	64.20	**77.03**	0.77	3.14	**3.91**	13.60	67.34	**80.94**
Blue grosbeak	22.01	59.69	**81.70**	5.72	20.08	**25.80**	27.73	79.77	**107.50**
Phainopepla	6.36	22.64	**29.00**	60.28	46.11	**106.39**	66.64	68.75	**135.39**
AMPHIBIAN SPECIES									
Southwestern toad	206.19	751.99	**958.18**	54.29	105.83	**160.12**	260.48	857.82	**1,118.30**

Yellow-Billed Cuckoo

Liberty was taken in delineating yellow-billed cuckoo habitat, as none of the complexes actually provide the habitat-size requirements for this species. However, because yellow-billed cuckoo habitat is so limited in the region, it was considered important to delineate habitat that could marginally support this species.

Yellow-billed cuckoo habitat was delineated only in Lincoln County on 252.65 acres (Table 16). Because of the large patch size requirement for this species, habitat was limited to 3 complexes of forest vegetation types made up of separate patches. Two of the defined yellow-billed cuckoo habitats are located in Rainbow Canyon.

The first complex that comprises yellow-billed cuckoo habitat is near Stine. This complex is comprised of a total of 68.31 acres. The complex varies in width; most of the complex is wider than 350 feet, although it narrows to less than 100 feet in a connecting stand of Freemont Cottonwood Forest. The complex is well developed and could potentially support yellow-billed cuckoo. The complex is dominated by well-developed Riparian Forest vegetation type (53.60 ac) and Freemont Cottonwood (14.71 ac). In general, the complex has a diverse understory of non-invasive vegetation including Freemont cottonwood, coyote willow, red willow, and velvet ash. Tamarisk was identified as an exotic within the understory on about 0.8 acre. This complex has also been delineated as SWWFC suitable habitat.

The second complex that comprises yellow-billed cuckoo habitat is south of Boyd in Rainbow Canyon and totals 75.35 acres. While narrower than the first complex, this complex does have large portions that exceed 300 feet in width and ranges up to more than 600 feet in width. The complex narrows to the south, where long stretches may only be about 200 feet wide. Because this complex has a well-developed canopy and diverse understory, it is believed to provide potential habitat for yellow-billed cuckoo, especially since desert riparian systems are limited. The complex is dominated by well-developed Riparian Forest (73.00 ac) and Freemont Cottonwood Forest (2.35 ac). The 3 stands of Freemont Cottonwood Forest do not have a diverse understory, but these stands comprise little of the complex. The Riparian Forest, on the other hand, has a diverse understory dominated by Freemont cottonwood, coyote willow, and red willow. Approximately 66.2 percent of this complex has also been delineated as SWWFC suitable habitat, primarily over the northern half of the linear complex.

The third complex that comprises yellow-billed cuckoo habitat is north of Rox near the south end of Lincoln County (109.00 ac). This complex is more robust than the other 2 complexes and better represents typical yellow-billed cuckoo patch-size requirements. The complex is approximately 10,000 feet long and ranges from about 650 to 1,100 feet wide over the northern portion of the complex, although the southern 4,000 feet narrow to about 200 feet wide. As stated, the complex is dominated by well-developed Riparian Forest/Tamarisk Woodland Mix (107.67 ac). The canopy of the complex is dominated by tamarisk and Freemont cottonwood, and has a diverse understory dominated by tamarisk, mesquite, red willow, and velvet ash (*Fraxinus velutina*). The entire complex has also been delineated as SWWFC suitable habitat.

The review of file material and historic documents revealed two positive sightings of the yellow-billed cuckoo in the Study Area. Both observations were made during NDOW surveys conducted during July 2001 and June 2002. The observation in July 2001 was made during a driving/call survey in Rainbow Canyon. The observation occurred approximately 0.5 miles north of Elgin near the mouth of Rainbow Canyon. The call response indicated that the bird could have been territorial. The observation was made in a Riparian Forest dominated by Freemont cottonwood and red willow

with a dense understory of coyote willow, red willow and cottonwood. However, this stand is only about 8 acres in size and not considered suitable yellow-billed cuckoo habitat. The observation occurred approximately 1 mile south of the delineated suitable habitat south of Boyd. The second observation occurred in the northern portion of the delineated suitable habitat north of Rox. This record included a call and response from two birds as well as a visual sighting of one bird flying to the call area. The observation indicated a possible mated pair. The pair was observed within habitat determined to be the most suitable habitat delineated within the Study Area.

Bell's Vireo

Bell's vireo habitat requirements are similar to those of SWWFC, and as such all SWWFC suitable habitat was delineated as Bell's vireo habitat (713.65 ac) (Table 16). The discussion for distribution of SWWFC suitable habitat is, therefore, relevant to Bell's vireo.

A review of available documentation identified 20 confirmed observations of Bell's vireo at discrete points within the Study Area. Nineteen (19) of these observations were conducted as part of a BLM in-house study by URS Corporation, and a hard copy map of these sightings was used to determine the location of those sightings for this Study. The other observation was made by the San Bernadino County Museum while under contract with the U.S. Bureau of Reclamation and was recorded using UTM coordinates. The record was precise enough to generally determine the recorded location of the observation.

The observations recorded by URS Corporation were local in scope and covered the general area of southern Lincoln County and northern Clark County. These observations were documented in 2001 and occurred in an approximate 2.5-mile reach of Meadow Valley Wash, from just south of the Lincoln-Clark County line north to about Rox. This area consists of a wide floodplain with a large complex of Tamarisk Woodland (34.55 ac) and Riparian Forest/Tamarisk Woodland Mix (21.29 ac). The observation recorded by the San Bernadino County Museum was made in 1998, approximately 1.2 miles north of Elgin near the mouth of Rainbow Canyon. The point of this observation was mapped 2,000 feet of delineated habitat for the species, based on the UTM coordinates. However, the description of the location indicates that the observation occurred further to the north within the delineated habitat. The habitat description accompanying the observation matches the understory and patch form (linear) of the delineated habitat.

Additionally, 11 separate driving/pedestrian transects were surveyed throughout the Study Area by NDOW and TNC. Three (3) transects were run by NDOW between 2000 and 2002. Eight (8) transects were conducted by TNC between 2000 and 2002. Because these transects were long and linear, sightings could not be definitively located. Seven (7) Bell's vireo observations occurred on 7 of these linear transects.

In July 2001 NDOW sighted a Bell's vireo along the longest transect, which ran through Rainbow Canyon. As previously described for the SWWFC, Rainbow Canyon supports the majority of non-invasive SWWFC suitable habitat (181.64 ac) and, as such, is conducive to Bell's vireo.

One observation occurred on a transect north of Carp, where habitat comprised primarily of Tamarisk Woodland was delineated at the north end. Another observation occurred on a transect near Vigo where a large complex of invasive and non-invasive vegetation types comprise habitat for the species. Both observations occurred between May and June 2002.

One observation was made on a transect immediately north of Rox, and the remaining three observations occurred in a 2-mile area from immediately south of the Lincoln-Clark County line to the north into Lincoln County. These 3 observations occurred on 3 transects that overlapped geographically, and all observations occurred in May-June of 2000 or 2002. Again, all of these transects ran through, or adjacent to, delineated habitat for the species. The narrative descriptions of these site occurrences match the delineated habitat descriptions.

Bell's vireo were not seen during census conducted over 3 consecutive years along a 7.5-mile transect north of Moapa. This transect bisected one large habitat patch for Bell's vireo. This was a stand of Tamarisk Woodland in the middle of the transect line.

Blue Grosbeak

Blue grosbeak habitat was delineated for 107.50 acres of the Study Area. The distribution of available habitat between the Counties is approximately proportionate to the distribution of overall aerial ground cover between the Counties. Table 16 presents the distribution of this habitat by counties and land ownership.

A review of available documentation did not reveal any confirmed sightings of this species at discrete census points within the Study Area. However, 7 individuals were observed on 5 transects surveyed between May 2000 and June 2002. These transects are the same as those described above for Bell's vireo.

The longest transect was surveyed by NDOW in July 2001 and ran through Rainbow Canyon. Habitat for blue grosbeak within Rainbow Canyon is limited to smaller patches or complexes ranging in size from approximately 0.6 acre to 6.2 acres and occurs sporadically throughout the canyon. The largest complex (6.2 acres) of Freemont Cottonwood Forest occurs near Stine.

Patches of discrete habitat or habitat complexes occur from Elgin downstream toward Leith. Blue grosbeak was observed on one transect north of Carp. Although Tamarisk Woodland was delineated at the north end of the transect and occurs throughout this, transect it was not delineated as blue grosbeak habitat. Only 1 small stand (0.64 ac) of habitat was identified near the south end of this transect in Seep Willow Shrubland. A blue grosbeak observation was made on a transect near Vigo. However, no habitat for this species was identified near the transect. The notes indicate that the species was observed in dense Riparian Forest/Tamarisk Woodland Mix. For this Study, this complex was considered too dense for delineation as habitat. A blue grosbeak was observed on a transect immediately north of Rox, and three observations of blue grosbeak occurred on overlapping transects in a 2-mile area from immediately south of the Lincoln-Clark County line to the north into Lincoln County. These 3 transects overlapped geographically, and all observations occurred in

May-June 2000 and 2002. Only 1 small stand of habitat considered suitable for blue grosbeak was delineated within the area of these 3 transects.

No blue grosbeak sightings were recorded during surveys on 4 other surveys. Three (3) of these surveys were conducted over consecutive years along the same transect north of Moapa over consecutive years. Approximately 7.0 acres of Desert Willow were defined as blue grosbeak habitat at the northern end of this transect. No habitat was noted along the other transect, which was located south of Elgin.

Summer Tanager

Summer tanager habitat was delineated for 366.90 acres of the Study Area. The distribution of available habitat between the Counties is approximately proportionate to the distribution of overall aerial ground cover between the Counties. Table 16 presents the distribution of this habitat by county and land ownership.

Rainbow Canyon supports approximately 35.9 percent (107.68 ac) of the summer tanager habitat in Lincoln County. One other area of non-invasive vegetation types that comprise summer tanager habitat occurs between Elgin and Kyle. Other habitat blocks are primarily comprised of invasive vegetation types (Tamarisk Woodland or Riparian Forest/Tamarisk Woodland Mix). Complexes of these vegetation types, which form larger patches of summer tanager habitat, exist south of Carp, in the Vigo area, and in the open floodplains north and south of Rox. In Clark County there are 2 linear strings of habitat: 1 in the northern portion of Clark County, comprised of Desert Willow Shrubland and Tamarisk Woodland, and one comprised of Tamarisk Woodland about 1.5 miles north of Glendale.

A review of available documentation identified 4 confirmed observations of summer tanager at discrete points within the Study Area. Three (3) of these observations were made as part of NDOW censuses in 1996, 1998, and 2001, and one (1) observation was made by the San Bernadino County Museum while under contract with the U.S. Bureau of Reclamation.

Two (2) of the observations occurred in Rainbow Canyon, the third occurred at the Lincoln County boundary, and the fourth occurred about 1.5 miles north of Glendale at the southern end of the Study Area.

The 2 Rainbow Canyon observations were in the southern half of the canyon: 1 observation was made approximately 2 miles south of Stine in 2001, the other observation was made in 1998 about 3.5 miles north of Elgin. The observation south of Stine occurred in close proximity to a complex of delineated summer tanager habitat comprised of approximately 5 acres of Freemont Cottonwood Forest. The observation north of Elgin occurred in a large stand of Riparian Forest that was delineated as summer tanager habitat.

The other 2 observations were made in the southern half of the Study Area. One observation, documented in 2001, was immediately north of the Lincoln-Clark County line. No summer tanager

habitat was delineated in this immediate area; however, the sighting occurred in Riparian Forest. The vegetation composition and structure of this patch appeared to meet summer tanager requirements, but the understory was considered too dense for suitable habitat. The observation occurring furthest south, near Glendale, was made in 1996. Tamarisk Woodland considered summer tanager habitat occurs over approximately 1.3 miles of Meadow Valley Wash about 1,000 feet from the mapped location of this sighting. Because of the precision used to record and locate sightings, it is likely that the bird was observed in the Tamarisk Woodland of the floodplain.

Additionally, 11 separate driving/pedestrian censuses were conducted throughout the Study Area by NDOW and TNC. Three (3) transects were surveyed by NDOW between the years 2000 and 2002. Eight (8) transects were surveyed by TNC between 2000 and 2002. Because these transects were long and linear, sightings could not be definitively located. Five (5) summer tanager observations occurred on 4 of these linear transects between 2001 and 2002.

The longest transect with a summer tanager sighting was surveyed by NDOW in July 2001 and ran through Rainbow Canyon. As previously described, Rainbow Canyon supports a substantial portion of the available habitat (107.68 ac) for this species in the Study Area.

One observation occurred in 2002 on a transect north of Vigo where a small stand of Freemont Cottonwood Forest was delineated as habitat for the species. In addition, there is a large complex of invasive and non-invasive vegetation types along the transect. The understory of this complex was too dense to be defined as summer tanager habitat, but it is likely that sufficient open areas exist to provide habitat.

The other 2 transects where sightings of summer tanager occurred were near Rox: 1 transect was immediately north of Rox and the other transect ran south of Rox to just below the Lincoln-Clark County line. The observation on the transect north of Rox was made in May-June 2002. Summer tanager habitat was delineated on approximately 5.5 acres of Tamarisk Woodland at the north end of this transect. In addition, there is an extensive complex of Riparian Forest/Tamarisk Woodland Mix and Tamarisk Woodland along this transect. These vegetation types were not defined as summer tanager habitat because of the general density of the understory. However, it is likely that sufficient open areas of the understory exist to provide additional habitat. The observation on the transect south of Rox occurred in May-June 2000. Summer tanager habitat was delineated on approximately 3.9 acres of Riparian Forest/Tamarisk Woodland Mix and Tamarisk Woodland in 2 separate stands dispersed over this transect. In addition, there is an extensive linear complex of Riparian Forest/Tamarisk Woodland Mix and Tamarisk Woodland (about 42.5 ac) along this transect. These vegetation types were not defined as summer tanager habitat because of the general density of the understory. However, it is likely that sufficient open areas of the understory exist to provide additional habitat.

One (1) transect was surveyed 3 times within Clark County that traversed habitat for summer tanager. These surveys were conducted on the same alignment, approximately 7.5 miles from Moapa north along Meadow Valley Wash, and surveyed during December 2000, 2001, and 2002. Approximately 20.4 acres of Tamarisk Woodland habitat occurs at the south end of this transect, and

about 13.6 acres of Desert Willow Shrubland and Tamarisk Woodland occur at the north end of the transect. Timing of the surveys may have precluded breeding bird observation. Habitat for summer tanager was only noted along transects where observations of this species occurred.

Phainopepla

Phainopepla habitat was delineated for 135.39 acres within the Study Area. Most (78.6%) of the phainopepla habitat occurs in Clark County where mesquite supports the parasitic desert mistletoe. Only 3.91 acres of phainopepla habitat occur in Lincoln County. Table 16 presents the distribution of this habitat by county and land ownership.

In Lincoln County phainopepla habitat occurs in 2 areas: a long, linear stand of Riparian Forest/Tamarisk Woodland Mix in the vicinity of Kyle (5.21 ac) and scattered stands from about Rox to the Lincoln-Clark County line. These scattered stands were Mesquite Shrubland, Tamarisk Woodland, and Riparian Forest/Tamarisk Woodland Mix, although individual mesquite with desert mistletoe were identified in one stand of Mixed Desert Shrub and a Knapweed Meadow.

In Clark County habitat for phainopepla occurred throughout Meadow Valley Wash, although the largest concentration (65.74 ac) occurred near Glendale and Moapa. This concentration was composed primarily of Tamarisk Woodland and Mesquite Shrubland. The other stands of phainopepla habitat located throughout Clark County were primarily Desert Willow Shrubland, Mesquite Shrubland, Tamarisk Woodland, or Burnt or Dead Tamarisk Woodland.

A review of available documentation identified only 2 confirmed observations of phainopepla at discrete observation points within the Study Area. Both observations, documented by NDOW in 1996, occurred between 1.5 and 2.0 miles north of Glendale. These locations were recorded in latitude-longitude minutes, placing the sightings approximately 1,500 feet outside of the Study Area. However, the accuracy of the records was limited; these sightings could have occurred within the Meadow Valley Wash riparian zone. Two (2) stands of delineated phainopepla habitat occur in the Meadow Valley Wash riparian zone in this locale, and extensive habitat occurs to the south. Because habitat no description was included with the documentation, the relation of these sightings to this habitat cannot be determined.

Additionally, 10 separate driving/pedestrian transects were surveyed throughout the Study Area by NDOW and TNC. Three (3) transects were surveyed by NDOW between the years 2000 and 2002. Seven (7) transects were surveyed by TNC between the years 2000 and 2002. Because these transects were long and linear, sightings could not be definitively located. Eight (8) phainopepla observations were recorded on these linear transects between 2000 and 2002.

As with the other species, the longest transect with a phainopepla observation was surveyed by NDOW in July 2001 and ran through Rainbow Canyon. No phainopepla habitat was identified in Rainbow Canyon as part of this Study.

One observation occurred along a transect immediately north of Rox in May-June 2002. Three stands (2.88 ac) of habitat were delineated along this transect. In addition, there is an extensive complex of Riparian Forest/Tamarisk Woodland Mix and Tamarisk Woodland along this transect, which has some mesquite that could support the desert mistletoe that is the requisite component of phainopepla habitat.

Three (3) transects were run from just south of the Lincoln-Clark County line to about 2 miles south of Rox. Two of these transects continued north for another mile. These 2 transects were on the same alignment but were surveyed at different times, 1 transect in May-June 2000 and 2 transects in May-June 2002. Phainopepla observations occurred on each transect. These transects traversed or ran in close proximity to 3 individual stands of delineated phainopepla habitat that totaled 20.90 acres.

Three (3) transects were surveyed on the same transect for about 7.5 miles from Moapa north along Meadow Valley Wash in Clark County. Observations of phainopepla were made during each survey in December 2000, 2001, and 2002. These transects traversed approximately 13.2 acres of the phainopepla habitat delineated in Clark County, and the transects were in close proximity to a large block of habitat (65.74 ac) at the south end of the Study Area. Observations are congruent with available winter habitat and species presence between September or October and May.

Two (2) of the linear transects were surveyed without phainopepla observations. One transect was near Vigo, the other was immediately north of Carp. No defined phainopepla habitat was identified near either of these transects.

Lucy's Warbler

Within the Study Area only 80.94 acres were delineated as Lucy's warbler habitat. It is likely that other stands of mature Riparian Forest and older mesquite stands have snags and cavities available for Lucy's warbler nesting, but the scope of the Study did not permit a detailed evaluation of each stand for these parameters. Almost all (95.1%) of the Lucy's warbler habitat was delineated in Lincoln County. Only 3.91 acres occur in Clark County. Table 16 presents the distribution of this habitat by county and land ownership.

Habitat for Lucy's warbler was primarily delineated in 3 areas, all within the northern half of Lincoln County. Rainbow Canyon supports 33.33 acres (43.3%) of the habitat in Lincoln County. The habitat generally occurs in small stands distributed throughout the canyon and consists of mature Riparian Forest types. A concentration of Freemont Cottonwood Forest (21.42 ac) that was delineated as Lucy's warbler habitat exists above Kyle, and another concentration of primarily Freemont Cottonwood Forest with some Desert Willow Shrubland exists below Kyle (17.31 ac). Several other, smaller stands are spread through the remaining portion of the county.

A review of available documentation identified only 1 confirmed observation of Lucy's warbler within the Study Area. This observation was documented as part of an internal BLM study by URS Corporation. The sighting is only recorded as "historic." The sighting occurred immediately north

of the Lincoln-Clark County line, and a hard copy map of this sighting was used to determine the location point for the Study. No Lucy's warbler habitat was delineated in the vicinity of this record. However, an extensive linear complex of Riparian Forest/Tamarisk Woodland Mix and Tamarisk Woodland (about 42.5 ac) occurs in the general area, and it is possible that cavities and snags occur within these stands.

Additionally, 10 separate driving/pedestrian transects were conducted throughout the Study Area by NDOW and TNC. Three (3) transects were run by NDOW between the years 2000 and 2002. Seven (7) transects were conducted by TNC between the years 2000 and 2002. Because these transects were long and linear, sightings could not be definitively located. Seven (7) summer tanager observations were recorded on 4 of these linear transects between 2000 and 2002.

As with the other species, the longest transect with a Lucy's warbler observation was surveyed by NDOW in July 2001 and ran through Rainbow Canyon. As previously described, Rainbow Canyon supports a substantial portion of the available habitat (33.33 ac) for this species in the Study Area.

One observation (May-June 2002) occurred on a transect north of Carp. No delineated habitat was identified along this transect, although substantial stands of Tamarisk Woodland do occur.

One observation (May-June 2002) occurred along a transect near Vigo where a small stand of Freemont Cottonwood Forest was delineated as Lucy's warbler habitat. In addition, there is a large complex of invasive and non-invasive vegetation types along the transect that could contain snags or cavities to support breeding Lucy's warbler.

Another observation occurred along a transect immediately north of Rox in May-June 2002. No habitat for the species was delineated along this transect; however, there is an extensive complex of Riparian Forest/Tamarisk Woodland Mix and Tamarisk Woodland along this transect that could have the necessary snags or cavities to support breeding Lucy's warbler.

Three (3) transects were run north, from just south of the Lincoln-Clark County line to about 2 miles south of Rox. Two of these transects continued north for another mile. The transects were on the same alignment, but surveyed at different times: 1 transect in May-June 2000 and 2 transects in May-June 2002. Lucy's warbler was observed on each transect, but no delineated habitat was traversed by these transects.

Three (3) transects were run on the same 7.5-mile alignment from Moapa north along Meadow Valley Wash in Clark County. No observations of this species were recorded. These surveys were conducted during December 2000, 2001, and 2002. This transects traversed or was proximal to 2 stands of Lucy's warbler habitat, a Desert Willow Shrubland (2.02 ac), and a Mesquite Shrubland (1.12 ac). One stand of habitat occurs near the north end of the transect, the other near the south end. Approximately 20.4 acres of Tamarisk Woodland habitat occurs at the south end of this transect, and about 13.6 acres of Desert Willow Shrubland and Tamarisk Woodland occur at the north end of the transect. Timing of the surveys may have precluded observation of breeding birds in these habitats.

Arizona Southwestern Toad

Extensive areas of potential Arizona southwestern toad habitat were defined in the Study Area. Habitat was based on the availability of standing water and includes all vegetation polygons where still water was observed. Thus, defined vegetation types indicative of still water are appropriate habitat and include Open Water, Bulrush Marsh, Cattail Marsh, Mixed Marsh, and Water Cress/Duck Weed Marsh. In addition, if still surface water was recorded within a woody riparian vegetation stand, the entire polygon was considered suitable Arizona southwestern toad habitat. In the latter case, the still surface water may not traverse the whole polygon, and substantial parts of some polygons may be further than 500 feet from available surface water. When the woody riparian vegetation types with still water are included, Arizona southwestern toad habitat totals 1,118.30 acres in the Study Area (Table 16). If just the wetland vegetation types are considered breeding habitat for the Arizona southwestern toad, the amount of available habitat drops considerably – to 54.93 acres. In either case, Arizona southwestern toad habitat predominates in Lincoln County, where perennial water is more available. It is probable that the former approach overestimates available Arizona southwestern toad habitat, while the latter approach underestimates Arizona southwestern toad habitat. Most (75%) of the documented observations occurred in, or adjacent to, delineated Arizona southwestern toad habitat that was comprised of polygons of woody riparian vegetation. Only 2 observations occurred in proximity to marsh habitat types. This indicates the appropriateness of identifying woody riparian vegetation types with still water as Arizona southwestern toad habitat.

Twelve documented observations of Arizona southwestern toad were recorded within the Study Area. Eight (8) of these sightings were made between 1992 and 2002, 1 observation was made in 1968, and the other 3 were recorded in the 1930s. The method of recording sighting locations varied in precision from latitude-longitude seconds to latitude-longitude minutes. However, the recordings were precise enough to generally determine the recorded location of the sightings.

Five (5) of the documented Arizona southwestern toad sightings occurred in Rainbow Canyon, and another 2 observations occurred at Elgin, near the mouth of the canyon. Three of these 7 observations occurred in 1992 and 2001. Within Rainbow Canyon, 4 of the 5 sightings occurred in or adjacent to delineated habitat comprised of woody riparian vegetation types. One (1) of these 4 sightings was also equidistant to a marsh habitat. While the 2 observations near Elgin did not occur near delineated habitat, 1 was located immediately on Meadow Valley Wash. The other 2 sightings were on upland side slopes approximately 1,800 feet to 2,400 feet from Meadow Valley Wash.

One (1) observation was made immediately north of Carp in 2001. This observation occurred in delineated Arizona southwestern toad habitat comprised of woody riparian vegetation. The location of this sighting appears to be adjacent to the Meadow Valley Wash channel, which was identified as flowing water during this Study.

One (1) observation was made at Vigo in 2002. The location of this sighting is adjacent to delineated habitat consisting of woody riparian vegetation with surface water present in the channel. The observation appears to have occurred on the dirt road adjacent to Meadow Valley Wash.

Three (3) observations were made at the Lincoln-Clark County line, all within woody riparian vegetation that was delineated as Arizona southwestern toad habitat because of the presence of surface water within the vegetation polygon. Open water was identified within 345 feet of these sightings. The observations were made during consecutive springs from 1997-1999.

Meadow Valley Speckled Dace and Desert Sucker

Peripheral to the Study, an attempt was made to determine available habitat for the Meadow Valley speckled dace and the desert sucker. Flowing water was further described in general categories of run, riffle, and pool. Since long reaches of flowing water could occur adjacent to or within one riparian community, the flowing water category was generalized for the entire reach through the discrete riparian community. Generalization of flowing water habitat could not effectively identify specific areas of riffle, run, or pool habitat. Thus, no specific habitat parameters for sensitive fish species could be ascertained for this Study. However, the presence of surface water in May-June was assumed to provide a good indication of reaches that likely support a fishery.

A review of existing records of occurrence indicates that both species have historically occurred within the Study Area. NDOW has 52 recorded occurrences of these species in the Study Area between 1987 and 2003. The vast majority of these occurrences (41 records) were in Rainbow Canyon and included 40 records for Meadow Valley speckled dace and 38 for desert sucker. Meadow Valley Wash through Rainbow Canyon is primarily a perennial stream with a mix of riffles, runs, and pools. Thus, Rainbow Canyon provides the best opportunity to support self-sustaining populations of these species.

Both species have also been documented sporadically from Elgin to Vigo. Five records of Meadow Valley speckled dace and 4 records of desert sucker were documented at one location immediately south of Elgin between 1993 and 2000. Both species were documented at two locations south of Kyle in 1991. While only Meadow Valley speckled wash were documented at Carp and Vigo during two surveys in 1991 and 2000. Four surveys conducted from north of Rox to the Lincoln County line in 1989 and 1992 failed to record either of these species.

CONCLUSIONS

Woody Riparian Vegetation

Woody riparian vegetation types became the focus of the Study, because these vegetation types provide the species composition and vegetative structure and density to support SWWFC and other covered avian species. Woody riparian vegetation types comprise 16.9 percent of the ground cover within the Study Area.

Because woody riparian vegetation types typically occur in floodplains prone to periodic disturbance, their distribution and ability to support SWWFC and other covered species are dynamic (USFWS 2002); therefore, habitat suitable for these covered species will likely change over time. Woody riparian vegetation types currently suitable as habitat for covered species may degrade with ecological, climactic, and anthropogenic events, while woody riparian vegetation types not currently suitable as habitat for covered species may evolve or be managed to meet habitat requirements for these species. Thus, distribution and viability of all woody riparian vegetation within the Study Area are important, especially those composed of native vegetation types.

Non-invasive Vegetation Types

Provencher et al. (2003) identified Meadow Valley Wash as ecologically significant, because it is the only remaining corridor for bird migration in southeastern Nevada between the Mojave Desert and Great Basin with a large portion of native riparian vegetation. As such, the delineated non-invasive vegetation types are of significant interest in this Study. Non-invasive vegetation types have been defined as those dominated by native vegetation or naturalized vegetation not on the State of Nevada's noxious species list. The SWWFC evolved and, until fairly recently, bred exclusively in native riparian vegetation (USFWS 2002). This same relationship with native riparian vegetation is considered relevant to the other covered avian species.

Lincoln County contains a disproportionate share of non-invasive woody riparian vegetation types. Although Lincoln County comprises approximately 82 percent of the aerial coverage of the Study Area, approximately 96 percent of the non-invasive woody riparian vegetation types occur in this county. The prevalence of non-invasive woody riparian vegetation types within Lincoln County is likely related to the available surface water and shallow groundwater needed to support these types. In order to maintain the extensive complexes and distribution of non-invasive woody riparian in Lincoln County, it is imperative that this hydrologic connectivity continues.

Rainbow Canyon supports the most prolific stands of non-invasive woody riparian vegetation types. About 41 percent of all non-invasive woody vegetation types within the overall Study Area occur within the canyon. Much of Meadow Valley Wash through Rainbow Canyon is perennial or appears to have groundwater shallow enough to support woody riparian vegetation types. As such, Rainbow Canyon is considered an integral component of the desert riparian ecosystem in the Study Area. Most (60%) of the increase in woody riparian vegetation types since 1976 has occurred in Rainbow Canyon and is indicative of the perennial water connectivity and the variety of attendant hydrologic events including flood events and, local scouring, and changes in hydrologic controls. In addition, proactive land management activities including livestock management and tamarisk removal, such as those currently implemented by BLM, have likely enhanced non-invasive woody riparian vegetation growth and improved the ecological site potential for woody riparian vegetation. Because most of the land within the Rainbow Canyon is publically owned and managed, the opportunity exists to effectively manage large blocks of non-invasive woody riparian vegetation. Management efforts should focus on preservation through maintenance of water connectivity and restoration though removal of stressors or threats such as those currently pursued by BLM (livestock management; tamarisk removal).

Other areas of importance within Lincoln County include large complexes of non-invasive woody riparian vegetation in the vicinity of Caliente and Kyle. Again, surface water or shallow groundwater is present and supports these complexes. Non-invasive woody riparian vegetation types occur only on private lands in Caliente, while 40 percent of the non-invasive vegetation types near Kyle are on private lands. Many of the stands near Kyle traverse both private and public lands. Preservation and management of these woody riparian vegetation types in these areas are important and will require cooperation between public and private land managers. Again, management efforts should focus on sustaining water connectivity and maintaining the connectivity of woody riparian vegetation stands across both public and private lands. Further, identification and alleviation of significant stressors should be explored.

Non-invasive woody vegetation in Clark County occurs on only about 30 acres and is comprised of primarily linear, discrete stands of Desert Willow Shrubland on publicly owned land. The limited distribution of non-invasive woody riparian vegetation in Clark County is indicative of the lack of perennial surface water or shallow groundwater. Invasive vegetation types (Tamarisk Woodland) have a deep root system and, thus, the ability to thrive where there is no, or limited, surface flow. Water limitations in the Clark County portion of the Study Area preclude the robust, diverse development of non-invasive woody riparian vegetation occurring in the northern Lincoln County portion of the Study Area. However, since non-invasive woody riparian vegetation, primarily Desert Willow Shrubland, are distributed in linear patches through Meadow Valley Wash north of Moapa's agricultural area, they can be important in providing habitat for covered species and should be managed to preserve their viability.

Invasive Vegetation Types

Invasive woody riparian vegetation types within the Study Area are those types dominated by tamarisk (Tamarisk Woodland, Burnt or Dead Tamarisk Woodland) or with a significant component of Tamarisk (Riparian Forest/Tamarisk Woodland Mix). The invasion of tamarisk throughout the Southwest over the past century has resulted in the displacement of native woody vegetation where these latter types have been disassociated from their historic hydrologic regime or in areas with historically limited water availability where the tamarisk has out-competed the native vegetation. Thus, stands with diverse vegetative composition and multi-layered structures are replaced with monotypic stands of tamarisk that are uniform in structure. Tamarisk vegetation types have high evapotranspiration rates and are suspected of depleting available water sources that could otherwise sustain native vegetation, support aquatic biota, and serve human activities. Tamarisk stands also accumulate high concentrations of salts in the soils where flooding does not occur. For these reasons, tamarisk (invasive vegetation types) is generally not considered desirable woody riparian vegetation.

However, tamarisk is now a naturalized component of the Southwestern drainages, including southern Nevada. As it has spread, it has not only displaced native riparian vegetation types but also established communities in areas where no woody riparian vegetation types existed. As tamarisk communities have become naturalized and a permanent component in the desert riparian ecosystem, they have been found to be used by SWWFC for breeding habitat (USFS 2000). Because

the tamarisk vegetation types can support SWWFC, they cannot be dismissed from consideration as possible habitat for avian species of interest.

Although it is certainly preferable to have diverse stands and complexes of stands composed of non-invasive vegetation types, this may not be entirely practicable within the Meadow Valley Wash desert riparian ecosystem. Tamarisk control appears to have merit in systems where the hydrologic regime can truly support native woody riparian vegetation types, but not where these conditions do not exist (Marshall and Stoleson 2000). This is likely the case from approximately Leith south through the remaining portions of the Study Area where surface water and shallow groundwater are not available.

In Lincoln County invasive woody riparian vegetation stands are very limited in Rainbow Canyon, although tamarisk was identified within about 21 percent of the stands of non-invasive vegetation types. Because of the general availability of water within Rainbow Canyon, management efforts can be directed to eradication of invading tamarisk on a site-by-site basis where the water regime dictates.

The majority of invasive woody riparian vegetation in Lincoln County occurs from just north of Lyman Crossing to south of Vigo and is primarily Tamarisk Woodlands and recently burned Tamarisk Woodlands in the vicinity of Carp.

Groundwater apparently becomes shallow immediately north of Carp where Tamarisk Woodland coexists with stands of Desert Willow Shrubland and Arrowweed Shrubland, although they are separated by large blocks of Alluvium or Sparsely Vegetated Lands. Agricultural activities also occur in the area, as much of the land is privately owned. Surface water becomes available immediately north of Carp. However, the riparian corridor is dominated by Tamarisk Woodland, much of it recently burnt. The burnt stands of Tamarisk Woodland appear to be regenerating prolifically, indicating the treatment was not successful, even with available water. Because water is available in this area, further management strategies may be successful in converting some of the large stands of tamarisk to non-invasive types. However, such activities need to be thoroughly investigated as to probability of success. This should include evaluation of periodic flooding of the floodplain, planting and seeding of desirable species, and close coordination and cooperation between public and private land owners. The latter is important, because much of the land in the area is privately owned.

In the vicinity of Vigo, similar conditions exist. The area is dominated by Tamarisk Woodland but interspersed with small stands of non-invasive vegetation types indicating shallow groundwater and some surface water in the channel. Water diversion was noted at the north end of the area, which may affect water availability for non-invasive vegetation types. Again, much of the land is privately owned. As with the area of Carp, tamarisk control may be an option and should be further investigated. However, such management should only proceed if it is determined that a sustainable hydrologic regime can be implemented.

A large complex of Riparian Forest/Tamarisk Woodland Mix occurs near Rox and is intermixed with stands of non-invasive woody riparian vegetation types. This complex is well developed with a shared canopy of tamarisk and Freemont Cottonwood Forest and a diverse understory of native and invasive species. The complex occurs on both a large parcel of private land and public land. The floodplain is wide at this location. Whether the vegetation components of this complex are stable or the tamarisk component increasing was not a determination that could be made during this Study. Because of the diversity of vegetative species structure of this complex, as well as the ready availability of surface water, it is possible that no immediate vegetative treatments need to be applied; the risk of unsuccessful treatment efforts could result in the conversion of this complex to monotypic Tamarisk Woodland. This complex should be managed to preserve it in its entirety. This will require cooperation between private and public land owners.

Invasive vegetation types dominate the riparian woody vegetation in Clark County. The distribution of the invasive woody riparian vegetation appears not to have increased since 1976. The distribution of Tamarisk Woodland is limited because of the unavailability of water. It is likely that no management activities are practicable to convert these invasive vegetation types to non-invasive woody riparian vegetation stands. However, these stands of invasive woody riparian vegetation do provide shrub and woodland vegetative structure, and can be locally important to avian species.

Southwestern Willow Flycatcher (SWWFC)

The goal of the Study was to characterize and evaluate riparian communities within Meadow Valley Wash in order to identify riparian sites that could be protected, enhanced, or restored in compliance with the MSHCPs. The Study focused primarily on the identification of suitable habitat and potentially suitable habitat for SWWFC.

Overall, 1,406 acres of the woody riparian vegetation types within the Study Area were identified as suitable or potentially suitable habitat for SWWFC. This accounts for approximately 81 percent of the woody riparian vegetation types within the Study Area, a significant proportion. Non-invasive woody riparian vegetation types that have been defined as suitable or potential SWWFC habitat are considered the most important, because these vegetation types have been historically used as breeding habitat as this species has evolved. Although suitable or potentially suitable habitat only occurs on about 423 acres of non-invasive vegetation types, this is approximately 61 percent of the non-invasive woody riparian vegetation within the Study Area, indicating the importance of preservation of these vegetation types throughout the Study Area.

While SWWFC suitable habitat currently contains the requisite components for SWWFC breeding, potential habitat is also an integral part of overall suitability. Potential habitats are the areas where changes in ecological conditions or effective management practices are most likely to create suitable habitat (USFWS 2002). Not only must suitable habitat always be present for long-term survival of the species, but additional acres of suitable habitat must develop to continually support SWWFC (USFWS 2002). As such, the Recovery Plan (USFWS 2002) states that management for recovery

of the species must include developing and/or maintaining a matrix of habitats so that sufficient suitable habitat will be available at any given time.

Three (3) categories of potential habitat were defined, based on vegetation structure and density, as well as the presence of water. Type A potential habitat met all the structural and density requirements of SWWFC suitable habitat but did not have surface water present. Type A potential habitat was very limited in distribution. Because of the isolation of these stands and limited water connectivity, their potential development as suitable habitat is questionable. Type C potential habitat has the appropriate vegetative species composition, but it does not have the requisite structure or density to support SWWFC. Type C potential habitat is fairly limited in distribution. The ability to develop these stands into suitable habitat may be a function of the current hydrologic regime, which limits flooding and regeneration of understory components, although anthropogenic stressors may also be a factor. Type B potential habitat has the necessary vegetative composition and structure to support SWWFC, but the understory is not dense enough to meet suitable habitat requirements. Type B potential habitat is the most prevalent type within the Study Area. Additionally, surface water was present on more than 41 percent of the Type B stands, which increases the potential for these stands to evolve into suitable habitat. Since stressors were noted on approximately half of the Type B potential habitat stands, opportunities exist to manage these stands as SWWFC suitable habitat. As such, Type B potential habitat is considered the first management and preservation priority. However, opportunities to manage Type C potential habitat stands toward SWWFC suitable habitat should not be overlooked, particularly since 24 of 39 stands of Type C potential habitat had stressors related to anthropogenic activities.

Lincoln County

Non-Invasive Vegetation Types as SWWFC Habitat

The non-invasive woody riparian vegetation types that comprise SWWFC suitable or potential habitat are considered the most important types, since these are the habitat types with which the SWWFC evolved. All of the non-invasive woody riparian vegetation types that were delineated as SWWFC suitable habitat occur in the northern half of the Lincoln County portion of the Study Area and provide the best opportunities to support breeding pairs. All but approximately 2 acres of the non-invasive SWWFC potential habitat exists in the northern half of the county.

Rainbow Canyon appears to provide the best opportunity to support SWWFC. The overwhelming majority (182 total ac) of non-invasive SWWFC habitat was identified in Rainbow Canyon. In addition, over 43 percent (83 ac) of the potential habitat is in Rainbow Canyon. It is also interesting to note that SWWFC suitable habitat has increased in Rainbow Canyon by approximately 129 acres since 1976.

The SWWFC Recovery Plan (USFWS 2002) states that a minimum size, distribution, and spatial proximity of habitat patches is essential to the survival and recovery of the species. Recovery is considered to be enhanced by increasing the number of larger populations. These populations must be distributed close enough to increase the probability of successful immigration by dispersing SWWFC. The Recovery Plan (USFWS 2002) states that management efforts should strive for a

minimum patch size that supports at least 10 territories. This minimum patch size is believed to have a mean size of 61.5 acres. Two (2) areas within Rainbow Canyon meet or approach this criteria. One (1) is a complex of connecting habitat patches from Stine to north of Boyd. This complex is approximately 97 acres and primarily composed of forested vegetation types (Freemont Cottonwood Forest and Riparian Forest). The complex consists of approximately 82 acres of suitable habitat and 15 acres of potential habitat. Two (2) SWWFC observations occurred in this complex; both were recorded as occurrences of either current or historic breeding pairs in designated suitable habitat. Another 2 observations occurred in potential habitat that is part of this complex immediately north of Stine, although neither observation was recorded as an occurrence of breeding birds. The other large habitat complex in Rainbow Canyon is south of Boyd. This complex is composed primarily of Riparian Forest and is approximately 74 acres. No observations of SWWFC were recorded in this complex.

One additional complex of suitable and potential habitat (41 ac) occurs near the northern end of Rainbow Canyon. This complex is somewhat fragmented, but because of its relative size it is considered an important complex.

Land or hydrologic connectivity threats currently occur on approximately half of the SWWFC suitable habitat in Rainbow Canyon and on more than 78 percent of the SWWFC potential habitat. The most frequent stressors appear to be grazing and channelization or lack of water connectivity. These stressors were identified on 16 of 30 stands of delineated SWWFC suitable habitat and 25 of 34 stands of potential habitat. While grazing may be managed, the channelization and downcutting may be more indicative of the channel morphology and gradient, as well the narrowness of the riparian corridor, which is often exacerbated by the confinement imposed by the railroad grade and the existing paved road. However, opportunities to promote floodplain inundation should be explored on a site-by-site basis. Since all of the stands occur on public land, the opportunity exists to effectively manage large blocks of SWWFC suitable habitat.

A large complex (approximately 75 ac) of suitable and potential SWWFC habitat occurs near Kyle. An additional complex of approximately 29 acres occurs approximately 1,500 feet downstream. This main complex (75 ac) is comprised primarily of Riparian Forest and Freemont Cottonwood Forest. SWWFC suitable habitat accounts for 21 acres. Of the potential habitat in this complex, approximately 37 acres are Type B. The smaller (29 ac) complex is a mix of forested vegetation types and Bush Seepweed Shrubland. Of the 29 acres in this complex 9 are suitable habitat, and approximately 17 acres are Type B potential habitat. Surface water was noted throughout much of the area, indicating an opportunity to preserve SWWC suitable habitat and manage potential habitat towards suitable conditions.

Approximately half of the these 2 complexes near Kyle have hydrological connectivity threats. The most frequent stressors appear to be grazing and channelization or lack of water connectivity. These threats were identified on 11 of the 26 stands. In addition, land development and OHV use were noted as stressors. Although public land comprises the majority of these 2 complexes, a substantial amount (38 ac) is on private parcels at the north end of the main complex. Management objectives should focus on preserving available habitat and managing stressors such as grazing and land

development. This will require cooperation between private and public land owners, as many individual vegetation stands traverse ownership boundaries. In addition, site-specific evaluations should be conducted to improve hydrologic connectivity, as there appears to be enough surface water available to increase riparian growth.

In the Caliente vicinity a complex of approximately 18 acres supports suitable and potential habitat. This complex is primarily potential habitat and may be affected by the local channelization. It is interesting to note that one recent SWWFC observation occurred near the south end of the complex adjacent to Type B potential habitat. Management opportunities, on a site-by-site basis, could promote hydrologic connectivity in this area and increase habitat sustainability. The area is owned by the City of Caliente, and optimal management will require participation from private land owners.

Invasive Vegetation Types as SWWFC Habitat

For this Study, invasive woody riparian vegetation types are those dominated by tamarisk or with a substantial component of tamarisk in the canopy. These types are not considered optimum habitat for SWWFC, primarily because of tamarisk's inherent problems: aggressive competition with native vegetation types, reduced thermal buffering, accumulation of salts in the soil, and perpetuation of a fire regime (USFS 2000). In addition, the species' high evaoptranspiration rate may limit the amount of water available for native vegetation and human opportunities. However, SWWFC appear to have responded to the widespread loss or modification of native vegetation types by using tamarisk stands for breeding where the vegetative structure and density, and surface water are available (USFS 2000). Since SWWFC has been documented using these vegetation types, they are considered possible SWWFC habitat in this Study.

Three (3) areas were identified with invasive woody riparian vegetation. This is considered suitable or SWWFC potential habitat because the complex of stands exceeds the minimum patch size of (61.5 ac) considered necessary to support 10 or more breeding pairs of SWWFC.

The most prolific complex of invasive woody riparian vegetation delineated as SWWFC habitat occurs from approximately 2.3 miles north of Carp to approximately 1 mile south of Carp. This complex contains approximately 292 acres of tamarisk vegetation types considered suitable or potential SWWFC habitat. The vast majority (256 ac) of this complex is Type B potential habitat. The remaining 36 acres were delineated as suitable habitat. The vegetation types are either Tamarisk Woodland or Burned or Dead Tamarisk Woodland that is regenerating with a dense understory of tamarisk. Surface water was noted through much of this complex. As can be expected, fire was identified as the most common stressor. Grazing was also a habitat stressor, but to a lesser degree. Because there appears to be surface water available through much of the area and no channelization occurs, there may be an opportunity for aggressive tamarisk control. However, the first priority of any such program would be to ensure that the hydrologic regime conducive to native species propagation could be established and maintained. Further, any tamarisk treatment must be site specific and include plantings and seeding of desirable species after the soils have been flushed of accumulated salts. Because some private parcels occur at the north end and at Carp, any management plan should coordinate efforts between public and private entities.

Another prolific complex of invasive woody riparian vegetation delineated as SWWFC habitat occurs from approximately 3 miles upstream to 3 miles downstream of Vigo. This complex contains approximately 200 acres of tamarisk vegetation types, primarily Tamarisk Woodland considered suitable (156 ac) or potential SWWFC habitat. This complex is centered around 1 large stand (133 ac) of Tamarisk Woodland. Surface water occurs upstream and downstream of this large stand, and it is likely that shallow groundwater exists at the location of the stand. Stressors were only identified on approximately 54 acres. However, access was not granted to the private property where the large Tamarisk Wooldand stand occurred. Thus, other, unidentified stressors may be present. Because this area appears to have available surface water and no channelization occurs, there may be an opportunity for aggressive tamarisk control. However, the first priority of any such program would be to ensure that the hydrologic regime conducive to native species propagation could be established and maintained. Further, any tamarisk treatment must be site specific and include plantings and seeding of desirable species after the soils have been flushed of accumulated salts. Because much of the complex occurs on private parcels, any tamarisk management plan should coordinate efforts between public and private entities.

The final large complex of invasive woody riparian vegetation delineated as SWWFC habitat occurs from approximately 1 mile upstream of Rox to the Lincoln County border. This complex contains approximately 177 acres of tamarisk vegetation types and is located on a wide floodplain. The complex lies predominately north of Rox, where a large (108 ac) wide stand of Riparian Forest/Tamarisk Woodland Mix of delineated SWWFC suitable habitat occurs. Approximately half of this stand occurs on private land. This complex is well developed and contains a shared canopy of tamarisk and Freemont cottonwood, and a diverse understory of native and invasive species. The stability of this stand was not determined for this Study. Because of the diversity of vegetative species structure of this complex, as well as the availability of surface water, it is likely that no immediate vegetative treatments need to be applied; the risk of unsuccessful treatment efforts could result in the conversion of this complex to monotypic Tamarisk Woodland. This complex should be managed to preserve it its entirety. This will require cooperation between private and public land owners. Grazing was identified as a stressor in most of the stands within this complex, including the large stand of Riparian Forest/Tamarisk Woodland Mix. A cooperative effort to manage grazing so as to eliminate species conversion and loss of understory density could be productive.

Clark County

Non-Invasive Vegetation Types as SWWFC Habitat

Non-invasive woody riparian vegetation types have extremely limited value for SWWFC in Clark County. No non-invasive vegetation types were delineated as SWWFC suitable habitat, and only approximately 7 acres of SWWFC potential habitat (Type B) occur in 2 discreet stands. Because of the lack of available surface water or shallow groundwater, it is doubtful that the Clark County portion of the Study Area could ever support stands of non-invasive vegetation types suitable for SWWFC.

Invasive Vegetation Types as SWWFC Habitat

Because of native woody riparian vegetation has been historically absent in the Clark County portion of the Study Area, the large complexes of invasive vegetation types become important. As noted previously, tamarisk vegetation types appear to provide SWWFC habitat in areas where native vegetation is not available. Of course, these tamarisk vegetation types need to meet the minimum habitat size and vegetative structure and density requirements, as well as have surface water or seeps available. Two complexes of invasive vegetation types delineated as SWWFC habitat were identified.

The first complex is east of Moapa and includes approximately 147 acres of Tamarisk Woodland, 21 acres of which been burned. This robust complex contains approximately 100 acres that were delineated as suitable SWWFC habitat. This complex is located primarily on public lands, although it is bordered by private parcels for much of its length. Because this complex contains a substantial amount of suitable SWWFC habitat, management activities should focus on preserving this habitat. Grazing and OHV use were identified as stressors on limited areas of the complex, but they are not considered to be threatening the habitat's stability.

The second complex occurs at the southern end of the Study Area near Glendale. This 76-acre complex of Tamarisk Woodland meets the minimum requirements for sustaining 10 breeding pairs of SWWFC. The value of this complex is decreased because stands are fragmented by roads and human encroachment. The core of this complex is approximately 23 acres of SWWFC suitable habitat at the confluence of Meadow Valley Wash and Muddy River. The complex occurs on private lands that are likely to sustain future development and fragmentation. A site-specific evaluation of this complex needs to be done to determine if it is practicable to preserve the Tamarisk Woodlands in this location or if land development may need to take precedence. Preservation would need to be a cooperative effort between all private property owners and ensure that enough of the Tamarisk Woodland can be preserved to provide continuity and meet minimum patch size requirements (61.5 ac) for 10 breeding SWWFC pairs.

Other Covered Species

Habitat was defined and delineated for other covered species. Historic records and recent files were searched to obtain records of sightings of covered species within the Study Area. In general, observations tended to occur in, or in close proximity to, defined habitat for these species.

Yellow-Billed Cuckoo

Yellow-billed cuckoos occur within the Study Area, at least infrequently. Two cuckoo sightings have been documented by NDOW between 1999 and 2002. In July 2001, a sighting was documented at the south end of Rainbow Canyon. The second sighting, possibly a mated pair, occurred in June 2002 north of Rox in the best suitable habitat delineated within the Study Area. Three complexes of Riparian Forest vegetation types considered habitat for the yellow-billed cuckoo were delineated in the Study Area, two of which are in Rainbow Canyon and the other in the large

complex north of Rox. These three complexes have also been defined as habitat for SWWFC, and efforts to manage the habitat for SWWFC will increase the value of these complexes for yellow-billed cuckoo.

Bell's Vireo

Habitat for Bell's vireo is similar to SWWFC habitat, and, as such, it is distributed the same. Concentrations occur throughout Rainbow Canyon and near Kyle. Other large complexes, primarily comprised of tamarisk vegetation types, occur in the vicinity of Carp, Vigo, and Rox, and from Moapa to Glendale. Historic records indicate that Bell's vireo can be locally common through the Study Area, particularly in Rainbow Canyon, in the Carp area, near Vigo, and from Rox downstream to the Lincoln-Clark County line. Historic observations appear to coincide with delineated habitat. Since Bell's vireo habitat requirements are similar to those for SWWFC, management efforts to preserve or improve SWWFC suitable habitat will also benefit Bell's vireo.

Blue Grosbeak

Approximately 107 acres of blue grosbeak habitat were identified within the Study Area. Most of the delineated habitat occurs in discrete stands within Rainbow Canyon. A smaller area of habitat is distributed between Elgin and Leith. Scattered stands of habitat occur near Carp, Vigo, and Rox, all in areas with some surface water or shallow groundwater. Historic observations of this species were limited within the Study Area. Observations did occur in Rainbow Canyon, near Carp, near Vigo, and from north of Rox downstream to the county line. Since discrete location points of these observations were not documented, it was not possible to determine if the blue grosbeak were sighted in defined blue grosbeak habitat. However, transects where blue grosbeak were observed did traverse defined habitat. No observations were recorded on transects that traversed areas with very limited to no defined habitat.

Summer Tanager

Substantial habitat for the summer tanager was delineated in the Study Area. Rainbow Canyon contains a substantial portion (36%) of this habitat. The area near Kyle also supports a substantial complex of summer tanager habitat. Otherwise, summer tanager habitat is scattered throughout the remainder of Lincoln County, and 2 linear complexes occur in Clark County. Four (4) discrete sightings of summer tanager were recorded in the Study Area: 2 in Rainbow Canyon, 1 near the county line, and one near Glendale. Defined summer tanager habitat occurred at or near 3 of these sightings.

Phainopepla

Phainopepla habitat is limited to about 135 acres within the Study Area, nearly half of which occurs between Glendale and Moapa. Most of this habitat occurs in mesquite stands in Clark County. In Lincoln County only 2 areas appear to support phainopepla habitat, one near Kyle and one near Rox.

However, desert mistletoe, the limiting factor in phainopepla habitat, may occur in other larger stands that have a mesquite component. Only 2 historic discrete point observations of phainopepla were recorded within the Study Area, both of these sightings were in Clark County north of Glendale. These sightings occurred near available phainopepla habitat. Eight (8) other sightings occurred on transects through the Study Area, including one in Rainbow Canyon, one north of Rox, three in the area from Rox to the Lincoln-Clark County line, and 3 north of Moapa. Delineated habitat for phainopepla was delineated on or near all but the Rainbow Canyon transect.

Lucy's Warbler

Only about 81 acres of Lucy's warbler habitat were delineated within the Study Area. It is probable that other stands of mature Riparian Forest and older mesquite have the snags or cavities required for nesting Lucy's warbler, but the limitations of this Study precluded a detailed investigation of this component within each stand. Habitat for Lucy's warbler primarily occurs in the northern half of Lincoln County and is concentrated in Rainbow Canyon and near Kyle. The only discrete point that was documented for a Lucy's warbler sighting within the Study Area was a historic sighting north of the Lincoln County line. No defined habitat was noted in this immediate area. Seven (7) additional sightings were documented as part of long linear transects in Rainbow Canyon, near Carp, Vigo, and the area from Rox to the county line. Only 2 of these transects were proximal to identified Lucy's warbler habitat. Again, these data may not be truly representative because an intensive evaluation of snags and cavities was not part of this Study.

Arizona Southwestern Toad

Extensive areas of potential breeding habitat for Arizona southwestern toad were defined for the Study Area and include not only marsh/wetland areas, but also woody riparian vegetation stands with still surface water. Total Arizona southwestern toad breeding habitat is approximately 1,118 acres. Arizona southwestern toad habitat falls predominately in Lincoln County, where perennial water is more available. Most (75%) of the documented observations occurred in, or adjacent to, delineated Arizona southwestern toad habitat that was comprised of woody riparian vegetation. Only 2 observations occurred near marsh habitat types. Twelve (12) documented observations of Arizona southwestern toad in the Study Area were recorded; 5 of these sightings occurred in Rainbow Canyon. The other sightings also occurred in Lincoln County near Carp, Vigo, and Rox. No Clark County sightings were documented. Suitable Arizona southwestern toad habitat exists in Clark County and is comprised of about 150 acres of the Clark County portion of the Study Area. This habitat primarily occurs in Tamarisk Woodland stands with surface water present, primarily in the vicinity of Moapa and Glendale. Other, smaller habitat areas of pooled water are dispersed throughout the north portion of Meadow Valley Wash. It is also likely that breeding habitat for the Arizona southwestern toad occurs in irrigation drainages that run adjacent to sparsely vegetated land types.

Meadow Valley Speckled Dace and Desert Sucker

A review of existing records of occurrence indicates that both species have historically occurred within the Study Area, primarily within Rainbow Canyon. Meadow Valley Wash through Rainbow Canyon is primarily a perennial stream with a mix of riffles, runs, and pools, and thus, provides the best opportunity to support self-sustaining populations of these species. Both species have also been documented sporadically from Elgin to Vigo, and they likely occur in pockets of available habitat, particularly in the vicinity of Kyle, Carp, and Vigo. The latter two areas may only provide habitat for speckled dace.

Summary

The Meadow Valley Wash is ecologically important, because it is one of a limited numbers of desert riparian ecosystem corridors in southeastern Nevada. The area from Caliente to Glendale supports substantial complexes of woody riparian vegetation that can currently support SWWFC or develop into SWWFC suitable habitat. In addition, these complexes also provide habitat for other covered species in this Study. The highest quality habitat is associated with non-invasive (native) woody riparian vegetation types. As expected, these important habitat complexes are associated with available surface water or areas with shallow groundwater.

Within the Study Area, the northern half of Lincoln County supports the vast majority of non-invasive woody riparian vegetation. The best opportunities to preserve, maintain, and develop habitat for SWWFC and other covered species exist in this area.

Rainbow Canyon contains the best, most prolific habitat for covered species. The canyon can best support SWWFC as substantial stretches of perennial water promote native woody riparian vegetation growth, which has been increasing in this area by approximately 129 acres since 1976. In addition, 5 of the 6 previously recorded documented SWWFC observations occurred in Rainbow Canyon including one observation of active nesting in 1998.

Previous records also indicate that Rainbow Canyon has historically supported all other covered species. Habitat for all covered species was delineated within the Rainbow Canyon during this Study, which further indicates the ecological value of Rainbow Canyon.

Because most of Rainbow Canyon is publically owned, a holistic management effort can be effectively established.

Other areas were identified as having high habitat value for SWWFC and other covered species. These areas have large complexes of woody riparian vegetation, although many are dominated, or co-dominated by tamarisk. Historic observations of other covered species have typically occurred in these areas.

Two (2) complexes of non-invasive woody riparian vegetation that are high quality and have the ability to support SWWFC and other covered species. Surface water or shallow groundwater is available to support this vegetation. Management efforts will require a partnership between public and private land owners.

The Carp area supports an extensive complex of Tamarisk Woodland considered SWWFC habitat. Surface water and shallow groundwater occur in the area, and the availability of water may provide an opportunity to re-establish native woody riparian vegetation complexes. However, any tamarisk treatment must be intensely evaluated, site specific, holistic in approach, and aggressively pursued. Any management efforts will require a partnership between public and private land owners.

The Vigo area has a prolific complex of tamarisk-type woody riparian vegetation. Surface water appears to be intermittently available in this area, which may provide an opportunity to re-establish native woody riparian vegetation. However, this may be problematic because of limited water availability and the amount of land owned by one individual.

The Rox area has a large complex of forest type vegetation co-dominated by Freemont cottonwood and tamarisk. This vegetative composition and structure of this complex is diverse and surface water is available This complex will likely continue to support high quality habitat for covered species and should be preserved.

In Clark County 2 complexes of Tamarisk Woodland support habitat for SWWFC and other covered species: one complex is east of Moapa, the other west of Glendale at the Muddy River confluence. Because of the restricted water availability in the Clark County portion of the Study Area, it is improbable that these complexes can be converted to non-invasive woody riparian vegetation. However, they are considered important components to the overall desert riparian system of Meadow Valley Wash and should be preserved.

Within the entire Study Area approximately 67 percent of the habitat defined as suitable or potential SWWFC habitat is currently undergoing varying degrees of stress. Stressors are most prevalent on potential SWWFC habitat where 91 percent of the habitat is undergoing some level of stress. The most frequently observed stressors were grazing and hydrologic connectivity (i.e., channelization, downcutting, water diversion). Other stressors observed include land conversion (development), OHV use, and fire. These stressors may be inhibiting full development of covered species potential habitat within riparian stands or the ability to sustain suitable habitat characteristics. Management opportunities can be designed to reduce the degree of ecological stress on site-specific stands where threats are determined to be significant. A management plan directed at eliminating or moderating significant adverse influences would help ensure sustainable habitat for covered species.

RECOMMENDATIONS

Because woody riparian vegetation types typically occur in floodplains prone to periodic disturbance, their distribution and ability to support SWWFC and other covered species are dynamic (USFWS 2002); therefore, habitat suitable to these species will likely change over time. Thus, the distribution and viability of all woody riparian vegetation within the Study Area are important. Of particular importance are the preservation and development of native (non-invasive) woody riparian vegetation types, because the covered species evolved in and, until fairly recently, bred exclusively in native riparian vegetation.

Although all non-invasive vegetation types should be preserved to the extent practicable, tamarisk-dominated vegetation types also need to be evaluated and managed as habitat for covered species. Tamarisk is now a naturalized component of the Southwestern drainages, including southern Nevada. As it has spread it has not only displaced native riparian vegetation types, but it has also established communities in areas where no woody riparian vegetation types existed. Some tamarisk communities are used by SWWFC for breeding habitat (USFWS 2002). Tamarisk communities may also provide habitat for other covered species. As such, they cannot be dismissed from consideration as possible habitat for avian species of interest.

Management efforts should focus on maintaining and increasing the size of non-invasive woody riparian vegetation types, especially those identified as suitable or potential habitat for SWWFC. The SWWFC Recovery Plan (USFWS 2002) states that management efforts should strive for establishing minimum patch sizes that support 10 or more SWWFC territories. This minimum patch size is believed to have a mean size of 61.5 acres. Management effort should focus on eliminating habitat patch fragmentation and promoting the creation of wider patches to minimize edge effect. Management efforts that promote larger complexes of non-invasive woody riparian vegetation will not only provide more sustainable SWWFC habitat but will also support habitat requirements for other covered species.

The approved Clark County MSHCP and the proposed Lincoln County MSHCP require the implementation of Meadow Valley Wash Conservation Plan. As part of the plan it is recommended that specific hydrologic information is obtained for each site proposed for preservation or enhancement of SWWFC habitat. Information should include the identification of hydrologic controls and constraints described in Appendix D that can affect floodplain connectivity and inhibit overall site potential for SWWFC habitat development. In addition, site specific evaluations on the source, cause and overall magnitude of potential stressors should be made at each site proposed for preservation or enhancement of SWWFC habitat. Specific identification of hydrologic constraints and the ability to control stressors at specific SWWFC suitable and potential habitat will permit effective implementation of conservation strategies.

Specific recommendations are provided by general area below, and the best opportunities for habitat preservation and enhancement of habitat are identified. It must be noted that smaller patches of woody riparian vegetation exist throughout the Study Area, and they must not be overlooked in a

comprehensive management strategy for the SWWFC, especially since this species can breed and successfully nest in a minimum of 0.25 acre of suitable habitat.

Lincoln County

The northern half of the Study Area in Lincoln County, from approximately Caliente to below Kyle, provides the best opportunities to preserve and establish habitat for SWWFC. Almost all of the non-invasive woody riparian vegetation delineated as suitable or potential habitat for SWWFC occurs in this portion of the Study Area. Improvement of this habitat is likely related to the available surface water or groundwater.

The southern half of the Lincoln County portion of the Study Area supports other areas of habitat for SWWFC and other covered species, although these complexes are primarily dominated by tamarisk.

Caliente Area

The reach immediately north of Caliente to the bridge over Highway 93 just south of Caliente provides a small (18 ac) complex of SWWFC habitat, primarily potential habitat. The area is affected by channelization and the flood-control efforts that protect Caliente and its associated infrastructure (bridges and roads). Because of the flooding risks to human endeavors in this area, opportunities for enhancement of the existing habitat are likely limited. However, management on a site-by-site basis should be investigated.

On specific sites simple erosion control measures could be taken to improve riparian conditions. For example, large amounts of sediment associated with the road fill/road crossing have been allowed to flow unchecked into Meadow Valley Wash, where the sediment buries riparian vegetation and blocks streamflow needed to support desirable riparian species. Physically removing some of the accumulated material and installing simple perimeter erosion controls, such as silt fence or straw bale barriers, would help reduce this sedimentation and aid in the recovery of a stream channel/riparian system that includes more desirable vegetation types.

Floodplain expansion at specific areas, particularly downstream of Caliente, would be another way to increase the amount of high-quality riparian habitat. Broadening the floodplain surface that currently supports willows and grading back the fill material would increase the width of the riparian corridor and improve its habitat value. Both of these approaches – floodplain expansion and improved sediment/erosion controls – may help reduce flooding risks by maintaining or increasing channel capacity. In fact, the concept of floodplain expansion has been proposed as a possible way to alleviate flooding concerns within Caliente (Otis Bay 2001).

Rainbow Canyon

Rainbow Canyon has been identified as the highest priority for preserving and promoting habitat for SWWFC and other covered species. The canyon supports most of the non-invasive riparian vegetation, has large stands of habitat complexes, generally has available water to support non-invasive vegetation, and is predominantly public land, which facilitates comprehensive management. Management efforts in Rainbow Canyon should focus primarily on the large complexes of non-invasive woody riparian vegetation near Stine and Boyd, although all of the woody riparian vegetation stands within Rainbow Canyon should be evaluated as to the opportunity to maintain their viability. Management recommendations include the following.

1. Actively preserve all stands of delineated potential and suitable SWWFC habitat. Emphasize preserving designated SWWFC suitable habitat and Type B potential habitat, particularly the larger complexes near Stine and Boyd.

2. Re-establish annual monitoring of suitable and potential SWWFC habitat for their presence. If breeding birds are identified, efforts should be concentrated on protecting the occupied habitat. These efforts could include fencing to prohibit livestock and recreation access, and monitoring to determine presence and effect of brown-headed cowbirds.

3. Evaluate habitat adjacent to occupied habitat to determine its potential as SWWFC habitat. Focus efforts should focus on livestock management and hydrologic connectivity.

4. Specifically evaluate all delineated suitable and potential habitat sites for current threats, particularly grazing. Under proper management livestock presence may be compatible with habitat development. In other cases grazing may need to be controlled by rotating schedules and timing of use, particularly to the dormant season of woody riparian species.

5. Investigate Tamarisk Woodland in the northern portion of Rainbow Canyon. One of these stands, approximately 1.25 miles south of Etna, is within a complex of Freemont Cottonwood Forest. Each stand should be investigated for the opportunity to replace the Tamarisk Woodland with non-invasive vegetation types. The tamarisk stand that is associated with the existing Freemont Cottonwood Forest complex should be a first priority. Prior to any tamarisk eradication efforts, this stand should be surveyed for 3 years to ensure that no breeding SWWFC occupy the habitat complex. Conduct site-specific evaluations of hydrology and the probability of regenerating non-invasive vegetation prior to eradicating tamarisk. Efforts must be aggressive and holistic to ensure success.

6. Monitor non-invasive vegetation types to determine whether tamarisk is increasing as tamarisk has invaded about 20 percent of the non-invasive vegetation types within Rainbow Canyon. No eradication should be done in these stands unless tamarisk dominates the stand, and the stand is not currently occupied by SWWFC.

7. Establish an education program to inform local users about the effects of OHV use, grazing, and poorly designed infrastructure developments (roads, culverts, berms, diversions) in the riparian zone.

8. Evaluate hydrologic connectivity for stands of SWWFC suitable or potential habitat, especially those stands that have been identified as currently affected by such connectivity. Channel reconstruction to expand the floodplain and reduce bank steepness could be an option. Because factors affecting floodplain conditions may be geomorphologic or topographic in scope, altering them may not be practicable. These conditions and opportunities are further described in Appendix D. There are specific locations where road construction activities have negatively affected riparian conditions, and these sites would benefit from restoration activities. Some specific site recommendations include the following, although there are likely additional road crossing impacts within the Study Area where similar redesign efforts would benefit riparian habitat.

    - At about UTM 714000E, 4158000 N and UTM 713500 E, 4157150 N, the existing roadway cuts off two meander bends disconnecting the existing channel on the west side of the road from historical channel and floodplain areas on the east side of the road. These areas on the east side appear to be currently used as pasture land. Re-establishing the hydrologic connection between the west side and east side floodplains would greatly increase the width and habitat value of the riparian corridor in this area. This could be achieved by realigning the road, installing additional bridges and drainage culverts, and/or re-grading pasture areas to promote reestablishment of cottonwood and willow vegetation.
    - At about UTM 713500 E, 4152700 N, placement of fill material and grading activities have reduced the width of the riparian corridor and isolated a patch of high quality cottonwood/willow vegetation from the main channel. Removing this fill material and re-connecting the two areas of existing high quality vegetation would restore a 1,000 foot-wide corridor with excellent habitat value for willow flycatcher.

    - At about UTM 714452 E, 4149386 N (at the hydrologic transect UR2), removing or redesigning the road crossing would be another simple restoration activity to improve riparian conditions. Replacing the existing fill material and overly-narrow culvert with a single-span bridge structure (such as a railroad flatcar) would eliminate the major ponding effect of the existing crossing and allow for re-establishment of desirable riparian vegetation.

9. Maintain beaver activity, particularly dams within Meadow Valley Wash. These beaver dams function as small "check-dams" that reduce flow velocities during flood events, increase water stage and width of bank saturation during low flows, and trap sediments that help prevent channel incision and help maintain a hydrologic connection between the floodplain and channel.

10. Evaluate artificial check dams on a site-specific basis where habitat blocks are disassociated from the adjacent floodplain. Build small, temporary check dams composed of biodegradable materials that help trap sediments, build up the streambed, and increase the width of floodplain saturation. Use of structural techniques, such as check dams, should be undertaken with caution, because improperly designed, improperly sized, or improperly installed structures could have negative effects on upstream and downstream infrastructure.

Vicinity of Kyle

Two (2) SWWFC habitat complexes occur near Kyle that should be targeted for preservation and enhancement. The following recommendations would help maintain and enhance habitat quality.

1. Develop cooperative stewardship agreements between public and private land owners so that large stands traversing ownership boundaries can be maintained as integral complexes.

2. Site-specifically evaluate all delineated suitable and potential habitat for current threats, particularly grazing. Under proper management livestock presence may be compatible with habitat development. In other cases grazing may need to be controlled by rotating schedules and timing of use, particularly to the dormant season of woody riparian species. Cooperative agreements between private and public land owners would be needed to develop site-specific livestock management plans.

3. Establish cooperative agreements between public and private land owners to exclude any land development or OHV use within the woody riparian vegetation types associated with the 2 large complexes.
4. Establish an education program to inform local users as about effects of OHV use, grazing, and poorly designed infrastructure developments (roads, culverts, berms, diversions) in the riparian zone.

5. Conduct annual surveys of suitable and potential SWWFC habitat for breeding birds. If breeding birds are identified, establish concentrated, collaborative efforts between public and private land owners to protect the occupied habitat. These could include fencing to prohibit livestock and recreation access, and monitoring to determine presence and effect of brown-headed cowbirds.

6. Evaluate stands adjacent to occupied habitat to determine their potential as suitable SWWFC habitat. Focus cooperative efforts between land owners on livestock management and hydrologic connectivity.

7. Consider flooplain restoration as habitat enhancement within the areas that contain base flows. the habitat enhancement could include floodplain restoration. Conduct site-specific evaluations to determine opportunities to expand the width of the floodplain. Specific activities could include road realignment, installation of new bridges/drainage culverts to reconnect relict channel meanders currently cut off by the road, relocation of

campsites/campsite access roads, and construction of retaining walls to reduce the encroachment of fill material into the floodplain. One specific location where the road appears to cut of a meander bend is at about UTM 723300 E, 4132500 N south of Kyle.

8. Monitor the one stand of invasive vegetation in the area. This is a Riparian Forest/Tamarisk Woodland Mix adjacent to the road. The stand is potential habitat and appears stable, and no vegetation manipulation is currently necessary. However, if tamarisk approaches dominance, consider eradication. However, this should only be done if it will not threaten occupied SWWFC habitat or the viability of adjacent stands.

Vicinity of Carp

A large complex of that provides Type B SWWFC potential habitat (primarily Tamarisk Woodland) occurs from approximately 2.3 miles north to 1 mile south of Carp. Because of the available surface water in this area, there may be an opportunity to aggressively control tamarisk. However, it appears that the recently burned Tamarisk Woodland is regenerating, indicating that eradication and management efforts would need to be aggressive and comprehensive. Tamarisk eradication must be accompanied by replacement of vegetation with non-invasive woody riparian vegetation types. Because private parcels occur at the north end of the complex, any tamarisk control efforts should be coordinated among land owners. If there is doubt as to the success of tamarisk removal and replacement with permanent native vegetation, this complex should be preserved and maintained in its current state since it does provide habitat for SWWFC.

Specific recommendations include the following.

1. Conduct annual breeding surveys of suitable and potential SWWFC habitat for3 years. Establish concentrated, collaborative efforts between public and private land owners should be immediately established to protect the occupied habitat if breeding birds are identified. In this case, no tamarisk management should be pursued if breeding birds are identified

2. Evaluate the possibility of eradicating tamarisk and replacing it with native woody riparian vegetation if no breeding SWWFC have been identified within 3 years. Eradication of Tamarisk Woodlands should only proceed where conditions are appropriate for native vegetation restoration. Use native seed sources for restoration efforts. Plant saplings to jump-start restoration, provide a competitive advantage, and stabilize soil and stream banks.

3. Focus tamarisk removal and restoration efforts within the site-specific areas that contain base flows. Identify water depletion in the area. Explore cooperative agreements with private land owners to manage water needs and conduct withdrawals so as to augment base flow.

4. Conduct site-specific evaluations to determine if the hydrologic regime will support native vegetation types and provide consistent surface water between mid April and July. Evaluate available groundwater depth during the growing season, flooding regime, soil salinity, and geomorphology. Manage tamarisk only where surface water flushing can substantially

reduce salt accumulated in soils and where management and monitoring efforts will be aggressive and continuous.

5. Evaluate floodplain enhancements on a site-specific basis. Specific activities could include road realignment, installation of new bridges/drainage culverts to reconnect relict channel meanders currently cut off by the road, and construction of retaining walls to reduce the encroachment of fill material into the floodplain Evaluate artificial check dams on a site-specific basis, especially downstream of Carp, where habitat blocks are disassociated from the adjacent floodplain.

6. Remove tamarisk in incremental blocks of no more than 25 percent annually if tamarisk management and native vegetation restoration is determined practicable.

Vicinity of Vigo

One large complex of SWWFC habitat occurs from approximately 3 miles upstream to about 3 miles downstream of Vigo. Much of this complex could not be investigated in detail because access to the private land was denied. However, shallow groundwater and areas of surface water appear to exist throughout much of this complex during the SWWFC breeding season, and this could possibly provide an opportunity to replace Tamarisk Woodland with non-invasive vegetation types. Any habitat management would require cooperation between public and the individual who owns most of the land in this area. Because of the complexity of land ownership and the unreliability of water and appropriate geomorphological conditions, tamarisk management is not as feasible here as it is near Carp. For these reasons this large complex should be preserved and maintained in its current state. Specific recommendations include the following.

1. Develop cooperative stewardship agreements between public and the individual who owns most of the land in this area so that the habitat can be maintained as an integral complex.

2. Actively preserve all stands of delineated potential and suitable SWWFC habitat.

3. Conduct annual breeding surveys of suitable and potential SWWFC habitat for their presence. Establish a collaborative effort with the private land owner to protect the occupied habitat if breeding birds are identified. Efforts could include fencing to prohibit livestock and monitoring to determine presence and effect of brown-headed cowbirds.

Vicinity of Rox

A large complex of tamarisk vegetation types occurs on the open floodplain upstream and downstream of Rox. High quality SWWFC habitat exists within a large stand of Riparian Forest/Tamarisk Woodland Mix, half of which is on lands owned by one individual. Because of the diversity of its vegetative species and structure, as well as the available surface water, no tamarisk management is recommended for this complex. The risk of unsuccessful management efforts could

result in the conversion of this complex to monotypic Tamarisk Woodland. The following measures are recommended for this area.

1. Actively preserve all stands of delineated potential and suitable SWWFC habitat.

2. Develop cooperative stewardship agreements with the private, majority land owner so that the habitat can be maintained as an integral complex. This complex is important not only to SWWFC but also to many of the other covered species within the Study Area.

3. Evaluate for current threats, particularly grazing. Under proper management livestock presence may be compatible with habitat development. In other cases grazing may need to be controlled by rotating schedules and timing of use, particularly to the dormant season woody riparian species. Establish a cooperative agreement with the one private land owner to be established to effectively manage grazing.

4. Conduct annual breeding surveys of suitable and potential SWWFC habitat for their presence. Establish collaborative efforts between public ownership and the private land owner to protect the occupied habitat if breeding birds are identified. Efforts could include fencing to prohibit livestock and monitoring to determine presence and effect of brown-headed cowbirds.

Clark County

Invasive vegetation types dominate the riparian woody vegetation in Clark County. This portion of the Study Area has limited surface water due to the infiltration of surface flows into the valley sediments and irrigation withdrawals. Lack of available surface water and shallow groundwater may limit any substantial increase in overall distribution of woody riparian vegetation in the Clark County portion of the Study Area. It is unlikely that management activities could convert these invasive vegetation types to non-invasive woody riparian vegetation stands. However, these stands of invasive woody riparian vegetation do provide shrub and woodland vegetative structure, and can be locally important to avian species. The following recommendations are made to preserve available SWWFC habitat in Clark County.

1. Actively preserve all stands of delineated potential and suitable SWWFC habitat by developing cooperative agreements with private land owners where necessary. Preserve the 2 smaller discrete stands of Desert Willow Shrubland that are delineated as potential habitat for SWWFC. Both stands occur on public land.

2. Focus habitat preservation efforts on the 2 large complexes – east of Moapa and west of Glendale at the confluence with the Muddy River.

3. Manage the complex east of Moapa to minimize habitat degradation from grazing and OHV use. Establish an education program to inform local users and adjacent private land owners

about the effects of OHV use, grazing, and poorly designed infrastructure developments (roads, culverts, berms, diversions) in the riparian zone.

4. Evaluate sites on the large complex east of Moapa for current threats, particularly grazing. Under proper management, livestock presence may be compatible with habitat development. In other cases, grazing may need to be controlled by rotating schedules and timing of use, particularly to the dormant season of woody riparian species.

5. Preserve the large complex immediately west of Glendale to the extent practicable. This complex is entirely on private lands that are likely to sustain future development and fragmentation. Make cooperative agreements, if possible, with private entities to preserve the riparian vegetation. Any agreements would need to include most, if not all, of the private land owners to preserve the diminishing integrity of this complex.

6. Conduct annual breeding surveys of the 2 large complexes of tamarisk vegetation types that comprise suitable and potential SWWFC habitat (the complex east of Moapa and the complex immediately west of Glendale and at the confluence with the Muddy River). Establish collaborative efforts between public and private land owners to protect the occupied habitat if breeding birds are identified. Efforts could include fencing to prohibit livestock and human trespass, as well as monitoring to determine presence and effect of brown-headed cowbirds.

Addendum to the Recommendations

On January 11-12, 2005, Meadow Valley Wash underwent extensive flooding that local residents compared with major stochastic flood events that have historically occurred in the Study Area. Intense flash flooding of this magnitude, though infrequent, is part of the hydrologic regime in Meadow Valley Wash. Anecdotal descriptions of the effects of the most recent flood event have been in the Las Vegas newspaper articles. Known effects to the community of Caliente include the loss of road and railroad bridges, undermining of the Union Pacific Railroad (UPRR) railroad bed, and the derailment of 21 rail cars into the floodplain. What is unknown is the effect this intense flood has had on riparian vegetation communities in the Study Area.

Healthy riparian systems are resilient and very capable of surviving sustaining high-runoff events. However, it is not understood if the discharge force of the most recent flood was sufficient to change the structure and/or composition of riparian communities. The catastrophe's effects on local floodplains, channel morphology and hydraulics (through sediment transport and redeposition), scouring, bank cutting, and channel realignment are unknown.

It is important to determine the ways and the extent to which the recent flood has affected the Meadow Valley Wash riparian community. For example, the flood may have had a substantial effect on the extensive areas of burned Tamarisk Woodlands near Carp through stand alterations, dilution of salts in the soils, sediment deposition, and channel configuration. These changes may

have made it more conducive for site-specific floodplain restoration. On the other hand, the flood may have had a negative effect on riparian community vitality in Rainbow Canyon where the floodplain is restricted by canyon walls, the railroad, and the existing road. High discharges may have caused further channelization and downcutting that could disassociate hydrologic connectivity from adjacent riparian communities.

Further, it is likely that the UPRR rail bed and the existing roads will require numerous repair and restoration efforts. Opportunities exist in these site-specific areas for collaboration during final design of these repairs such as enhancing floodplain values through road realignment, installing new bridges/drainage culverts to reconnect relict channel meanders currently cut off by the road, relocating of campsites/campsite access roads, and constructing of retaining walls to reduce the encroachment of fill material into the floodplain.

The following steps are recommended as opportunities to understand the effects of catastrophic floods and initiate restoration of floodplains.

1. It is important to establish communication and cooperation between those entities responsible for long-term repair of local infrastructure. These entities include the UPRR, the Counties, the State of Nevada, and the City of Caliente. Wherever practicable, the design of long-term repairs should include opportunities to enhance floodplain values in Caliente and the Highway 93 bridges, in Rainbow Canyon, and near Kyle. The chance to provide input during design of long-term repairs may be the best opportunity to enhance local floodplain values for sustainable riparian development.

2. To determine if the recent flood affected riparian communities, it is recommended that an aerial reconnaissance is recommended. Changes in riparian communities can be mapped using the Vegetation Atlas prepared as a component of this Study. This reconnaissance can also identify areas where the Meadow Valley Wash channel and floodplain have been altered. The aerial reconnaissance should be conducted prior to "leaf-out" (e.g., spring) so that surface changes can be identified.

3. Extensive change is identified in SWWFC habitat comprised of non-invasive vegetation types, habitat should be mapped. These areas should be monitored over the next 3 years to develop an understanding of the long-term effects of floods on these communities.

4. A site-specific evaluation should be conducted within the extensive Tamarisk Woodland around Carp, especially the recently burned communities, to determine if flooding has altered floodplain characteristics and increased the opportunity for replacing invasive tamarisk with non-invasive riparian vegetation. This evaluation should be conducted during the peak of the growing season to determine tamarisk regeneration. This evaluation should include the extent of tamarisk removal by the recent flood, concentration of salts in the soil, changes in hydrologic connectivity, and sediment deposition. If conditions warrant, an aggressive plan for non-invasive vegetation replacement should be developed.

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ACRONYMS

BLM	Bureau of Land Management
Counties	Lincoln and Clark Counties
CCC	Civilian Conservation Corps
DOQ	digital orthophoto quadrangles
GIS	geographic information system
GPS	global positioning satellite
MSHCP	Multiple Species Habitat Conservation Plan
NDOW	Nevada Division of Wildlife
NNHP	Nevada Natural Heritage Program
OHV	off-highway vehicle
Study	Meadow Valley Wash Baseline Ecological Assessment
Study Area	approximately 85 miles of the lower-elevation portion of the Meadow Valley Wash main channel that extends through the area covered by the Southeastern Lincoln County MSHCP and the Clark County MSHCP
SWWFC	southwestern willow flycatcher
TNC	The Nature Conservancy
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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GLOSSARY

community	An interacting assemblage of plants and animals sharing a given habitat.
covered species	In general, those plant or animal species identified in either the Southeastern Lincoln County Multiple Species Habitat Conservation Plan or the Clark County Multiple Species Habitat Conservation Plan that are currently Federally listed as threatened or endangered species or those species that may become so in the future. Specifically, this refers to those species identified in the MSHCPs for the desert riparian communities of the Meadow Valley Wash.
GIS	A type of computer software for digital mapping and data analysis.
habitat	A place where a species normally lives, often described in terms of physical features (such as topography) and in biological features (such as plant species composition).
invasive vegetation	Vegetation on the State of Nevada's noxious species list.
non-invasive vegetation	Native vegetation or naturalized vegetation not on the State of Nevada's noxious species list. Naturalized vegetation has been adapted to the local environment and has become established as native.
potential habitat	A vegetation stand that does not currently have all the components necessary for a specific animal species to establish territories and/or reproduce but that could develop these components over time, if managed properly.
riparian plant communities	Plant communities occurring adjacent to or near the Meadow Valley Wash where the vegetation type is so influenced by, and dependent upon, surface or subsurface water flows associated with Meadow Valley Wash that the dominant plant species are either facultative or obligate wetland species.
senesced	An individual plant has reached the stage in its life cycle when metabolic activity has declined, and there is a change in physiology as the plant approaches dormancy.

suitable habitat	A vegetation stand that appears to have all the components necessary for a specific animal species to establish territories and/or reproduce. Suitable habitat may be occupied or unoccupied.
SWWFC suitable habitat	A woody riparian vegetation stand, either trees or shrubs, that appears to have all the components necessary for southwestern willow flycatchers to establish territories and/or nest. The primary components include (1) a stand, or patch size, of 0.25 acre or greater; (2) a vegetation width of more than about 30 feet; (3) a dense canopy; (4) dense interior vegetation from ground level up to about 15 feet or dense patches interspersed with openings; and (5) surface water or saturated soils present within the stand or within 125 feet of the stand. Suitable habitat may be unoccupied for any of a multitude of reasons.
Technical Review Team	The team of Clark and Lincoln County representatives, Federal agency and stakeholder group representatives that have administrative oversight, scientific expertise, and/or policy responsibilities in regard to the Southeastern Lincoln County Multiple Species Habitat Conservation Plan and the Clark County Multiple Species Habitat Conservation Plan. Team members represented Clark County, Lincoln County, the U.S. Fish and Wildlife Service, the Bureau of Land Management, the Natural Resources Conservation Service, the Nevada Department of Wildlife, the Red Rock Audubon Society, the Muddy River Regional Environmental Impact Alleviation Committee, and the Moapa Town Advisory Board.
threats and stressors	Those activities or processes that potentially affect the vegetation composition, structure, density and health of a riparian community.

TECHNICAL REVIEW TEAM MEMBER LIST

Name	Position	Representing
Rhonda Hornbeck	Lincoln County Commissioner	Lincoln County
Lewis Wallenmeyer	Desert Conservation Program Administrator	Clark County
Marci Henson	Acting Clark County MSCHP Administrator	Clark County
Jeri Krueger	Fish and Wildlife Biologist	USFWS Southern Nevada Field Office
Cris Tomlinson	Wildlife Diversity	NDOW Southern Region
Jon Sjoberg	Fisheries Biologist	NDOW Southern Region
William Smith	Wildlife Management Biologist	BLM Caliente Field Office
Gary Medlyn	Special Projects Manager	BLM Ely District Office
Paul Podborny	Lead Natural Resource Specialist	BLM Ely District Office
James Potts	Soils Scientist	NRCS Caliente Field Office
Hermi Hiatt	Plant Ecologist	Red Rock Audubon Society
Ann Schrieber	Director	Muddy River Regional Environmental Impact Alleviation Committee /Moapa Town Advisory Board
Mike Baughman	Project Coordinator	Lincoln County
Blaise Chanson	Project Manager	BIO-WEST, Inc.

APPENDIX A: VEGETATION/LAND TYPES

Vegetation/Land Types

Alluvium: This land type comprises the unconsolidated sands and gravels deposited within the Meadow Valley wash.

Arrowweed Shrubland: Arrowweed, *Pluchea sericea*, is the dominant species in this vegetation type. Very few other plants are found within this type, but occasionally seepwillow, *Baccharis salicifolia* and *Baccharis emoryi*, are subdominants. This vegetation type is found on silty, flat flood plains of Meadow Valley wash in areas that are frequently flooded. These nearly impenetrable thickets of arrowweed from 4-8 feet tall are fairly common in the middle section of the project area.

Bare Soil: These are areas where no vegetation occurs, outside of the creek bed. This type was fairly uncommon as almost every site had at least some vegetation, and therefore many more areas were classified as Sparsely Vegetated Lands than as bare soil.

Bulrush Marsh: This herbaceous wetland type is dominated by bulrush, mainly American threesquare, *Schoenoplectus americanus,* or hard stem bulrush, *Schoenoplectus acutus*. The bulrush vary from 3 to 8 feet high and is usually has an aerial cover of over 75 percent. It is a fairly uncommon vegetation type, but small patches of bulrush are found within many other wetland communities. Most of the bulrush marsh areas are found in close proximity to Meadow Valley Wash; however, some are also found near seeps and springs in other parts of the valley, especially in the northern 1/3 of the project area.

Burnt or Dead Tamarisk Woodland: This vegetation type/ land type is characterized by scattered burnt or dead tamarisk *Tamarix ramosissima*. Dead or burnt tamarisk has at least 25 percent aerial cover, and ranges from 15 to 30 feet in height. Some stands have a small percentage of living individuals sharing the canopy with the dead tamarisk; however, most stands have no living canopy. The understory is quite variable, from nearly absent, to extremely dense. For the most part, the burnt tamarisk area shows prolific resprouting, and a thickly vegetated shrub layer dominated by tamarisk. A large portion of the burnt tamarisk areas occur in the middle portion of the project area, and the dead tamarisk (not burned) areas are found in the southern portion. The areas in the southern portion of the project area where tamarisk has simply died do not show much resprouting and seem to be dying, possibly due to lack of water.

Bush Seepweed Shrubland: This vegetation type is found is rather flat, saline and alkaline, silt or clay soils within the flood plain of Meadow Valley Wash. Bush seepweed, *Suaeda moquinii*, is a opportunistic shrub, when conditions are right and water is abundant, it grows to a height of nearly 6 feet, but in times of drought, the plant dies back to it's main stem about 2 feet tall. Very little else is found within this extremely dense plant community, but there are some areas where saltgrass, *Distichlis spicata*, is a major component. This vegetation type is restricted to the southern half of the project area, but nowhere is it very common.

Cattail Marsh: This wetland vegetation type is primarily associated with saturated or inundated areas near Meadow Valley Wash or outlying ponds near seeps or springs. Typha latifolia or *Typha domingensis* are the primary species. Very little else is found within this dense plant community that is from 5 to 12 feet tall. Small patches of cattail marsh vegetation, however, occur in many other riparian vegetation types, nearly everywhere that permanent water is found.

Coyote Willow Shrubland: This vegetation type is composed of very dense nearly monotypic stands of coyote willow, Salix exigua. Coyote willow shrubland is usually from 5 to 18 feet tall; however, some stand can reach 25-30 feet tall. Seepwillow, arrowweed, and cattails are often found on the perimeter. This is not a common vegetation type, but small stands of Coyote willow occur commonly within the tamarisk woodland, red willow forest, Fremont cottonwood forest, and riparian forest vegetation types.

Creosote Bush Shrubland: This upland vegetation type is fairly common in the southern half of the project area. This vegetation type includes areas that are predominantly creosote bush, Larrea tridentata, with few other shrubs, as well as other areas where creosote bush is co-dominant with shadscale, *Atriplex confertifolia*. Other species such as white ratany, *Krameria grayi*, burrobush, *Franseria dumosa*, and hopsage, *Grayia spinosa*, are also common as subdominant species. Creosote shrubland is an open, fairly sparse vegetation type of between 2 and 4 feet tall. This vegetation type occupies the driest portions of the projects area, and are predominantly found outside of the Meadow Valley Wash flood plain.

Desert Willow Shrubland: While not a common vegetation type, this in one of the few that occur nearly throughout the project area. Only near Caliente is the desert willow shrubland absent. Desert willow, Chilopsis linearis, a riparian shrub or small tree is found scattered throughout the project area. It is found primarily in proximity to Meadow Valley Wash, but also can be found growing in upland areas quite distant. It apparently can persist in areas even when the wash moved laterally away over time. Most often desert willow is a component of tamarisk woodland, riparian forest, or the upland mixed canyon shrubland. There are some areas however, where desert willow is the dominant plant. In these situations the structure of the vegetation type is more shrub-like than tree-like and therefore it is classified as shrubland. There is a canopy with desert willow having an aerial vegetative cover of at least 25 percent, mainly between 5 and 20 feet high, sometimes with individuals reaching 30 feet tall. Desert willow shrubland is densest below 10 feet, but is never a very dense habitat. Subdominant species include: tamarisk; mesquite, *Prosopis glandulosa*; catclaw acacia, *Acacia greggii*; and quailbush, *Atriplex lentiformis*.

Developed Lands: These areas are developed as residential, commercial, or agricultural building areas.

Fremont Cottonwood Forest: Fremont cottonwood, *Populus fremontii*, is the largest tree within the project area, up to 80 feet high and several feet in diameter. It forms stands along the Meadow Valley Wash throughout the project area. While plants become established only where surface water and flooding occur, the mature trees can persist as long as subsurface water is present with the help of a deep root system. Fremont cottonwood has at least 25 percent aerial cover from 20 to over 40 feet tall in this vegetation type. Fremont cottonwood forests are often complex dense stands with many associated plant species found in the understory, however Fremont cottonwood is always the primary overstory species, distinguishing this type from riparian forest. Small patches of other plant types often exist within larger areas of Fremont cottonwood forest, including cattail marsh, bulrush marsh, coyote willow shrubland, red willow shrubland, and desert willow shrubland. In addition to these more dense and complex types, some areas of Fremont cottonwood forest are also found in upland areas where little understory exists. These are areas where the Meadow Valley Wash has either moved laterally within the flood plain, or eroded downward, leaving the Fremont cottonwood on benches.

Gambel Oak Shrubland: This vegetation type is found only within the northern third of the project area, and then only associated with rocky cliffs or canyons that provide a more mesic and shaded environment than that provided on the flood plain. It is never very common and is usually found on the perimeter of the project area. Gambel oak, *Quercus gambelii*, is the dominant species in this habitat, often with a rather diverse assemblage of understory plants. There is at least 25 percent aerial cover of Gambel oak, from 5 to 25 feet tall, most often more than 50 percent cover. This is not a major component within the Study Area, and is not of primary interest as it is not a riparian community. At higher elevations this type can be an important riparian community, but at these lower elevations it is restricted to side canyons mainly outside of the project area.

Greasewood Shrubland: Greasewood, *Sarcobatus vermiculatus*, is the dominant plant species in silty somewhat alkaline flats in the northern third of the project area, often on benches or within the Meadow Valley Wash flood plain. This vegetation type is rather dense, and has a diverse assemblage of grasses and forbs in the understory. This vegetation type is from 3 to 6 feet tall. Rabbitbrush, *Chrysothamnus viscidiflorus* and *Ericameria nauseosa*, and sagebrush, *Artemesia tridentata*, are often associates. This vegetation type is not of primary interest as it is not a riparian community within the Study Area.

Knapweed Meadow: This vegetation type is composed primarily of the noxious weed, spotted knapweed, *Acroptilon repens*. It is rare within the project area and is only found in one location in the southern quarter of the project area. It is very dense and is about 3 feet tall.

Mesquite Shrubland: Although mesquite, *Prosopis glandulosa*, is commonly found in many places in the southern half of the project area, it is the major predominant species in rather few areas. This vegetation type is rather dense, but can be patchy with open areas alternating with extremely dense patches of mesquite and catclaw acacia. Areas classified as mesquite shrubland have a aerial vegetative cover of at least 25 percent Mesquite - from 2 to 25 feet in height - mostly about 15 feet tall in the project area. Many of the mesquite plants in the southern 1/4 of the project area host mesquite mistletoe, Phoradendron californicum, a distinctive semiparasitic plant that forms broom-like growths in the branches.

Mixed Canyon Shrubland: This vegetation type is an assemblage of upland plants with no single species predominating. Species include sagebrush, greasewood, rabbitbrush, and desert willow. Grasses such as Great Basin wildrye, *Leymus cinereus*, and bluebunch wheatgrass, *Pseudoroegneria spicata*, are commonly found as well. This vegetation type varies from moderately open to very dense, and from 3 to 20 feet tall. This vegetation type is found primarily in the northern third of the Study Area, and is replaced by the mixed desert shrubland in the southern half. This vegetation type is not of primary interest as it is not a riparian community within the Study Area.

Mixed Desert Shrubland: This vegetation type is composed of several codominant shrub species including creosotebush, shadscale, burrobrush, desert willow, rabbitbrush, mesquite, as well as several other minor shrub species. It differs from creosote shrubland, which can be composed of creosote and shadscale, in being more diverse and tends to have a higher aerial plant cover and more grass and forb cover as well. Plant heights vary from 2 to 15 feet tall. It differs from Mixed Canyon Shrubland by it's predominance of Mojave Desert shrubs, which contrasts with the predominance of Great Basin shrubs in the Mixed Canyon Shrubland. This vegetation type is not of primary interest as it is not a riparian community within the Study Area.

Mixed Grassland: There are not many areas of grassland within the project area. Those that do exist were lumped into one vegetation type. Species were not extensively examined, but bluebunch wheatgrass, sand dropseed, *Sporobolus cryptandrus*, and Indian ricegrass, *Achnatherum hymenoides*, are commonly found. This vegetation type is not of primary interest as it is not a riparian community within the Study Area.

Mixed Marsh: The Mixed Marsh vegetation type is an assemblage of marsh types that do not fit into cattail marsh or bulrush marsh, but are too infrequent to classify separately. Cattails, and bulrushes are also found as components in these marshes, however, this type also include areas dominated by sedges, grasses, and forbs, such as Nebraska sedge, *Carex nebraskensis*; mannagrass, Glyceria species; and watercress, *Rorippa nasturtium-aquaticum*. The permanent water cover in this areas distinguish it from the mixed wet meadow.

Mixed Wet Meadow: Mixed Wet Meadow is a vegetation type that included herbaceous wetland plant communities characterized by low-statured vegetation and lack of standing water. Plants include saltgrass; yerba mansa, *Anemopsis californica*, spikerush, *Elocharis* species; and sedges, *Carex* species.

Open Water: This type is composed of the open water areas within the project area.

Pasture/ Agricultural Lands: Numerous pastures and haying areas are found in the project area. A few area of cropland, mostly fallow, also occur. These are all part of the Pasture/Agricultural Lands land type.

Quailbush Shrubland: Quailsbush, *Atriplex lentiformis*, is the dominant and nearly the only species in this vegetation type. Quailbush grows to a height of 5 to 8 feet and forms a very dense thicket. It is mainly found along roads and the railroad in the southern third of the project area. This vegetation type is not of primary interest as it is not a riparian community within the Study Area.

Quarry : A large rock quarry makes up this land type, located in the southern portion of the project area.

Rabbitbrush Shrubland: This vegetation type is dominated by rabbitbrush species, namely *Chrysothamnus viscidiflorus* and *Ericameria nauseosa*. A few varieties of these species are also named, however, extensive, plant taxonomy was not carried out for them. They all share similar characteristics, and form dense to moderately dense stands in the northern half of the project area from 2 to 6 feet tall. This vegetation type is not of primary interest as it is not a riparian community within the Study Area.

Railroad/ Road: Areas mapped as Railroad/road, are the paved and unpaved roads, and the railroad tracks found throughout the project area. The disturbed right-of-ways for these corridors provide suitable substrates for incidental plant species including knapweed and other noxious weed species.

Red Willow Forest: Red willow, *Salix laevigata*, is found throughout the northern third of the project area. It makes up a forest vegetation type where it grows to nearly 50 feet tall with trunk diameters of nearly 3 feet. Red Willow is the dominant tree and makes up at least 25 percent aerial cover in the canopy from 20 to over 40 feet tall. In most areas Red Willow makes up more than 50 percent of the aerial vegetative cover. Understory within this vegetation type is diverse and includes small areas of other wetland plant types, such as cattail marsh, bulrush marsh, mixed wet meadow, and coyote willow shrubland. Fremont cottonwood is a frequent subdominant species, as is velvet ash, Fraxinus velutina.

Red Willow Shrubland: Red willow shrubland is distinct from red willow forest in that it is composed of small multi-stemmed red willow plants and a nearly impenetrable thicket-like structure of between 5 and 15 feet tall. The type is composed of at least 25 percent aerial cover of red willow; although, in most areas, red willow has an aerial cover of more than 75 percent. This vegetation type is found in the northern portion of the project area in close proximity to the stream channel. Coyote willow is often a subdominant species, but other plants are rare and crowded out by the thick growth of the willows.

Riparian Forest: Riparian forest is composed of a mixture of Fremont cottonwood, velvet ash, red willow, tamarisk, and New Mexico locust, *Robinia neomexicana*, in the canopy from 20 to over 40 feet tall. It differs from Fremont cottonwood forest in this mixture of codominant trees, and by having a much more diverse understory. There is a mixture of species, with no plant thoroughly predominating - but overall riparian tree species make up at least 25 percent aerial cover, with most areas well over 75 percent in aerial cover. This vegetation type has a multi-storied canopy structure, and a quite diverse understory and ground layer. As with Fremont cottonwood forest, small areas of other riparian plant types are found within this type, including cattail marsh, bulrush marsh, mixed wet meadow, and coyote willow shrubland.

Riparian Forest Tamarisk Woodland Mix: This vegetation type is dominated by tamarisk, but has a significant amount of riparian trees, such as Fremont cottonwood, velvet ash, and red willow, interspersed throughout. Tamarisk is the predominant species and has at least 25 percent aerial cover, with other trees also with at least 25 percent cover. The tamarisk is usually between 15 and 25 feet tall, while other species are usually from 20 to 40 feet tall. It is mainly found in the middle portion of the project area. It is unclear whether tamarisk is out competing the other riparian species in these areas or whether it is a stable assemblage. There was some regeneration of Fremont cottonwood that was observed within this vegetation type, as well as areas where coyote willow is codominant with tamarisk.

Sagebrush Shrubland: Big sagebrush, *Artemisia tridentata* ssp. *tridentata*, is found only on the driest parts of the northern third of the project area. It is found throughout this region, but only is dominant in a few areas. This species is much more widespread north of the project area where it is the dominant species over a vast portion of Nevada, and other Great Basin states. This vegetation type is dominated by big sagebrush, but rabbitbrush is sometimes co-dominant. It is a fairly open vegetation type with an aerial coverage of Sagebrush from 25 to 50 percent, and about 2 to 6 feet tall. Numerous Great Basin grasses and forbs are also found, including bluebunch wheatgrass, Idaho fescue, *Festuca idahoensis*, Great Basin wildrye, and Indian ricegrass. This vegetation type is not of primary interest as it is not a riparian community within the Study Area.

Saltgrass Grassland: Saltgrass Grassland is found primarily on saline or alkaline silty flats where subsurface water is found. The vegetation type is nearly monotypic, but a few other species are often found, including Baltic rush, *Juncus balticus*, spikerush, and Yerba Mansa. Only three small saltgrass grasslands, totally less than three acres, were identified. One such type occurred as part of the large riparian complex north of Rox; the other two occurred adjacent to a large tamarisk woodland north of Vigo.

Screwbean Shrubland: Only one patch of this vegetation type was found in the project area. Screwbean, *Prosopis pubescens*, a shrub or small tree, is found sporadically in the southern third of the project area. This vegetation type is rather open and diverse, with mesquite and catclaw acacia as major components. Screwbean has a cover of at least 25 percent in this vegetation type.

Seep Willow Shrubland: Seepwillow, *Baccharis salicifolia*, and *Baccharis emoryi*, is common throughout the southern half of the project area. However, it only rarely forms plant communities where it dominates the vegetation. In the defined vegetation type, seepwillow forms a densely vegetated thicket with arrowweed, tamarisk, and coyote willow often at the edge of the Meadow Valley Wash where water is consistently found at the surface.

Shadscale Shrubland: Shadscale, *Atriplex confertifolia*, is found throughout the southern half of the project area where it makes up a major portion of the upland vegetation types. This vegetation type is dominated by shadscale, while other shrubs only make up a minor proportion. It is found on finer texture soils than creosote bush shrubland, but otherwise alternates with this vegetation type, along with mixed desert shrubland throughout the entire southern project area. This vegetation type is not of primary interest as it is not a riparian community within the Study Area.

Sparsely Vegetated/ Disturbed Lands: This land type consists mostly of lands that have had exposure to ground disturbing activities with a very low cover of weedy plants. Russian thistle, Salsola kali, and green molly, Kochia americana, are the main plant species found in these areas.

Tamarisk Woodland: Tamarisk, *Tamarix ramosissima*, an invasive species, considered a noxious weed in Nevada, is the predominant species found in the riparian areas in the southern half of the project area. It makes up densely vegetated thickets up to 25 feet high. Tamarisk has an aerial cover of 25 percent, but in most areas the aerial cover of tamarisk in this vegetation type is over 75 percent. Most often there is little understory, but along open water, small patches of cattail marsh, bulrush marsh, and water cress/duck weed marsh are commonly found.

Water Cress/ Duck Weed Marsh: This vegetation type is found in small patches throughout the project area, but only forms areas of substantial size that could be mapped in two locations. It is found in slowly moving water of between 1 and 18 inches in depth. Water cress, and duckweed, lemna species, are the dominant species.

Wolfberry Shrubland: Wolfberry; *Lycium pallidum*, is found sporadically throughout the southern half of the project area. In a few areas it is the dominant plant, and makes up a nearly monotypic wolfberry vegetation type. It forms a thicket averaging about 5 feet high, in flat fine textured soils, within the flood plain of Meadow Valley Wash.

APPENDIX B: MEADOW VALLEY WASH RIPARIAN INVESTIGATION DATA SHEET

MEADOW VALLEY WASH
RIPARIAN INVESTIGATION

Polygon ID #: _____ Date: _____
Photo #: _____ Time: _____
Sheet #: _____ Investigator: _____
Weather: _____

_____

HINK AND OMAR CLASSIFICATION

CANOPY		UNDERSTORY		TYPE	FLYCATCHER HABITAT	
				1 2 3 4 5 6		
				CAT MS MH AG OP OW	**G** YES	**G** NO

WATER WITHIN 125 FEET (area of water > 100 sq. ft)

NONE	SATURATED SOILS		STILL WATER		FLOWING WATER	
G	**G** Yes	**G** No	**G** Yes	**G** No	Riff Run Pool	**G** No

EXISTING CONDITIONS

STABILITY	HYDROLIGIC	HEALTH	SERAL CHANGE
G No Young Shoots	**G** Groundwater Pumps	**G** Dead Branches	**G** New Species
G No Older Growth	**G** Ditch or Drainiages	**G** Degradation	**G** Early Seral Stage

THREATS AND STRESSORS

G Channelization	**G** Fire	**G** Fragmentation	**G** Exotic Species
G Downcutting	**G** Development	**G** Mineral Extraction	Sp. _____ -
G Water Diversion	**G** Grazing	**G** OHV/recreation	Sp. _____ -

ADDITIONAL INFORMATION

G Fly Catcher Call	**G** Beaver Activity	**G** Tree Snags	**G** Recent Fire
G Cowbird	**G** Mistletoe	**G** Tree Cavities	**G** Flooding

Additional Notes: _____

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APPENDIX C: MEADOW VALLEY WASH ORAL REPORT

FINAL REPORT FOR MEADOW VALLEY WASH ORAL HISTORY

Prepared by Lesley Argo, Historical Ecologist
For Bio-West, Inc.
Project Code #903-2
May 7, 2004

INTRODUCTION

The following report was prepared for Bio-West, Inc. as part of the Meadow Valley Wash Baseline Ecological Assessment for the Lincoln and Clark County Commissioners. The information was derived from two oral history sessions conducted with current, long-term residents regarding the past environmental conditions along the riparian corridor of the Meadow Valley Wash (MVW). The first session of interviews was conducted during the week of December 15th through 21st, 2003. The second session was conducted from March 31st through April 5th, 2004. Between both sessions, a total of 16 interviews were completed with nearly 23 hours of recorded discussions. Some interviews involved multiple parties (i.e. husband and wife or family members together) bringing the total number of participants to 21 (See Appendix I). All of the participants listed signed an agreement authorizing the use of information on the tapes for the project by Bio-West and for donation to Nevada libraries (See Appendix II). One participant did not sign a release and, therefore, information from that interview was not included in this report. Of the 21 participants, 9 were residents from Caliente, 9 were from Moapa, 1 in Logandale, 1 in Overton and 1 at the Moapa Indian Reservation.

Questions for these oral histories were directed at conditions concerning water levels, flooding events and their results, vegetation and vegetation changes, animal occurrence, climate differences and other changes perceived over time. In addition, some historical photographs were collected. The people interviewed represented a wide range of professions and interests (i.e. scientists, hunters, ranchers, teachers etc.). This provided a broad perspective in the type of information that different people remembered and discussed. The participants also represented a wide range of ages. The oldest participant was born in 1913 and the youngest in 1953. This age range provided first hand recollection of the timeframe defined by Bio-West for this project (1930s to present). Even though it was outside the original scope of the project, information concerning conditions in the MVW prior the 1930s was also included because of the relevancy to the overall goals for the ecological assessment.

There were several challenges encountered in this project that were both common and unique for this type of oral history project and for this particular area. First, many former residents within the Meadow Valley Wash who would have been excellent resources have passed away, moved away, or were simply not available during the two scheduled sessions. These circumstances were regrettable but often unavoidable in oral history work. Second, the very nature of human memory was a challenge for recovering historical information about the environment. Most oral histories focus upon the things that humans remember the best – events. Environmental oral histories, on the other hand, ask people to describe the mundane backdrop behind those events. This is much more difficult for most people to recall. In other words, people tend to remember the actors and the storyline of the play much better than the stage on which they were set. Third, the study area for this project contains some 80 miles of riparian

corridor within the MVW from just north of Caliente to the confluence with the Muddy River near Moapa. Currently, most of the population lives at either the northern end of the study area in Caliente or towards the southern end in the Moapa Valley. While there is still some private land scattered throughout the corridor, it has very little year round residency. Historically, there were more people living within the MVW. However, even during the height of the railroad, agricultural and ranching development, people were still relatively isolated and tended to keep to family and small community groups (Brundy). Leisure time for long distance travel was limited and further constrained by the multiple stream crossings (Bradshaw, Wrights) and the expense of automobiles and parts during the war years (Pers. commun., Ute Leavitt). Therefore, people can recall certain stretches of the MVW better than others (i.e. Caliente to Elgin or Rox to Moapa) and few have familiarity with the entire 80 mile study area. These oral histories are combined as sort of a patch work quilt to cover the entire corridor.

Despite these challenges, the people interviewed had many memories to offer that were both informative and consistent among participants. Where possible, their recollection of historic conditions, along with some historical photo points, have been indicated on the aerial photography base maps prepared by Bio-West. The more general recollections are provided in a narrative format under the following headings: Water, Vegetation, Animals, Climate and Other Changes. The names of some specific participants are cited parenthetically to substantiate the source of the information for this report and to assist with future reference. The section on water begins with some very general observations about water and then addresses flooding, flood control and sedimentation. Vegetation incorporates riparian vegetation changes, observations concerning agriculture, and discussion of other plants. The section on animals is broken down by aquatic, terrestrial and avian species. A complete list of animals discussed by participants is provided in Appendix III. The section on climate is fairly brief and straight forward. Finally, the section of other changes includes information about the environment that was not easily categorized in one of the above mentioned sections.

WATER

Water was essential for all settlement, agriculture and development of the railroad in the MVW. But the water in the MVW was as ephemeral historically as it is today. The water in the MVW "rises" and "falls" above and below ground in a series of "water zones" (Bradshaw). For example, just south of Elgin, it may be dry for few miles then it raises again at Kyle and runs down to below Leith where it sinks and raises again at Carp (Bradshaw). This is the general pattern except in wetter years and, of course, if there is a flood (Bradshaw). To compensate for these water zones and times of low water, people devised irrigation systems to store and move water from one zone to another. Margaret Valentine remembers her father put in reservoirs at the Henrie ranch (or the old Kiernan Ranch) to store flood waters for irrigation at their lower ranch (known as the Lone Tree). The remnants of what is called the "highland ditch" seen along the hillsides by Leith (Bradshaw) further demonstrates the effort to move water for irrigation. Don Bradshaw said farming has been tried at the Carp area since the early Mormon settlers but the water dried up in the summer. He even gave it a try in the 1960s and put in about 400 acres of hay with two irrigation wells. The costs were simply too high and he eventually sold the property (Bradshaw). Rachel Wright remembered her father (Henry J. Schlarman) discussing the importance of water for the people and the railroad. Trains had to take on water about every

ten miles for the steam engines (Wrights). Participants noted that the water used by the trains was not surface flow, but came from wells and was pumped into reservoirs like at Carp (D. Rowe) or into water tanks like at Elgin (Bradshaw).

Several of the participants mention that there was more water in creek in their earlier memories (D. Rowe, Singletons, Wrights). The creek at the Yoachum family ranch (4 miles north of Caliente) got deep enough to provide swimming holes, and there were reports of children drowning in the creek in Caliente in the past (Singletons). A couple participants discussed contamination of the water. One recalled that before the sewage treatment plant was built, raw waste went into the creek and people living on the ranches below Caliente would get sick (Pete). The current sewage systems has had problems with groundwater seeping into the pipes and pushing the outflow to almost capacity (Orr). Although none of the streams in MVW have established maximum daily loads, Rick Orr said that the volcanic soils surrounding the watershed can provide for high levels of base phosphorus that can impact water quality. Although there have been derailments with some spills (i.e. grain and TV sets), people did not believe there was any hazardous contamination from those events (Orr, Leavitts).

Flooding

Flooding has had a large impact upon both the land and the culture in the Meadow Valley Wash. For example, "flood chasing" is a kind of recreation down in the Moapa Valley (Brundy, Haworth, Rice). According to Larry Brundy "you go find a hill and watch it". Jim Haworth also recalls that when he was a kid he would get in the flood waters on his horse, slip off the back, hold on to the horse's tail and "go for a ride". But the floods were also dangerous. Flood waters in the MVW could be heard coming from Warm Springs some 5 miles from the Wash (Haworth). The flood waters also carried a bad odor of death and decay with them (Wrights). When she was just a kid, Louise Hickman recalled her father stepped out on the porch because he thought he heard something strange. He came back to the breakfast table to hurry her family over to the neighbor's house on higher ground just in time to escape the rushing waters. It seems almost everyone has a good flood story. They occur just about every year to some extent, according to most, but with decreasing intensity. Some would like to see the flooding come back because the believed it did more good than harm for the land (Haworth).

Residents have good information to offer concerning when floods occurred, what impact they had on the riparian area, and when and where flood control measures were constructed by the Union Pacific Railroad, government agencies and private property owners. An important characteristic of flooding in this region is the combination of waters through different washes that culminate in the MVW (Wright, Haworth). Often these combinations will generate the big floods that people remember the most.

The Flood of 1910

Ruth Dewey says her Grandfather called this flood the "first one and the worst one". This flood doubled up with water coming out of the Clover Creek drainage (Pete) and is said to have started the channel through Caliente (Singletons, Pete). Since then, the channel just kept getting deeper and deeper until it made the creek. The Singletons recall Mariba's father saying

that before the flood of 1910 at the Yoachum's ranch, just north of Caliente, the ditch was not over 6''deep and the water used to just spread out. This flood is also infamous for what it did to the Union Pacific Railroad (UPRR) tracks that at that time ran essentially through the middle of the valley. A good portion of the current road through the MVW is constructed on what used to be the railroad grade prior to the "highline" in 1912 (Bradshaw; see map). Even the construction of this early grade had required piling up dirt and that begun to cut a channel for the wash. After this flood the railroad needed dirt to create the new highline grade and a way to help control the water so they dug a channel and used the dirt to build up the new highline grade (Bradshaw). That channel continued to get deeper and changed many areas where it used to be "swampish" through the canyon (Bradshaw). Stories of great flooding continue through the 1920s (Dewey, Singletons) but the next really big one comes in 1938.

The Flood of 1938

In Caliente, there was already a channel for the creek, when flood waters came, they clogged up the channel by the bridge and spread out over the Caliente area (Singletons). Ruth Dewey recalls that the flood took out about 40 acres of the Conway's ranch. She was teaching at Etna at the time and had to drive up on the railroad grade for a while to get down to the school. But in other areas the train tracks were left hanging because the water had cut under the tracks (Bradshaw). After the flood of 1938, the federal government offered to buy many of the farms and ranches in the MVW. There were some that took the opportunity but several stayed on there (Dewey, Bradshaw). Jim Haworth also remembers there were offers to sell land to the federal government. He said they offered very little and doesn't know anyone who took them up on the offer down by Moapa. Another response to this flood was control measures put in by the Civilian Conservation Corps (CCC) that are discussed in flood control. Even so, flooding continued in the MVW through the 1940s and each time the UPRR would use rip rap rock to keep it from undercutting the tracks (Bradshaw). Jim Haworth recalls rescuing a woman and child from the churning waters in 1941.

Floods in the 1980s

There is a large gap in stories told about the big floods until the wetter years of the 1980s. In 1981, another flood came out of California Wash and drowned 800 head of Holstein cows at the dairy in the Moapa Valley (Haworth). In 1984, multiple floods from spring run off and summer rains blew out much of Kershaw Ryan State Park near Caliente (Orr). Returning floods in 1987 and 1989 also did damage to the park (Orr). There was a significant amount of headcutting in the Clover Creek drainage and lots of sedimentation through Caliente (Orr)

Flood Control

Following the flood of 1938, a great deal of work was done by the Civilian Conservation Corp (CCC) to control flooding on both the northern and southern stretches of the MVW. In the northern end through Caliente, flood control was put in at Spring and Denton Heights (Bradshaw, Tibbets). The Army Corp of Engineers also dredged the channel through Caliente after the 1938 flood (Tibbets). The channel was about 30 feet deep and went all the way down to hard clay (G. Rowe, Tibbets). On the southern end, the CCC camped just south of Rox so that

they could haul water from there (Wrights) while they worked on flood controls south of Rox with 25-50 teams of horses using scrapers (Haworth). These structures could not be located on the aerial photographs but should be visible on the ground (Haworth, Wrights). Later, in the 1960s, the Army Corp of Engineers put in the Pine and Matthew Dams north of Caliente (Bradshaw, Tibbets). John Tibbets recalled that these dams really helped control the floods. He also said that they have slowed the water down so much it does not scour out the channel like it used to so more vegetation has developed. More recently, flood control was constructed within Caliente to drain ground water into the MVW creek to alleviate basement flooding in the town (Tibbets). Another relatively new catchment that gets mentioned on the southern end of the MVW is the gravel mine pits that fill up with water (Grady,Wrights, Leavitts). In the 1960s, Don Grady was hired to put in a diversion ditch for a private property owner just south of the "narrows" to protect their house from floods.

Sedimentation

One of the most frequently discussed results of the flooding in the MVW was sedimentation (silting, sand and gravel). Although many (especially around Caliente) report that the sedimentation is increasing, it is certainly not a new phenomenon for the MVW. Flooding used to bring a lot of sand and was a problem with the ditches and pipes in the 1930s (Bradshaw). When the flood waters receded, they left anywhere from 6-7 inches of mud (Pete). Floods brought a lot of rocks in down by Elgin (D. Rowe). At Cottonwood Canyon, sediments used to wash down and fill in under the railroad bridge all the time (D. Rowe). The UPRR has cleaned it out and used the deposited material to build up the road along there (Bradshaw). It has not washed down out of Cottonwood Canyon like that in a least 10 years (D. Rowe). The same type of work is done at the base of Taylor Mine road where the wash out has been moved around and used to build up the roads (Bradshaw).

According to residents in Caliente, the sedimentation and filling in of the creek channel has been quite dramatic in the past several years. As was mentioned previously, several remembered the creek as a 30 foot gulch. They say it has mostly filled up with sand now (G. Rowe, Tibbets, Singleton). The creek at the bridge crossing to Nevada Youth Center used to be about 4 feet below the culverts (10-12 feet in diameter) and now they are almost totally closed (Orr, Tibbets). Only about 2 feet of the culvert is still open (Orr). This type of sedimentation can be seen throughout Caliente (Orr). There was an emergency channel cleaning done by the Nevada Department of Transportation a few years back and they were only able to get the bridge to 10 feet above the water level when the original drawings from when the bridge was built show the bottom girder of bridge was 15 feet above the water level (Orr). Explanations for this increasing sedimentation include loss of understory vegetation in the upper watershed allowing for increasing erosion (Orr), more beaver ponds slowing down the water, dams upstream slowing the water down so it does not scour out, and increasing vegetation that traps more sediments (Tibbets, Bradshaw). Rick Orr described the sedimentation as a "mixed blessing" because even though from a resource standpoint the MVW is doing what it is supposed to do, sedimentation puts the community at risk during floods (Orr). There is less talk about sedimentation problems in the Moapa Valley and, in fact, some say that the channel is actually getting deeper (Valentine, Brundy). However, there is recollection that the Tamarisk got so thick in the old channel around Moapa that the flooding waters cut a new one (Wrights).

VEGETATION

The amount of specificity concerning vegetation is highly variable among participants. Some specific sites from interviews and photograph points are indicated on the aerial base map where possible. Overall, participants refer to the changes along the riparian corridor, changes in agriculture, and miscellaneous recollections regarding plants.

Riparian Corridor

An overwhelming number of the residents interviewed believed that, in general, vegetation along the riparian corridor has increased over time. They recall that it was more open, with less trees and vegetation (D. Rowe, Hickman, Haworth, Bradshaw, Tibbets, Dewey, Orr, Singletons, G. Rowe, Valentine, Brundy, and others). The change is often attributed to the removal of cattle from the riparian area, the invasion of Tamarisk and slower flood waters not scouring the channel (Bradshaw, Dewey, Haworth, Tibbets). When he was growing up, Don Bradshaw said the cattle kept the trees out of the creek area. Since around 1985, the tree growth has really taken off (Bradshaw). Tibbets says that once you got past first railroad bridge out of Caliente, there was more vegetation than in town because it had been dredged out in town to an extra depth. Rick Orr recalled that in the late 70s to early 80s, the creek channel was more or less open or a tunnel of mostly black willows and cottonwoods. He said there were little or no Gooding's willow or slender leaf willow except in patches where it was more open (Orr). Now, he says, it is thick with cattails, Goodings and slender leaf willows. Even though the vegetation has been cut back several times, the change has not been permanent (Orr). Flooding did strip vegetation out of the channel by the in recent years but it has come back substantially (Orr). For example, the area where Willow Creek joins the MVW above Elgin was scoured by floods and recovered very quickly (Orr). In many places the MVW has changed very little; still herbaceous understory with cathedral cottonwoods. He believe there are some places that are dying back because of a drop in the water table (Orr) (See map). South of Caliente, at Old Elgin, there were no trees until after the 1950s (G. Rowe). Even further south, Jim Haworth recalls that there was always brush to contend with but it was not as bad as it is now. He said it used to be able to get right up along the creek for the most part. There were mesquite trees up to just north of Rox and then the cottonwoods would start up (Haworth).

Another consistent recognition among participants is the spread and increasing density of Tamarisk (or salt cedar) in the MVW. Mariba Singleton remembered there were a few Tamarisk along the ditch at the Yoachum ranch when she was growing up (Singletons). It may have been planted along the creek as a stabilizer after dredging the channel in Caliente, said John Tibbets, because he can remember them growing up on the banks as a kid. Ruth Dewey remembers the Tamarisk being in the MVW for all her life but said that it was scarce enough early on that when you saw one, you would make a bouquet out of the flowers for the table. She thinks maybe some of the first ones she remembered seeing were down toward Leith and the Henrie ranch (Dewey). Margaret Valentine remembers that there were cottonwoods and black willow around the creek at the Henrie ranch and that the Tamarisk came in around the time she graduated from highschool (about 1937). From then on, she said, they just got worse up and down the MVW. Don Bradshaw remembers Tamarisk starting after the WWII (Bradshaw) and that he saw it first at Carp. He said the railroad used it to keep shifting sand off the tracks and does not remember

people complaining about it for some time (Bradshaw). However, Margaret Valentine recalled people trying to burn it out and cut it down but it just kept coming back. Further south, Jim Haworth remembered that the Tamarisk started in 40s to 50s. Now, Tamarisk is found essentially along the entire MVW. The distribution of it has not increased in recent years although the density of it has probably increased (Orr). Now, people talk about it getting thicker and thicker. There have been removal projects conducted around Moapa using prison labor (Grady), private attempts at clearing it on private lands (Grady, Leavitt). In 2003, a fire burned through a good portion of the Tamarisk forest at Carp (Bradshaw, Orr, G. Rowe).

Agriculture

Agriculture has been a part of the MVW since before the first white settlers arrived. Ruth Dewey's grandfather came to Elgin in the 1870s and he told her that the Indians had already been farming there. He told her that they left their cultivated land alone and that they all lived their together until the reservation was created and even beyond then. Margaret Valentine, growing up on the "old Kiernan place", said they used to have orchards and vineyards and that they raised hay just south of there. She recalled, "you could raise anything there". Rachel Wright says her father described the MVW as lush and green. It was named the Meadow Valley for a reason (Bradshaw). Charles Singleton recalled cutting native meadow hay at the Conway ranch in the 40s (Singleton). A lot of the area around the Conway ranch was just brush until they got the wells and were able to irrigate and put in alfalfa. They used to be able to get at least three cuttings out of the meadow hay (wild hay) down by Carp (Pete). But the meadow seems to have diminished (Bradshaw, G. Rowe). George Rowe says his grandmother told him it was mostly meadow between Caliente and Elgin but it is not been that way since he can remember it. Don Bradshaw also described places where the land was sub-irrigated and formed meadows and "swampish" areas all the way across the valley (See Map).

Other Plants

Some other plants and changes were discussed as well. Ruth Dewey remembers less rabbitbrush, more sagebrush and much less pinyon and juniper on the hillsides. Both Ruth Dewey and Dorothea Rowe recalled more wildflowers including foxgloves, California poppy, bleeding hearts and especially more Indian paintbrush. It was also noted that the Joshua trees did not look as good and healthy as they used to look (D. Rowe). Willard Pete remembered a plant he called "stinkweed" that the kids used to tease each other with when he was a boy. Between Moapa and Rox, there were greasewood, desert willows, snakeweed and lots of barrel cactus by Farrier (Wrights). A couple of women recalled collecting and eating watercress from around Rox by the steel bridge and believe it should still be there (Virginia Rice and Rachel Wright).

ANIMALS

Not surprisingly, many people recall sightings of animals better than vegetation. Animals are less ubiquitous and generally more dynamic than plant life. These interviews provide a good deal of information regarding animal life in the MVW. This section discusses the most commonly discussed aquatic, terrestrial and avian species. A complete list of animals is listed in Appendix III.

Aquatic Species

The aquatic species that people discussed included suckerfish, minnows, trout, frogs and several other introduced species. The residents remember suckerfish within the MVW and seem to think their populations have decreased some (Singletons) although they are still around. Many of the participants remembered chasing and catching the mudsuckers as a kid (Bradshaw, Valentine, Singletons). Mudsuckers are also called "horny head" suckers and the ones with lots of little spikes are called "hog fish" (Wrights). Everyone makes it clear that they were not any good for eating. There also used to be whole schools of minnows that looked like mini trout (Singletons). As a young boy playing in the creek, Charles Singleton recalled that the minnows and suckers were so common that it was a great game to step through the water and watch them scatter (Singletons). Workers at the UPRR used to catch minnows and sell them as fish bait in Las Vegas in the 40s (Singletons). Irene Benn said the kids did a lot of swimming when she was growing up and she also remembered there being small fish and frogs and such in the Muddy but they left them alone.

Trout, on the other hand, are believed to have increased in both numbers and range within the riparian area (Bradshaw). Although they are not native, the trout have been in Clover Creek drainage for a long time (Bradshaw, Singletons). No one could really recall the introduction of trout but it could have been done privately or from an agency putting in fish up at Eagle Valley Reservoir and then cleaning out the trucks (Orr). Either way, the trout were washed down from Clover Creek with flood waters, thrived, and multiplied to the point that they are at the head of Don Bradshaw's ditch by Elgin and come out his irrigation valve into the orchards!

Nearly everyone talks about catching, playing with or gigging frogs. Even if they did not eat them, they might have know someone that did. Don Bradshaw does not remember the bullfrogs being at Elgin as a kid and thinks they probably washed down from up stream and now they are all over. Others, specifically recall introductions of bullfrogs. For example, they were introduced around the Yoachum family ranch for food source around the 1940s (Singletons, Pete). Jim Haworth transplanted bullfrogs from Conway ranch to Warm Springs in the 70s. George Rowe remembers frog gigging and said you could bring back 15 frogs in a night. Overall, it seems the bullfrog populations are still thriving. John Tibbets remembers catching little leopard frogs with white spots when he was a kid. Margaret Valentine also remembers good sized frogs (or toads) being in her father's reservoirs but said they were not the imported kind like were down at Rox. There were also turtles that layed eggs in the banks along the MVW (Valentine and Brundy).

Residents of Caliente report that there are now crawfish (or crawdads) in the creek (D. Rowe, Singletons). There were Bass planted into in the beaver dams after the beaver were planted by Grapevine Canyon (G. Rowe). There are also bullhead catfish that were not there before in the MVW (G. Rowe). Jim Haworth remembers there being Carp and several people mentioned fishing for catfish down by the Muddy.

Terrestrial Species

The terrestrial animals that people discussed the most included raccoon, porcupine, beaver, deer, big horn sheep, tortoise and livestock. Both raccoon and porcupine are reportedly rarely if ever spotted anymore. While making trips to his grandfather's place as a kid (in the 40s and early 50s), George Rowe remembers seeing seven or eight porcupine between Caliente and Elgin every time. They were also known to be around the Tennille ranch in the 30s (Dewey), the Yoachum's place (Singletons) and at the Keirnan place (Valentine). Only one person has seen porcupine still around in the pinyon trees eating sap (Pete). Others say they have seen only one in the last 20 years in all of Lincoln County (G. Rowe) and that they are hardly ever found even around the pinyon trees anymore (Tibbets). The apparent decline is attributed to the 10/80 poison stations put out in the 1950s to kill predators (coyotes) that also killed off other animals (Tibbets). This explanation is also given for the reported decline in raccoon in the MVW. George Rowe said his Grandfather told him there used to be lots of raccoon between Caliente and Elgin until the bait stations were put out by the government in the 30s and 40s. Racoons were also reported to be accidentally poisoned during attempts to control birds in the corn fields (Wrights). This kind of trickle down effect by poison also killed off many skunks when there were attempts to get rid of gophers (Haworth). Now, there are raccoons near Warm Springs that did not used to be there (Haworth). George Rowe caught a raccoon just below Elgin for the first time in 40 years last year and John Tibbets saw a little one a few years back.

Unlike the porcupine and raccoon, participants report that beaver populations are increasing. Don Bradshaw does not remember his grandfather or father ever talking about beaver but now their dams are catching and holding sediments that used to spread out over the "Carp sink". There were several reports of the Nevada Department of Wildlife planting the beaver in 1950s or 60s (G. Rowe, Bradshaw) between Caliente and Elgin. Some people did not remember them being in the MVW before the 50s or when they were kids (G. Rowe, Pete). Others did recall them being in the Clover Creek drainage, around the Yoachum ranch north of Caliente and maybe around Rox (Tibbets, Singletons, Haworth, Wrights) but now they have spread to within Caliente and there are many more than in the past (D. Rowe, Tibbets, Bradshaw, Singletons, G. Rowe, Dewey and others). One explanation was that they were trapped pretty heavily for a while and may be coming back (Valentine, Brundy). When beaver built dams across Jim Haworth irrigation ditches out at Warm Springs in the 70s, the Nevada Department of Wildlife trapped them and put them in the MVW. Margaret Valentine also remembers beaver being brought in from St. George in the 1920s.

Another animal population reportedly on the rise is deer. George Rowe tells a story about his grandfather tracking a deer all day and never finding it. He said that if someone saw a deer between Caliente and Elgin it used to be the talk of the town in his grandfather's day (G. Rowe). The population has really exploded since the 50s to early 60s (Singletons, Pete, Bradshaw). Now, they are practically "taking over the town" (Pete) and are spotted in and around Caliente quite often (D. Rowe, Tibbets). Many believe they are looking for food and water because of the recent drought. Around Moapa, there is more mention of the big horn sheep than deer coming close to town in search of feed and water (Haworth, Wrights). In the 60s, the largest heard in the area was in the Mormon mountains. Then, in the late 70s, there was a disease that killed off a lot of the sheep (G. Rowe). They have also been reported sightings

around Caliente recently (Singletons). Ruth Dewey remembers a family of big horn sheep in Grapevine Canyon when picnicking with her family as a child (in the 20s). Margaret Valentine says her father once shot a big horn right out the window of her childhood house. They have also been seen in the Meadow Valley mountains and some were recently planted in the Delamar Range (G. Rowe).

The desert tortoise is mentioned frequently by participants. A couple people recall keeping them as pets when they were kids (D. Rowe, Tibbets). Some say they used to see a lot more tortoise (D. Rowe, Wrights) but they are still seen infrequently (G. Rowe) and others have never seen one (Grady). If a tortoise is spotted, it is usually only south of Elgin (Wrights, D. Rowe, Tibbets, G. Rowe). Predation by crows (or ravens) was also mentioned as a risk to the young tortoise.

Finally, many people brought up the fact that there are less cows, horses and burros in the MVW than there used to be (Haworth, Rice, Bradshaw). This change was attributed to policy changes such as restrictions and changes in grazing permits. Also, people used to round up the horses and burros to sell until they became protected (Haworth, Rice).

Avian Species

You can find "just about any kind of bird" in the MVW and there are more and more as you go north (Valentine, Brundy). Rachel Wright said her father talked about a lot of geese and ducks around her family ranch (Schlarman). She said it must have been a "flyway" of some sort and they liked to pond there. Margaret Valentine recalled ducks on their family reservoirs, too. Irene Benn remembered seeing ducks while living at Carp. There are also introduced turkeys, pheasants, and chukars reported from north to south (G. Rowe, Singletons, Wrights, Grady). Several people mentioned an increase in the crows or ravens (Singletons, G. Rowe, Tibbets). They also say that boat tail grackles have arrived in Caliente in the past 15 years or so (G. Rowe, Singletons). Because both crows and grackles are nest robbers, it may explain why there are not as many other birds (Singletons). A complete list of birds mentioned is provided in the Appendix III.

CLIMATE

Almost all of the participants discussed changes in climate. They not only discuss the more recent drought, but also the overall long term trend in warmer and drier weather. Many say there is less snow, less rain, it is less cold and much hotter than it used to be throughout the MVW (Tibbets, Wrights, Haworth, D. Rowe, Singletons, Dewey and others). There is wonderful anecdotal evidence for this change. For example, children used to sled down Denton Heights and Spring Streets in Caliente in the winter time. Now, kids in Caliente probably do not even own sleds (Singletons). Also, in the winter of 1947-1948, Charles Singleton ice skated right up company row in Caliente. The participants say they just do not have winters like that anymore. Several people mentioned a great snow storm that stranded and killed many cattle in the 1950s (Tibbets, Singletons, Haworth). Even Moapa used to get some snow every 10 or 15 years but, it has been a long time since that happened (Wrights). And, "you can't count on summer rain storms anymore either" (Singletons, Grady, Haworth). Jim Haworth said that he

used to be able to run 400 head cattle from Glendale to near Elgin year round, but now that area wouldn't take care of a hundred head year round because of the lack of rain.

OTHER CHANGES

Finally, when asked an open ended question about other changes that participants have noticed, there were several answers that did not fit easily into the previous headings. One is the change in transportation along the MVW. Multiple creek crossings in the MVW made travel difficult and discouraged people from buying cars (R. Wright). Before the new road was built in about 1977, there were 11 creek crossings between Caliente and Elgin that people could get stuck in (Bradshaw). Also, people used to be able to take the local train to go to school and back home (Bradshaw). Of course, the train no longer carries passengers through the MVW. Another is the change in fire. Some say it seems like there are more fires now than in earlier years (Singletons) and that they do not remember there being a lot of fires in the MVW (D. Rowe). George Rowe says that for at least 50 years, the railroad has sparked some fire but they do not really go very far. A different kind of fire in the sky, above ground nuclear testing, was once a part of life for people living in the MVW. There was one mention of cattle developing discolored spots and marks on their hind quarters following one of the nearby tests at the Nevada Test Site (Rice).

Other changes mentioned were changes in people and economics of the area. There were less ranches and less people living in the MVW as farming and ranching became less profitable (Dewey, Orr, Tibbets). At the same time, more people are moving into the Moapa area to commute to jobs in Las Vegas, retire, or even buy a second home (Grady, Wrights, Leavitts). There is also a change in what the children growing up around the MVW want to do for recreation. Some people say that kids do not do the same things they did; they would rather watch TV (Benn, Hickman). Others say it seems like people of all ages do not go into the MVW for recreation as much as they once did.

CONCLUSION

From this set of interviews, it is clear that the vegetation, hydrology, fauna, land use, climate and people of the Meadow Valley Wash have all been changing over the past nearly 100 years. These oral histories provide a unique look at historic conditions within the Meadow Valley Wash. The information they provide may not be found in other sources and can also help guide supplemental work. In conjunction with the other historical documentation and data collection in this project, a better understanding of the range of variability within the Meadow Valley Wash should begin to take form and provide valuable insight for formulating recommendations. A sincere and hearty thank you to all of the participants who gave their valuable time to this project.

Appendix I

Meadow Valley Wash Baseline Ecological Assessment
List of Oral History Participants
Prepared by Lesley Argo, Historical Ecologist
Project #903-2

Name	Occupation/Personal Info	Location	Born
Irene Benn	Grew up on Moapa Indian Reservation	Moapa Res.	1923
Donald Bradshaw	Agriculture/Orchards Former County Commissioner (60s) Family settled in Elgin in late 1800s	Caliente	1926
Larry Brundy	Grew up in Moapa Maiden name is Perkins Family settled in valley	Moapa	1939
Ruth Dewey	Retired teacher; maiden name is Bradshaw; family settled in Elgin in late 1800s	Caliente	1914
Donald Grady	Construction	Moapa	1926
James S. Haworth	Retired rancher, grew up in Moapa Valley	Moapa	1918
Louise Hickman	Grew up in Overton	Overton	1913
Gary Leavitt Dianne Leavitt	Grew up in Moapa Dianne's maiden name is Lewis	Moapa	1951
Richard Orr	Assistant Field Manager, BLM Caliente Field Office Former NRCS employee	Caliente	1953
Willard Pete	Retired Military Paiute; family in area since 1850s	Caliente	1924
Virginia Rice	Husband ran cattle and rounded up Horses and burros in MVW	Logandale	1933
Dorthea Rowe	Mail carrier to Carp Father and husband worked for UP	Caliente	1921

George Rowe	Lincoln County Commissioner Post Master, avid hunter, Dorthea Rowe's son	Caliente	1943
Charles Singleton Mariba Singleton	Retired Highway Department Mariba's maiden name is Yoachum Family settled in valley in late 1800s	Caliente	1929 1928
John Tibbets	Youth Center Employee Hobby historian and collector Grew up in area	Caliente	1941
John B. Wright Rachel Wright Bob Lyman	Retired Airforce Rachel's maiden name is Schlarman son-in-law	Moapa	1935
Margaret Valentine	Grew up in MVW Maiden name is Henrie	Moapa	1920

Appendix III

Animals Mentioned During Interviews

Mammals

Deer
Racoon
Porcupine
Rabbit
Beaver
Mountain Sheep
Coyote
Grey and Red Foxes
Skunks
Horses
Burros
Badger
Bob Cats
Mountain Lion
Chipmunks
Ringtailed cats

Reptiles

Tortoise
Chuckwallas
Gila monsters
Horny toads (Moapa)
Bullfrogs*
Turtles (by Moapa and Muddy)
Leopard frogs
Rattlesnakes
King snakes

Fish

Carp* (in the Muddy River)
Crawfish* (Caliente)
Suckers
Trout* (From Caliente to Elgin)
Minnows
Bullhead catfish

Birds

Quail
Crows (or Ravens)
Ducks
Geese
Road runners
Turkeys* (Caliente/Moapa)
Pheasants
Eagles
Robins
Mocking birds
Owls
Hawks
Swallows
Orioles
Humming birds
Grackles
Starlings
Woodpeckers
Mourning Doves
Redwinged black birds
Chukars*
Geese
Blue jays
Blue birds
American Kestral

* mentioned as an introduced species

APPENDIX D: DRAFT MEADOW VALLEY WASH RIPARIAN EVALUATION HYDROLOGIC CONDITIONS REPORT

Meadow Valley Wash Riparian Evaluation Hydrologic Conditions Report

March 2005

B-W PN 903

Submitted by:

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Providing Context-Sensitive Environmental Services Since 1976

Meadow Valley Wash Riparian Evaluation
Hydrologic Conditions

1. INTRODUCTION

A baseline riparian ecological assessment of Meadow Valley Wash is being completed as part of habitat conservation planning efforts for Lincoln and Clark Counties, Nevada. One component of the baseline riparian assessment involves evaluating the hydrologic conditions within the riparian vegetation communities present along the Meadow Valley Wash. This technical report describes the methods and results of this hydrologic conditions inventory. A description of some potential mitigation opportunities is also provided as part of this report.

2. METHODS

REACHES AND TRANSECT SURVEYS

The current Study Area is synonymous with the overall Meadow Valley Wash Riparian Vegetation Evaluation Study and includes the stream channel and riparian corridor of the Meadow Valley Wash from approximately one mile north of Caliente, Nevada to the confluence with the Muddy River near Moapa, Nevada. Elevations range from approximately 4,500 feet north of Caliente to approximately 1,600 feet near the confluence with the Muddy River at the south end of the Study Area. Within the Study Area, Meadow Valley Wash was divided into eight large-scale reaches with generally similar channel pattern, valley width, land use, and streamflow characteristics. Because the Study Area spans more than 80 miles of stream length, it was not feasible to develop a complete longitudinal profile (slope) map of the entire Study Area within the scope of this baseline assessment effort. Similarly, it was not feasible to comprehensively classify each individually-homogeneous stream segment using a system such as the Rosgen classification (Rosgen 1994). Instead, the reach breaks that were established simply represent large-scale differences in overall geomorphic setting and dominant land use. Table 1.1 lists some general characteristics of each reach.

In upstream to downstream order, the eight reaches and their abbreviations are:

1. Caliente Reach (CA)
2. Etna Reach (ET)
3. Upper Rainbow Reach (UR)
4. Rainbow Canyon Reach (RC)
5. Elgin Reach (RR)
6. Cottonwood Reach (CW)
7. Vigo Reach (VI)
8. Rox Reach (PE)

Within each of these eight reaches, two transects were surveyed for a total of 16 transects. In each reach, one of the transects was located in an area with relatively high quality riparian habitat, and the other transect was located in an area with lower quality/degraded habitat. In general, transects were not placed in portions of reaches that lacked flowing surface water. Rather, the transects representing "degraded" habitat were typically placed in areas that appear to have the potential to support higher quality riparian conditions, but have been degraded by anthropogenic impacts of some sort. Surveys were completed using a total station, rod and prism.

Transect endpoints were permanently monumented by installing rebar (buried to ground-level) at each transect endpoint. Each rebar endpoint was capped with a metal or yellow plastic cap and labeled with the reach abbreviation and transect number. Coordinates of each endpoint were obtained using a standard (multi-meter accuracy) GPS unit. By monumenting these transect endpoints with capped rebar, future monitoring and repeat surveys at the same transect locations will be possible. The reach and transect locations are shown in Figure 1.1.

Table 1.1. General Characteristics of Study Reaches

Reach	Valley Width	Channel Pattern	Streamflow	Land Use
CA	wide	single-threaded	flowing	urban
ET	wide	primarily single-threaded	flowing	grazing/ agriculture
UR	moderately wide	primarily single-threaded	generally flowing; loses flow near bottom of reach	some grazing/ agriculture
RC	narrow/ confined	primarily single-threaded	flowing	recreation
RR	moderately wide/ occasionally confined	primarily single-threaded	dry in upstream part; flowing in downstream part	recreation; some agriculture
CW	moderately wide	primarily single-threaded	flowing	recreation
VI	very wide/ unconfined	relatively straight, multi-threaded	dry in upstream part; flowing in downstream part except where diverted	grazing/ agriculture
PE	generally very wide/ unconfined with narrower sections at top of reach and near Rox	meandering/ single-threaded in confined sections; otherwise straighter and multi-threaded	alternates between dry and flowing sections	grazing/ agriculture; some residential near Glendale at downstream end of reach

Figure 1.
Meadow Valley Wash
Hydrologic Conditions
Overview Map

0 1 2 4
Miles

Cross Section Endpoints

Stream Gauges

River Reaches

- Caliente Reach
- Cottonwood Reach
- Etna Reach
- Rox Reach
- Rainbow Canyon Reach
- Elgin Reach
- Upper Rainbow Reach
- Vigo Reach

CA1
CA2
Caliente
ET2
ET1
9418500
Etna
Stine
UR1
UR2
Boyd
RC1
RC2
Elgin
Kyle
RR1
RR2
CW1
CW2
Cottonwood Wash
Leith
Carp
VI1
VI2
Rox
PE1
PE2
9418700
Glendale

File: D:\biowest\meadow_valley\maps\hydromap.mxd, Sep 13, 2004 12:57:45 PM, GEO/Graphics, Inc.

HYDROLOGY

Gage Data

Two U.S. Geological Survey (USGS) gaging stations –one near Caliente/Etna, and one near Rox –are located on Meadow Valley Wash within the Study Area (Figure 1.1). The Caliente gage provides 48 years of daily flow data, while the Rox gage has collected data for a total of about 10 years (Table 2.1).

Table 2.1. Meadow Valley Wash Gage Stations.

Gage Name	Gage Number	Period of Record
Meadow Valley Wash near Caliente, NV	09418500	2/1/51-9/30/60; 12/1/64-9/30/83; 10/1/84-present
Meadow Valley Wash near Rox, NV	09418700	2/6/87-9/30/94; 10/1/01-present

Flow duration curves were developed using the complete daily flow records for each gage. A log-Pearson Type III flood frequency analysis was completed using peak flow data at the Caliente gage. No flood frequency curve was developed for the Rox gage, because only 7 years of peak flow data are available.

Field Discharge Measurements

At transects with measurable flowing water, BIO-WEST measured discharge using a velocity meter. For some transects, vegetation (cattails or algae) in the channel made it impossible to obtain an accurate measurement directly at the transect; in these cases, discharge was measured slightly upstream or downstream from the transect where the channel became clear enough to accurately measure discharge.

HYDROLOGIC ASSOCIATIONS ANALYSIS

Previous studies of flow regime effects on riparian ecosystems have found that certain vegetation communities are associated with specific depth, frequency and duration of inundation (Auble et al. 1994). In order to assess these relationships for Meadow Valley Wash, at the transects where vegetation types occupied specific topographic levels, hydraulic conditions were modeled to determine the range of flows associated with the vegetation type. Specifically, calculations were performed using WinXSPRO cross-section analysis software. This software uses inputs of slope and roughness to determine the stage-discharge relationship at a given cross-section (transect).

Water surface or streambed slopes were surveyed in the field at the time of the transect surveys. Low-stage roughness (Mannings "n") values were back-calculated from field-measured discharge and stage values for the transects with measurable streamflow. High-stage roughness values and low-stage values for sites without measurable streamflow were estimated using published Manning's "n" tables (Bedient and Huber 1992). At transects RR2, CW1, and VI1, the back-calculated "n" values were unreasonably high (0.27, 0.20, and 0.53, respectively). At RR2 and CW1, the low-flow stage is likely elevated due to downstream beaver activity. At VI1, which is located in a recently-burned area, the unusually high stage at low flow is most likely a function of the thick algae growing in the channel as well as the indefinite elevation of the extremely soft, unconsolidated, "bottomless" silt streambed. For these three transects, a low-stage "n" value of 0.18 was used, which is one of the highest published "n" values for natural channel/floodplain areas.

3. RESULTS

REACHES AND TRANSECT SURVEYS

Table 3.1 provides locations and descriptions of the transect endpoints. Transect plots are included in Appendix A, and photos of the transects are provided in Appendix B.

Caliente Reach

This reach is located in the vicinity of the town of Caliente, and is affected by roads and residential and commercial development. Although it is bordered by residential development on both sides and is relatively narrow, transect CA1 crosses an area with fairly diverse, dense riparian vegetation. Transect CA1 represents the "higher quality" riparian habitat within the Caliente Reach. In contrast, transect CA2 crosses a portion of the channel that has poor riparian diversity and density due to sediment impacts from uncontrolled roadside erosion. In general, valley width is fairly wide in the Caliente Reach.

Etna Reach

In this reach, Meadow Valley Wash flows through a fairly wide, unconfined valley, and is affected by grazing and agricultural land uses in portions of the reach. Transect ET1 is located in a grazing-affected area where the channel flows through fine-grained alluvial deposits. The stream is incised and narrow at ET1, and riparian vegetation consists only of a narrow strip of grass on either side of the channel. Some mature red willow trees are present on the streambanks upstream and downstream from transect, but overall riparian vegetation width, density, and canopy cover are generally poor in the vicinity of ET1. In contrast, the channel at transect ET2 is wider and less entrenched, and contains more extensive riparian vegetation. Transect ET2 represents the "high quality" riparian habitat within the Etna Reach, while ET1 represents degraded riparian habitat conditions in the reach.

Table 3.1. Transect Endpoint Locations.

Transect Name	End-point*	UTM Zone 11 south/ NAD 83 Coordinates from GPS**			Description
		Easting	Northing	Elevation (ft)	
CA1	LEP	719560	4166319	4402	metal cap; ~2' downstream of fencepost
CA1	REP	719540	4166347	4411	yellow plastic cap
CA2	LEP	718325	4165396	4386	yellow plastic cap; ~1' upstream of wood stake
CA2	REP	718267	4165430	4373	metal cap; ~2' upstream of fencepost
ET1	LEP	716492	4160764	4247	yellow plastic cap
ET1	REP	716469	4160781	4263	metal cap; ~2.5' upstream of fencepost
ET2	LEP	716025	4160437	4267	yellow plastic cap; at edge of mature cottonwoods; rock cairn
ET2	REP	715985	4160463	4244	metal cap; on floodplain ~25' from toe of road fill
UR1	LEP	714090	4150159	3896	metal cap; ~2' upstream and ~2' east of fencepost
UR1	REP	714061	4150137	3898	yellow plastic cap; ~1' downstream of wood stake at edge of wetland veg.
UR2	LEP	714452	4149388	3871	metal cap; ~1.5' upstream of fencepost
UR2	REP	714420	4149384	3850	yellow plastic cap; just upstream of rusted car part
RC1	LEP	716337	4140706	3662	metal cap; ~1.5' upstream of fencepost
RC1	REP	716315	4140665	3575	yellow plastic cap; ~4' in from white line on road
RC2	LEP	716826	4140044	3429	yellow plastic cap; halfway down steep slope in line with wooden stake at top of slope
RC2	REP	716760	4140017	3474	metal cap;~2.5' upstream of fencepost at toe of road fill
RR1	LEP	722535	4132912	3211	metal cap; ~250' west of road and ~3' upstream of fencepost
RR1	REP	722435	4132885	3233	yellow plastic cap
RR2	LEP	723380	4132358	3179	metal cap; ~3' upstream of fencepost at top of road fill

RR2	REP	723381	4132327	3188	yellow plastic cap
CW1	LEP	724688	4130720	3090	metal cap; downstream of very large cottonwood tree trunk
CW1	REP	724656	4130713	3069	yellow plastic cap near wooden stake between 2 large cottonwoods
CW2	LEP	724166	4129814	3079	metal cap; ~2' downstream of fencepost and ~3 ft upstream of large cottonwood tree trunk; rock cairn
CW2	REP	724143	4129801	3063	yellow plastic cap; upstream from large cottonwood tree and near rocks marked with orange paint
VI1	LEP	722380	4108959	2545	metal cap near road
VI1	REP	722331	4109012	2574	yellow plastic cap; marked w/rock cairn
VI2	LEP	716510	4103346	2441	metal cap; ~2' from road edge; ~4' southeast of fencepost
VI2	REP	716486	4103353	2416	yellow plastic cap
PE1	LEP	708026	4081411	1833	metal cap; ~3' upstream/downhill of fencepost
PE1	REP	708001	4081414	1830	yellow plastic cap near shrub
PE2	RIP	708570	4080351	1834	yellow plastic cap on right bank of stream
PE2	REP	708540	4080329	1820	metal cap; ~2' downstream of fencepost and ~10' from toe of railroad fill slope; near barbed wire fence

** LEP=left (facing downstream) endpoint; REP= right endpoint; RIP=right intermediate point*
***GPS coordinates taken with standard (i.e., NOT survey-grade) GPS unit*

Upper Rainbow Reach

In this reach, the valley becomes narrower than in the Etna and Caliente reaches. In portions of the Upper Rainbow Reach, Meadow Valley Wash is affected by grazing and agricultural land uses. In general, the riparian corridor in this reach contains diverse vegetation including cattails, willows, and cottonwoods. However, in a number of places within the reach, road and road fill impacts from the main road as well as various side roads limit the width of the riparian corridor by cutting off historic meanders and filling in floodplain areas. Transect UR1 represents "high quality" riparian conditions within the UR reach, and crosses a slowly-flowing section of the channel between two small beaver dams. Vegetation is fairly dense, consisting of cattails with a cottonwood and willow over story. A mix of grass, rush, and horsetail occupies the slightly higher ground on either side of the main channel, and the drier portion of the right floodplain supports an herbaceous understory with some scattered cottonwoods. In contrast, transect UR2 supports very little riparian vegetation -

only a narrow band of cattails. Transect UR2 crosses the channel at a site where road fill and a culvert have been placed across the stream, creating a wide ponded area. Although high quality riparian habitat (moderately dense stands of cottonwoods and willows) is located upstream and downstream, the poorly designed road crossing at UR2 blocks streamflow and negatively impacts riparian conditions. Transect UR2 represents degraded/impacted riparian habitat conditions within the Upper Rainbow Reach.

Rainbow Canyon Reach

In this reach, Meadow Valley Wash is confined between steep canyon walls and valley width is narrow. Although the narrow canyon naturally restricts overall riparian corridor width, in some portions of the reach the road and railroad further limit riparian width. Transect RC1 is located in a section of channel that is narrowly confined between the road fill on one side and the railroad fill on the other side. Although both grass and cottonwood trees are present at RC1, their habitat value is lessened by their low density and narrow width. In contrast, transect RC2 crosses a wider portion of Meadow Valley Wash where dense, tall cattails are present in the main channel and the broad right floodplain contains a 70-foot-wide stand of dense cottonwood trees. Transect RC1 represents impacted/lower quality riparian habitat conditions, while transect RC2 represents higher quality riparian habitat within the Rainbow Canyon Reach.

Elgin Reach

As Meadow Valley Wash exits the narrow Rainbow Canyon Reach and widens out near Elgin, the channel becomes dry and riparian vegetation becomes sparse. Just downstream from Rainbow Ranch, groundwater rises close enough to the ground surface to support a wider riparian corridor, then rises to become surface water near Kyle. Recreational land uses such as camping and off-road vehicle riding are the most significant in terms of affecting Meadow Valley Wash in this reach. Transect RR1 spans a very wide floodplain/riparian corridor upstream (north) of Kyle, where flow is still entirely below the ground surface at the transect. At RR1, there is evidence of aggradation from natural tributary and upstream sediments inputs (i.e., trunks of cottonwood trees are buried in sand), and no surface flow is present. However, groundwater is apparently near the surface because RR1 supports a very wide stand of dense, mixed-age cottonwood and willow trees. Transect RR2 is located about 4,000 feet downstream, where flowing surface water is present. However, the channel is confined between the road and railroad at RR2, which limits riparian width and overall habitat value. Transect RR2 therefore represents impacted/lower quality riparian conditions within the Elgin Reach, while RR1 represents higher quality riparian vegetation conditions. Beaver activity is evident throughout the Elgin Reach, and alters local flow and channel conditions.

Cottonwood Reach

The Cottonwood Reach is a short reach located in the vicinity of Cottonwood Wash. Land use and valley width in this reach are similar to Elgin Reach. Rather than specifically representing "high" vs. "low" quality riparian conditions, the two Cottonwood transects (CW1 and CW2) were set up specifically to compare streamflow and riparian conditions upstream and downstream from a major tributary wash (in this case, Cottonwood Wash) that contributes large amounts of sediment to the mainstem of Meadow Valley Wash. Sediment inputs from Cottonwood Wash appear to reduce the

amount of surface water flow downstream (see Hydrology Results section below). This is likely due to the process of streamflow infiltrating into the coarse sediment deposits and converting into groundwater.

Although the overall riparian widths at both CW transects are narrow relative to the broad corridors present at RR1 and RC2, the reduced streamflow at CW2 results in a somewhat narrower riparian corridor than at transect CW1. At CW2, herbaceous wetland plants and macrophytes are present in narrow (about 4feet wide) bands along the margins of the open-water portion of the channel, and a 3 foot wide strip of young Fremont cottonwood is present on the right bank. A few scattered mature cottonwood trees are present on the floodplain beyond the banks, but there is no riparian understory growing in the bare, dry sand and gravel floodplain deposits. At CW1, a stand of tall, dense cattails occupies the wet part of the main channel, with thick willows and cottonwoods present along the banks.

Vigo Reach

In the Vigo Reach, the character of Meadow Valley Wash changes dramatically from the upstream reaches. The valley becomes very broad, and the channel changes from a generally meandering, single-threaded pattern to a less-sinuous pattern with multiple, ill-defined threads. Tamarisk becomes a dominant riparian species. The upstream part of the Vigo Reach is dry, with surface flow returning near Carp. Much of the Vigo Reach is in private property, and agricultural/grazing practices along with water diversions affect streamflow and riparian conditions in the reach. Because so much of this reach is private property that could not be accessed, the results presented here are based on observations made at the few accessible locations and do not necessarily represent conditions throughout the entire Vigo Reach

Transect VI1 crosses a section of channel that recently burned. Although the left floodplain is quite broad at VI1, the only riparian vegetation currently growing at the transect is new tamarisk shoots coming out of the burnt trunks. The floodplain ground surface consists of bare sand. Thick "new-growth" tamarisk occupies both banks at this transect. The channel is narrow and incised, with dense macrophytes and filamentous algae occupying the wet portion of the channel. The large amount of algae at this site is most likely due to the loss of shading and canopy cover following the fire, resulting in higher water temperatures and greater light penetration. The lack of ground cover appears to have resulted in considerable erosion and sedimentation in this section of channel. At VI1, the in-channel substrate consists of soft, "bottomless", unconsolidated silt and sand deposits greater than 5 feet deep. There is good streamflow at this site, and if the area had not recently burned, it would likely support a wide, dense riparian corridor dominated by tamarisk. Unless management efforts are undertaken to prevent further tamarisk re-growth and promote growth of other riparian species, the transect will most likely return to this condition. Although other species such as willow may be more "desirable", a wide, thick tamarisk corridor would provide high quality shading and canopy habitat. Therefore, transect VI1 is considered to represent the potential for "good" riparian conditions within the Vigo Reach.

In contrast, transect VI2 crosses an area that has been affected by cattle grazing and flow diversion, and therefore represents "lower quality" riparian conditions within the reach. The riparian corridor at VI2 is narrow and dominated by tamarisk. VI2 is located downstream from a water diversion, and there was no streamflow at the time of BIO-WEST's survey–just some shallow standing water choked with algae. The channel at VI2 is relatively narrow and incised, which may be the result of overgrazing. However, additional research into historical channel conditions, grazing and irrigation practices, and natural factors such as arroyo inputs would be needed to conclusively identify the factors responsible for the current riparian conditions.

Rox Reach

Much of the Rox Reach is similar in character to the Vigo Reach, with a wide valley and multiple ill-defined channel threads; however, in the upstream-most part of the Rox Reach and also in a section near Rox Siding, the valley narrows and the channel becomes single-threaded and more sinuous. Large portions of the Rox Reach are dry. Agriculture and grazing are the main land uses within the Rox Reach. Several gravel pits are also present within the lower half of the reach, and near Glendale/Moapa, some residential development has occurred near the wash.

Transect PE1 is located in a fairly wide section of valley (valley width is about 1450 feet), but the width of the riparian corridor is narrow because the stream channel is deeply incised in this location. The flow is stagnant and filled with algae at PE1. Extremely dense willows and dead willow branches are present on each bank; tamarisk are also present immediately upstream and downstream from PE1. As with transect VI2, it appears that the narrow, incised condition of PE1 may be due to overgrazing, but, again, additional research would be needed to definitively determine the cause of the current conditions. PE1 represents degraded/low quality riparian habitat conditions within the Rox Reach.

Transect PE2 is located in a portion of Meadow Valley Wash where the total valley width is only about 250 feet. The right floodplain at PE2 is fairly broad and densely vegetated with a mix of willow and tamarisk, providing high quality riparian habitat. Flow at PE2 is stagnant and ponded behind a beaver dam, and was too deep to wade completely across to survey. However, the left side of the transect that could not be surveyed contains only a narrow band of riparian vegetation because the left side of the channel is very close to the steep valley wall at this location.

HYDROLOGY

Gage Data Analysis Results

As seen in the flow duration curves developed from the historical USGS gage data, (Figure 3.1), flows at Rox are typically between 0.3 and 3 cubic feet per second (cfs); at Caliente flows are typically between about 1 and 10 cfs. Streamflow at both gages follows a similar seasonal pattern, with the highest flows occurring in the winter and early spring and the lowest flows occurring in the summer and early fall (Figure 3.2). Based on log-Pearson Type III analysis of the Caliente gage peak flow data, the magnitude of a flood with a recurrence interval of 1 year is about 4 cfs, while the 2-year flood magnitude is about 300 cfs (Figure 3.3).

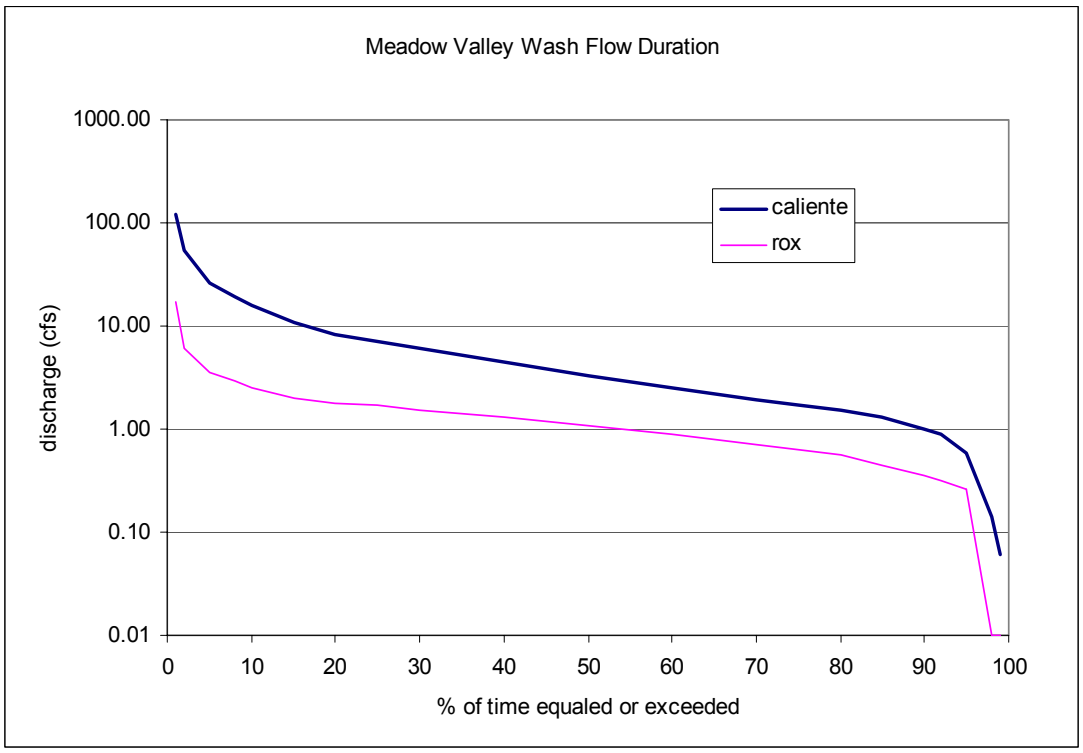

Figure 3.1. Flow duration curves for USGS gages on Meadow Valley Wash.

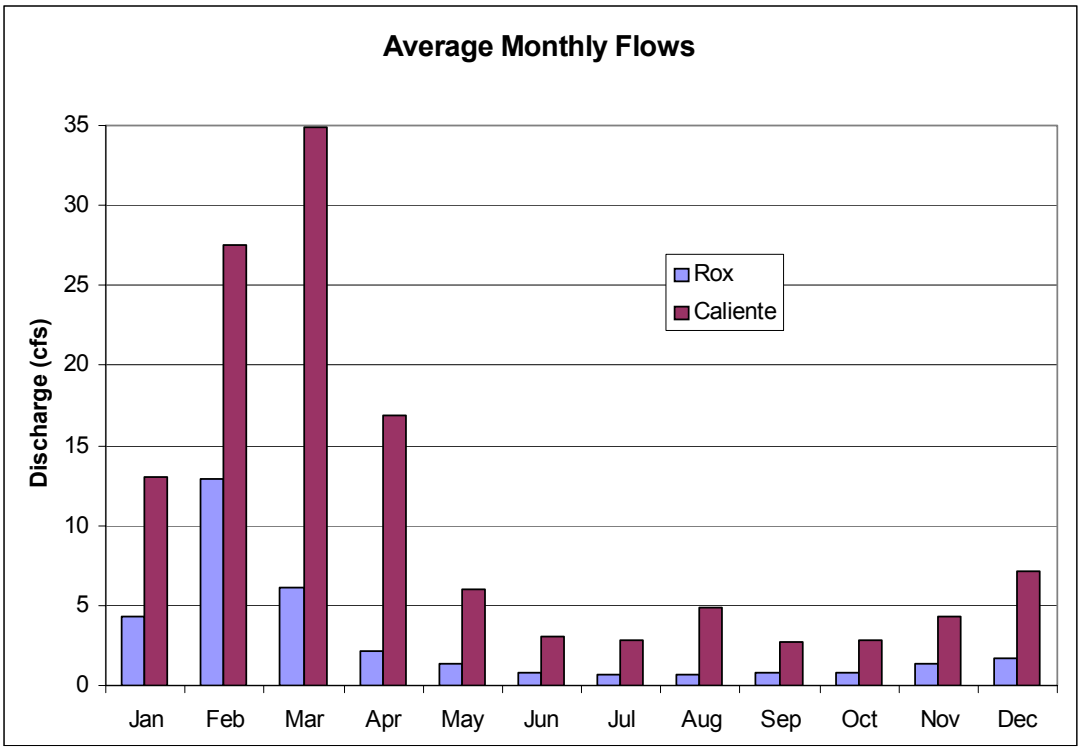

Figure 3.2. Average Meadow Valley Wash mean monthly streamflows at the Rox and Caliente gages.

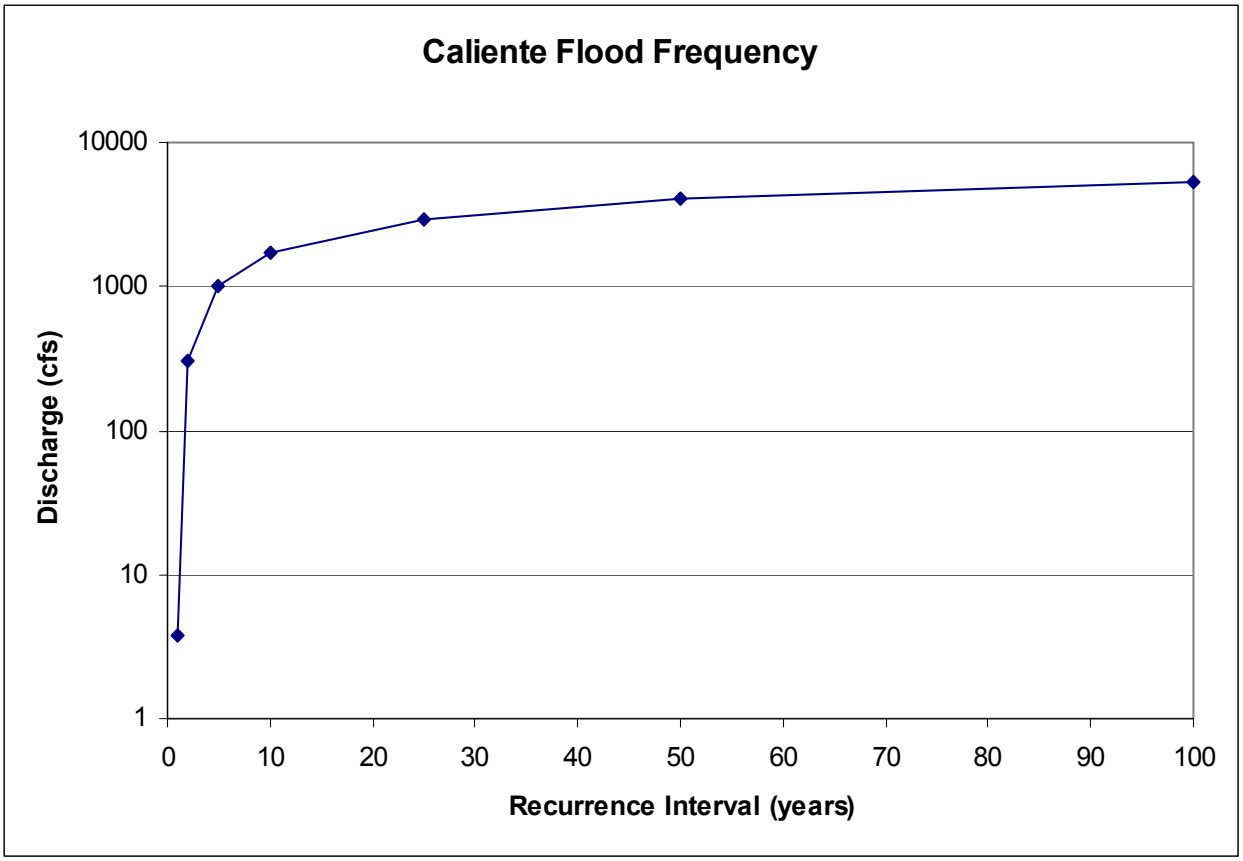

Figure 3.3. Flood frequency (log-Pearson Type III) curve for Meadow Valley Wash near Caliente.

Annual peak flows reported for the Caliente gage since 1951 range from a low of 25 cfs in 1991 to a high of 2,400 cfs in March, 1978 (Figure 3.4). Five of the seven highest recorded peak flows occurred during the wet period from the late 1970's to the early 1980's. The highest flow within the last 10 years – 1,930 cfs – occurred in March, 1995.

Discussion of Surface Water-Ground Water Patterns

As evident in Figures 3.1 and 3.2, discharge is typically greater at the Caliente gage than at the Rox gage, even though the total drainage area is greater downstream at Rox. This is just one indication of the fact that surface flows in Meadow Valley Wash do not follow "typical", straightforward hydrologic patterns. Within the Study Area, Meadow Valley Wash passes through highly variable geologic settings, including wide alluvial valleys and constricted, steep canyons. Numerous tributary arroyos bring in large amounts of sediment that are deposited in various locations along the mainstem valley. The Wash starts off at an elevation of 4400 feet in Caliente and drops to less than 1800 feet as it reaches Moapa, resulting in major temperature and climate differences between the upstream and downstream parts of the Study Area.

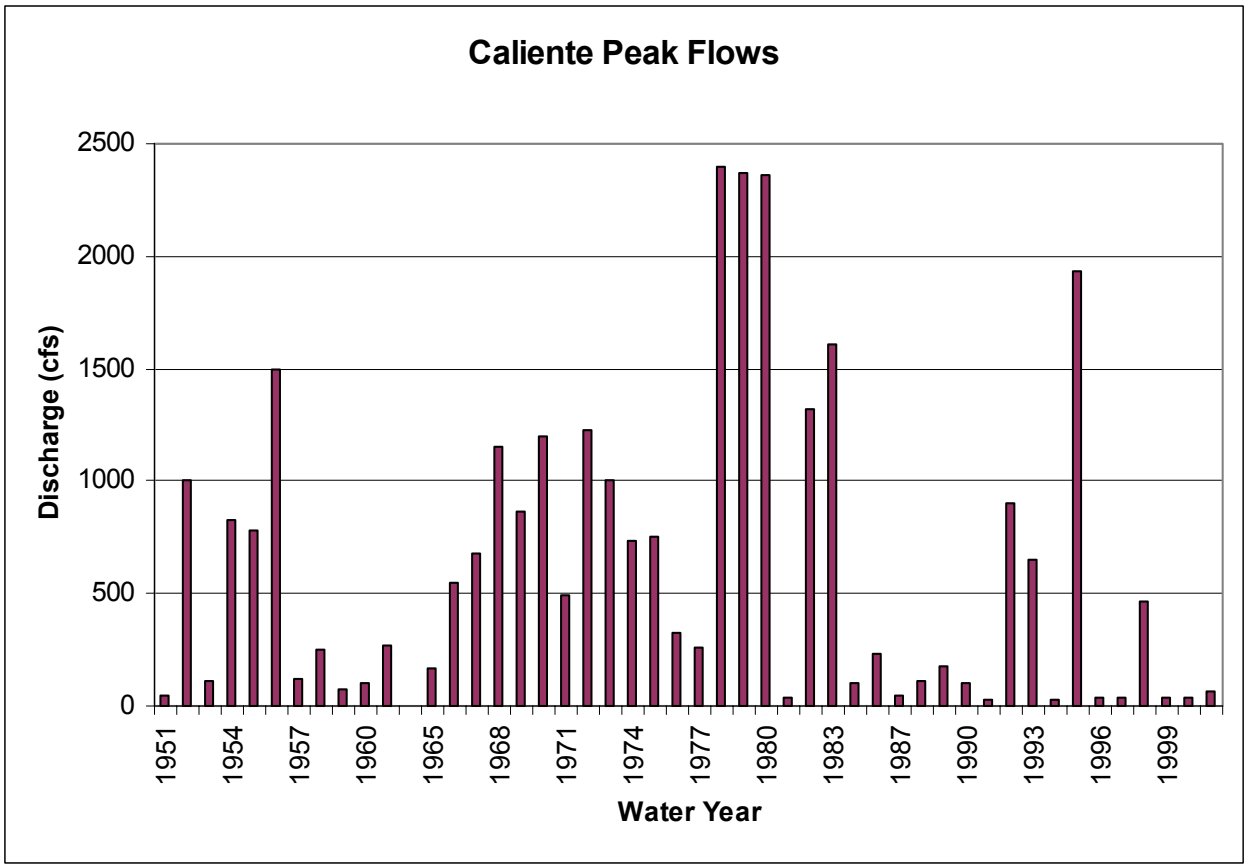

Figure 3.4. Annual peak flows reported for the USGS gage at Caliente.

These variable climatic and geologic conditions result in variable ground water-surface water patterns. In areas where arroyo tributaries deposit large quantities of sediment, often a large portion (or all) of the surface streamflow infiltrates into the unconsolidated sediments and becomes groundwater flow. Field measurements of discharge taken above and below Cottonwood Wash by BIO-WEST on 6/25/04 confirm this phenomenon: above the tributary at CW1, discharge was 2.5 cfs; below the tributary at CW2, discharge was only 0.9 cfs (Table 3.2). Shortly below CW2, the surface flow infiltrates completely and the stream goes dry. A similar pattern of streamflow loss to groundwater often also occurs where Meadow Valley Wash transitions from a narrow canyon reach into a broad valley underlain by coarse alluvial deposits. For example, this occurs near Elgin where the wash exits the narrowest part of Rainbow Canyon and the stream goes dry.

Because of this longitudinal variability in ground water-surface water conditions, the USGS gage data can only be considered representative of flow conditions within a localized area near each gage, and can not easily be extrapolated to long stream reaches, at least during low flow conditions. This reality is illustrated by Table 3.2, which compares field-measured discharge values to provisional real-time gage values at the different study transects. An additional factor that has a major influence on local flow and water stage is beaver activity. Beaver dams are very prevalent throughout the entire Study Area. Many of our study transects are located in ponded areas behind or between beaver dams.

It is important to note that although sediment inputs from arroyo tributaries appear to reduce surface flows in parts of Meadow Valley Wash, these inputs should not generally be considered "bad". In arid regions with sparse ground cover and short-duration, high intensity storm events, flash floods with high sediment loads and tributary debris flows are common occurrences. These events supply sediment and associated nutrients to main stem channels, where the sediment is subsequently re-mobilized and deposited to form and maintain floodplain surfaces and in-channel habitat features such as bars. Without these sediment inputs, long-term maintenance of habitat features and recruitment surfaces for riparian vegetation would not be possible. Therefore, despite the fact that they appear to reduce surface water availability, tributary sediment inputs are an important component of the overall Meadow Valley Wash riverine system. In contrast, however, human impacts that destabilize hillsides or otherwise artificially increase local sedimentation rates can disrupt the equilibrium between natural erosion and deposition processes and negatively affect instream and riparian habitat.

Table 3.2. Comparison of USGS gage records and field-measured discharge values.

Transect	Date of Field Measurement	Approx.Time of Field Measurement	Field-Measured Discharge (cfs)	Discharge at Caliente Gage* (cfs)	Discharge at Rox Gage* (cfs)
CA1	6/23/04	1:30 PM	minimal (too shallow to measure)	0.14	0.13
CA2	6/23/04	3:00 PM	0 (stagnant)	0.14	0.13
ET1	6/23/04	4:50 PM	0 (stagnant)	0.14	0.13
ET2	6/24/04	7:00 AM	0 (stagnant)	0.23	0.11
UR1	6/24/04	9:00 AM	0 (stagnant-behind beaver dam)	0.23	0.11
UR2	6/24/04	11:00 AM	0 (stagnant-behind fill)	0.23	0.11
RC1	6/24/04	3:30 PM	2.5	0.23	0.11

RC2	6/24/04	4:30 PM	est. 2.5 (assume same as RC1)	0.23	0.11
RR1	6/25/04	6:30 AM	0 (dry)	0.33	0.12
RR2	6/25/04	9:50 AM	2.8	0.33	0.12
CW1	6/25/04	2:30 PM	2.5	0.33	0.12
CW2	6/25/04	12:10 PM	0.9	0.33	0.12
VI1	6/25/04	5:50 PM	2.5	0.33	0.12
VI2	6/25/04	7:00 PM	0 (stagnant)	0.33	0.12
PE1	6/26/04	9:30 AM	0 (stagnant)	0.37	0.12
PE2	6/26/04	11:00 AM	0 (stagnant-behind beaver dam)	0.37	0.12

** provisional recent daily data obtained via internet http://water.usgs.gov; site accessed 9/6/04*

HYDROLOGIC ASSOCIATIONS

The complex groundwater-surface water conditions and beaver influence make it difficult to accurately correlate riparian conditions with streamflow inundation duration and frequency within the Study Area. However, at several of the transects where the relationships appear to be more straightforward, it was possible to model hydraulic conditions to determine the range of flows associated with specific vegetation communities. The results of the analysis are presented in Table 3.3.

Cattails are one of the common in-channel vegetation communities in the upper portions of the Study Area between Caliente and Leith. At transects CA1, RC2, RR2, and CW1, cattails are present throughout the low-flow channel, and extend to a level associated with flows between 5.6-29 cfs (Table 3.1). Based on flow data from the Caliente gage, flows within this range are equaled or exceeded between 5 percent and 30 percent of the time. Although the Caliente gage data do not necessarily represent the flow duration conditions at each study transect, it nevertheless is reasonable to conclude that the cattail vegetation community grows in portions of the channel that are inundated on a fairly regular basis. If baseflows at these sites were to increase or decrease, the extent of the cattail community would increase or decrease in response. Beaver activity also influences the cattail community by providing areas of slower-velocity flow where cattails can take root and survive flood events.

Table 3.3. Flow Ranges Associated with Riparian Vegetation Types.

Transect	Roughness "n" Value Used	Approximate Cattail Flow Range (cfs)	Approximate Willow/ Cottonwood Flow Range (cfs)
CA1	0.18	0 to 6.5	6.5 to 374
RC1	0.085* (low stage) to 0.05 (high stage)	n/a	63 to 189
RC2	0.11* (low stage) to 0.07 (high stage)	0 to 29	59 to 180
RR1	0.08	n/a	0 to 203 (right side); 85 to 1494 (left side)
RR2	0.18 (low stage) to 0.09 (high stage)	0 to 12.5	47
CW1	0.18 (low stage) to 0.09 (high stage)	0 to 5.6	7.7 to 222
CW2	0.11* (low stage) to 0.07 (high stage)	n/a	0.9 to 44.5
VI1	0.18 (low stage) to 0.07 (high stage)	n/a	8 to 87.7 (tamarisk)

** "n" back-calculated using field measured stage and discharge*

The willows and young cottonwoods in Meadow Valley Wash are associated with higher, less frequent discharge levels than the cattails. Although exact values vary from transect to transect (Table 3.3), at most of the transects analyzed, the upper extent of the community is associated with flows of about 200 cfs, which have an inundation duration of less than 1 percent (based on the Caliente gage data; see Figure 3.1). At two transects, the upper limit is associated with flows of about 45 cfs, which are equaled or exceeded less than 5 percent of the time. Flow in this range (45-200 cfs) have flood return intervals between 1 and 2 years (Figure 3.3).

It is interesting to note that this result appears to match some established general geomorphic patterns. Research has found that, for many streams, the bankfull flood (i.e., the discharge that overtops the channel banks and begins to inundate the floodplain) typically has a recurrence interval of between 1-2 years (Leopold 1994). In much of the western U.S., floodplain surfaces often support riparian willow and cottonwood communities. Thus, despite the complex surface water/ groundwater hydrology of Meadow Valley Wash (i.e., multiple transitions from gaining to losing stream reaches), the floodplain and riparian cottonwood/willow surfaces in the Wash appear to match the bankfull level that is inundated by the 1 to 2-year flood.

It is important to be clear that it is not simply the "presence" of 1 to 2 year flood events that enables healthy riparian communities to develop. The presence of floodplain surfaces and the availability of consistent baseflows or shallow groundwater are also essential for the establishment and survival of sizable cottonwood/willow riparian communities. Flood events are important for the long-term health of these communities because they are needed to scour the floodplain surface, deposit substrate for seed germination, and establish the proper conditions for recruitment of new seedlings. Snowmelt and storm-driven flood events with 1-2 year frequencies occur throughout Meadow Valley Wash, and are not something that can easily be altered or "produced" through human mitigation efforts. However, channel and floodplain shape can be reconfigured, and baseflows or groundwater availability could potentially be increased through adjustments to irrigation/diversion systems or other techniques. The results of the hydrologic associations analysis described here are most useful in that they identify the stage (i.e., relative elevation above the channel bottom) of the relevant floodplain surfaces that support the highest quality riparian vegetation, and therefore are helpful in determining the type of channel/floodplain configurations that should be preserved, created, or restored.

The relationship of tamarisk riparian communities to inundation/frequency of streamflow in Meadow Valley Wash is somewhat less clear. At transect VI1, tamarisk trees grow on the steep streambanks between about the 8 and 90 cfs flow levels. Burnt trunks of mature tamarisk trees are also present on the broad left floodplain at VI1, and some re-sprouting from these trunks is currently occurring. However, it is unclear whether current hydraulic conditions are adequate to support seed-based establishment of new tamarisk beyond the existing vegetative sprouting. The stage-discharge relationship at this transect will evolve during the post-fire recovery process as vegetation cover increases, the streambed and banks become more stable, streamside shading increases and algae growth decreases, and erosion rates decrease. Tamarisk is also present mixed with willows on the floodplain at transect PE2 (see Appendix A); however, accurately determining the inundation flow level at this site is not possible due to the significant beaver influence on water stage at this location.

In general, tamarisk are better able to survive drought and salinity stress and rapid water table declines than native willows and cottonwoods (Horton and Clark 2001, Smith et al. 1998). Therefore, tamarisk may be able to grow in areas that lack consistently available surface water flows or shallow groundwater tables. Our observations suggest that this may be the case on Meadow Valley Wash, where broad, thick tamarisk stands were observed in portions of the Vigo and Rox reaches that are dry. However, teasing out the answers to complicated questions such as "would willows survive here if they were not out-completed by tamarisk?" or "are the tamarisk transpiring excessive amounts of water that would otherwise support cottonwoods and willows?" would require additional detailed data collection and research that are beyond the scope of this report.

4. MITIGATION/RESTORATION OPPORTUNITIES

The results of the transect surveys suggest several different mitigation and restoration opportunities to improve riparian conditions for willow flycatcher within the Study Area. These opportunities are discussed for each study reach. It is important to bear in mind that the recommendations described below are merely preliminary, and are based on the results from the relatively brief, large-scale hydrologic conditions inventory described above. The Meadow Valley Wash Study Area is a large, varied, and complex ecosystem, and additional detailed field data collection, historical research, and/or monitoring studies should be completed before implementing any specific mitigation or restoration effort at a particular location.

CALIENTE REACH

Although restoration opportunities in the Caliente area are somewhat limited due to existing development, there are some simple erosion control measures that could be taken to improve riparian conditions. For example, large amounts of sediment associated with the road fill/road crossing at CA2 have been allowed to flow unchecked into the wash, where the sediment buries riparian vegetation and blocks streamflow needed to support desirable riparian species. Physical removal of some of the accumulated material and installation of simple perimeter erosion controls such as silt fence or straw bale barriers would help reduce this sedimentation and aid in the recovery of a stream channel/riparian system that includes more desirable vegetation types. There may also be additional road crossings or construction projects within the Caliente Reach where riparian conditions could be improved through better erosion and sediment controls.

Floodplain expansion would be another way to increase the amount of high-quality riparian habitat within the Caliente Reach. Transect CA1, for example, contains desirable, dense willow vegetation, but is confined between fill material on both sides. Broadening the floodplain surface that currently supports the willows and laying back the fill material would increase the width of the riparian corridor and improve its habitat value for willow flycatcher. Both of these approaches -- floodplain expansion and improved sediment/erosion controls -- would also help reduce flooding risks by maintaining or increasing channel capacity through town. In fact, the concept of floodplain expansion has been proposed as a possible way to alleviate flood concerns within Caliente (Otis Bay 2001).

ETNA REACH

Portions of the Etna Reach appear to have been impacted by grazing and agricultural practices. The incised channel shape at transect ET1 could be the result of overgrazing/loss of bank vegetation and/or historical channel realignment to increase pasture area. Improving grazing management and cattle rotation practices or fencing cattle out of the riparian corridor could help new cottonwoods and willows establish along the banks. Channel reconstruction to expand the floodplain and reduce bank steepness could be another option. However, either of these approaches should be preceded by more extensive research into historical channel conditions and current grazing practices to more

conclusively identify the factors responsible for the current riparian conditions. Variables such as arroyo deposits that absorb surface water, non-cohesive bank sediments, and beaver activity may have more influence on the existing channel and riparian conditions than anthropogenic impacts. The potential limitations on riparian habitat quality imposed by these factors should be taken into account when assessing the benefits and costs of possible restoration or mitigation activities.

UPPER RAINBOW REACH

As with the Etna Reach, any restoration efforts within the Upper Rainbow Reach should be preceded by detailed investigation of local groundwater-surface water conditions, and assessment of arroyo sediment deposit locations, etc. However, several obvious sites where road construction activities have negatively affected riparian conditions were noted within the Upper Rainbow Reach, and these sites would benefit from restoration activities. Near the upstream end of the reach, the existing roadway cuts off two meander bends (at about UTM 714000E, 4158000 N and UTM 713500 E, 4157150 N), disconnecting the existing channel on the west side of the road from historical channel and floodplain areas on the east side of the road. These areas on the east side appear to be currently used as pasture land. Re-establishing the hydrologic connection between the west side and east side floodplains would greatly increase the width and habitat value of the riparian corridor in this area. This could be achieved by realigning the road, installing additional bridges and drainage culverts, and/or re-grading pasture areas to promote reestablishment of cottonwood and willow vegetation.

Farther downstream in the reach (at about UTM 713500 E, 4152700 N), we noted a spot where placement of fill material and grading activities had reduced the width of the riparian corridor and isolated a patch of high quality cottonwood/willow vegetation from the main channel. Removing this fill material and re-connecting the two areas of existing high quality vegetation would restore a 1,000 foot-wide corridor with excellent habitat value for willow flycatcher.

Removing or redesigning the road crossing at transect UR2 would be another simple restoration activity to improve riparian conditions. Replacing the existing fill material and overly-narrow culvert with a single-span bridge structure (such as a railroad flatcar) would eliminate the major ponding effect of the existing crossing and allow for re-establishment of desirable riparian vegetation. There may be additional road crossing impacts within the Study Area where similar redesign efforts would benefit riparian habitat.

RAINBOW CANYON REACH

Within Rainbow Canyon, Meadow Valley Wash has consistent streamflow and supports desirable willow/cottonwood vegetation. However, the width of the riparian corridor is limited by the narrow canyon walls. The width is further constricted by the road and railroad in locations such as RC1. Efforts to broaden the floodplain width by realigning the road farther away from the channel or installing retaining walls to limit the extent of fill material would result in improved riparian habitat conditions in this reach.

ELGIN AND COTTONWOOD REACHES

Because the willow flycatcher needs a constant water source, restoration opportunities in the Elgin and Cottonwood Reaches are limited to the areas downstream from Kyle, where surface streamflow returns after being absorbed into the alluvial sediments near Elgin. Within the areas that contain baseflows, the main restoration opportunities would involve expanding the width of the floodplain by reducing the constricting effects of the road, railroad, and campsite areas. Specific activities could include road realignment, installation of new bridges/drainage culverts to reconnect relict channel meanders currently cut off by the road, relocation of campsites/ campsite access roads, and construction of retaining walls to reduce the encroachment of fill material into the floodplain. One location where the road appears to cut of a meander bend is at about UTM 723300 E, 4132500 N.

VIGO AND ROX REACHES

Restoration options become more limited in the downstream reaches of the Study Area, where the invasive tamarisk tree becomes a dominant component of the riparian community. Water availability is also a limiting factor because large portions of the Vigo and Rox Reaches are dry due to the infiltration of surface flows into the valley sediments. However, riparian conditions in incised channel areas (such as the areas crossed by transects VI2 and PE1) may benefit from efforts such as improved cattle management, riparian fencing, or bank reconstruction/willow planting. In areas also affected by irrigation diversions, it may be possible to enhance physical channel or bank restoration efforts with increased baseflows by making adjustments to irrigation practices or relocating diversion/return flow points. As discussed previously, however, any restoration efforts should be preceded by more detailed investigation of ground water-surface water conditions, soil characteristics, tributary influences, and historical land uses to provide a better understanding of the factors responsible for current channel and riparian conditions. The interacting influences of tamarisk, depth to groundwater, grazing, and irrigation withdrawals are complex, and therefore it is difficult to accurately predict the outcome of changing one of these variables as part of a restoration project.

Simpler restoration efforts, such as removing road fill from the channel in an upstream part of the Study Area that has consistent baseflows and is not affected by tamarisk, would be more certain to succeed in improving flycatcher habitat.

GENERAL NOTE: BEAVER INFLUENCE

During the fieldwork conducted for the hydrologic conditions inventory, it was observed that many of the sites with the highest quality, widest riparian cottonwood/ willow communities in Meadow Valley Wash are influenced by beaver activity. Numerous small-size (generally less than 10 feet wide) beaver dams were observed throughout the Study Area. These beaver dams function as small "check-dams" that reduce flow velocities during flood events, increase water stage and width of bank saturation during low flows, and trap sediments that help prevent channel incision and help maintain a hydrologic connection between the floodplain and channel. In these ways, beaver

activity can help promote the development and maintenance of high quality riparian habitat. In addition, because some research has found that cottonwoods may be better able to survive prolonged flooding better than tamarisk (Gladwin and Roelle 1998), the saturated conditions created by beaver dams may help native species out-compete tamarisk (Glausiusz 1996).

Because of the apparently beneficial influence of beaver dams, any restoration or mitigation efforts should be designed to encourage beaver colonization of the area. Another possible restoration tool could be to install "artificial beaver dams" – small, temporary check dams composed of biodegradable materials to help trap sediments, build up the streambed, and increase the width of floodplain saturation. Such dams could be used to help cottonwoods and willows get an early "head start" on tamarisk as part of a channel restoration/revegetation effort. Ideally, beaver would ultimately move into the area and build dams to replace the artificial check dams once they began to decompose. However, any use of structural techniques such as check dams should be undertaken with caution, because improperly designed, improperly sized, or improperly installed structures could have negative ecological effects and negative effects on upstream or downstream infrastructure.

5. REFERENCES

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APPENDIX A

Cross-section Transect Plots

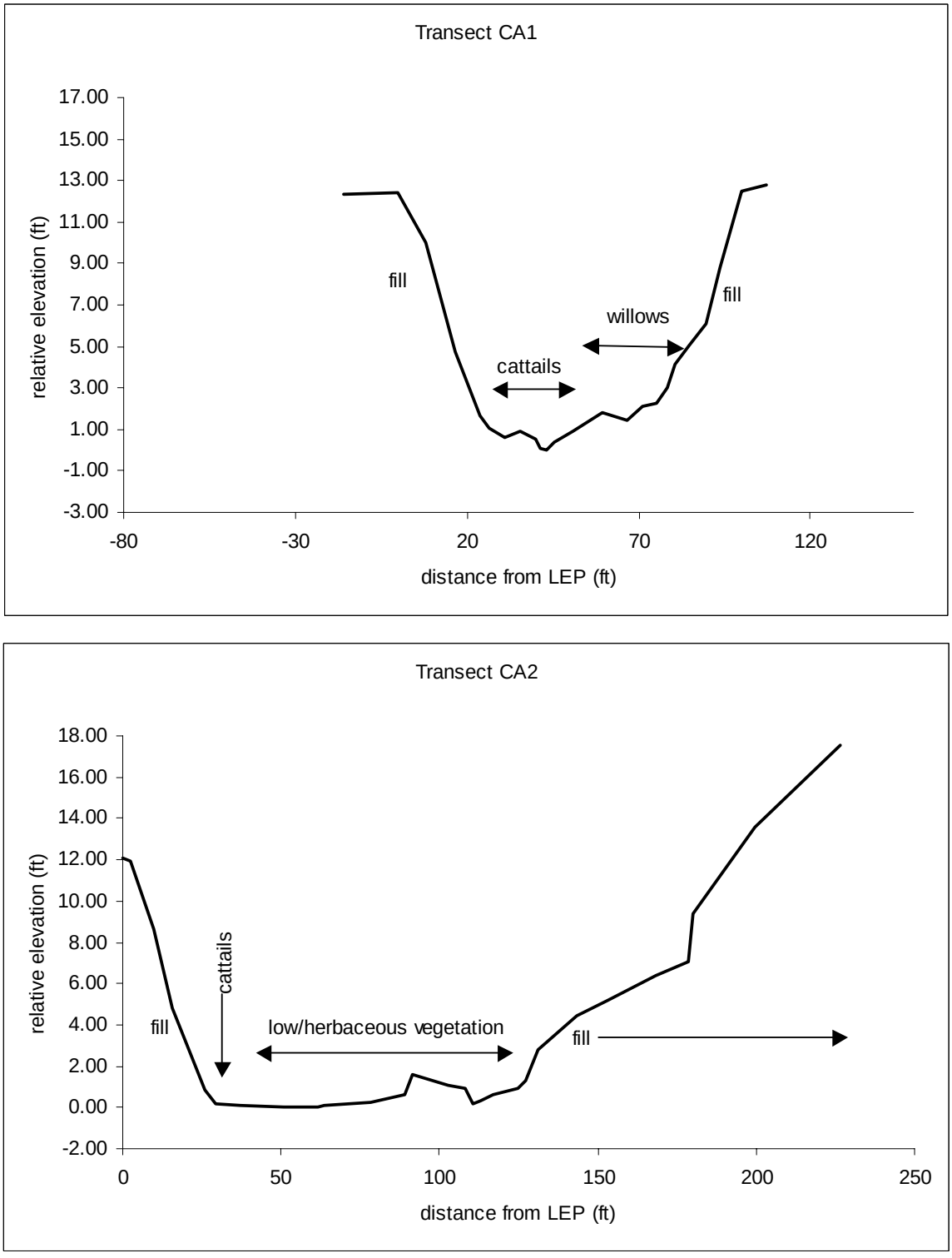


Figure A1. Caliente Reach transect plots. Dashed blue line indicates water surface at time of survey.

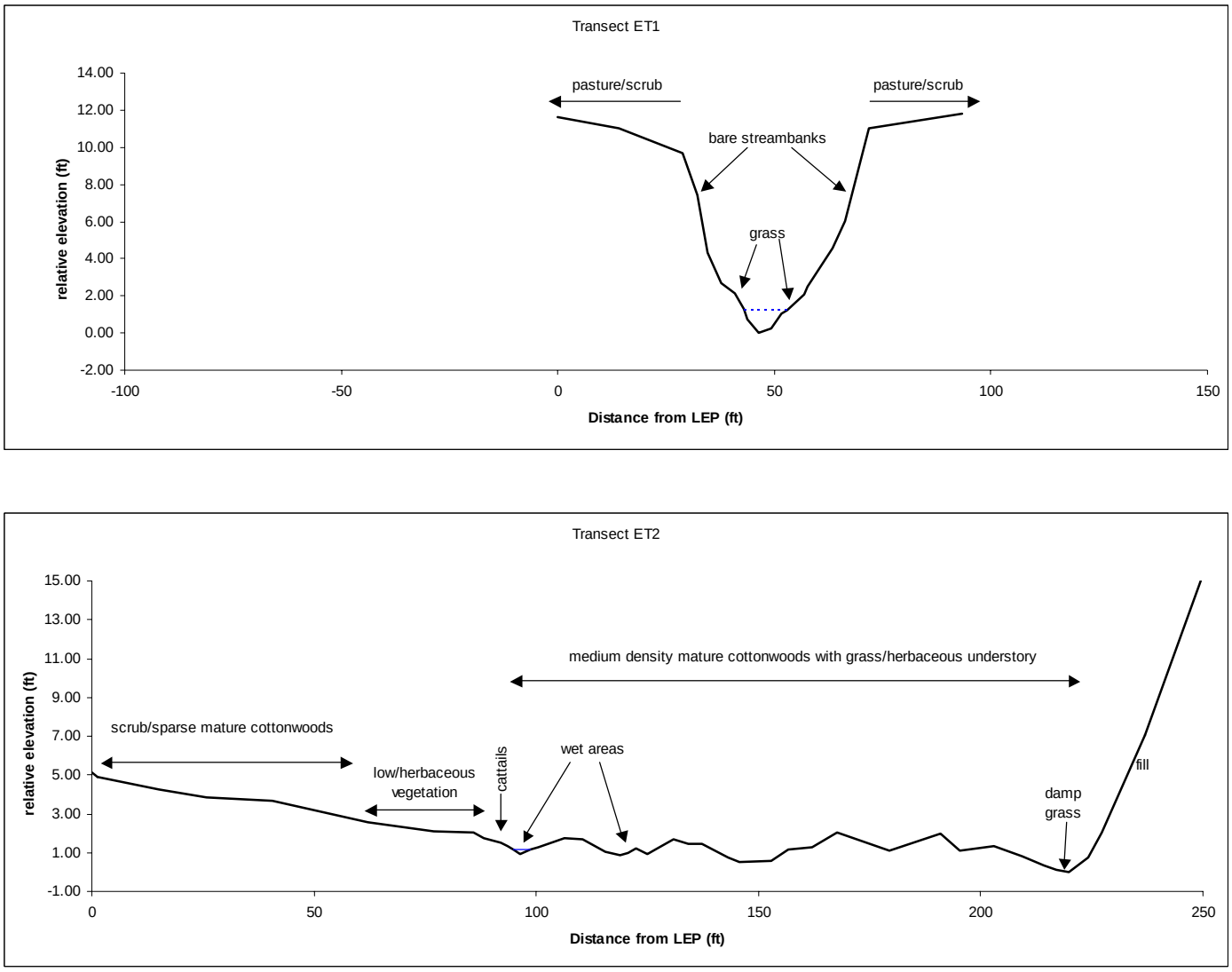


Figure A2. Etna Reach transect plots. Dashed blue line indicates water surface at time of survey.

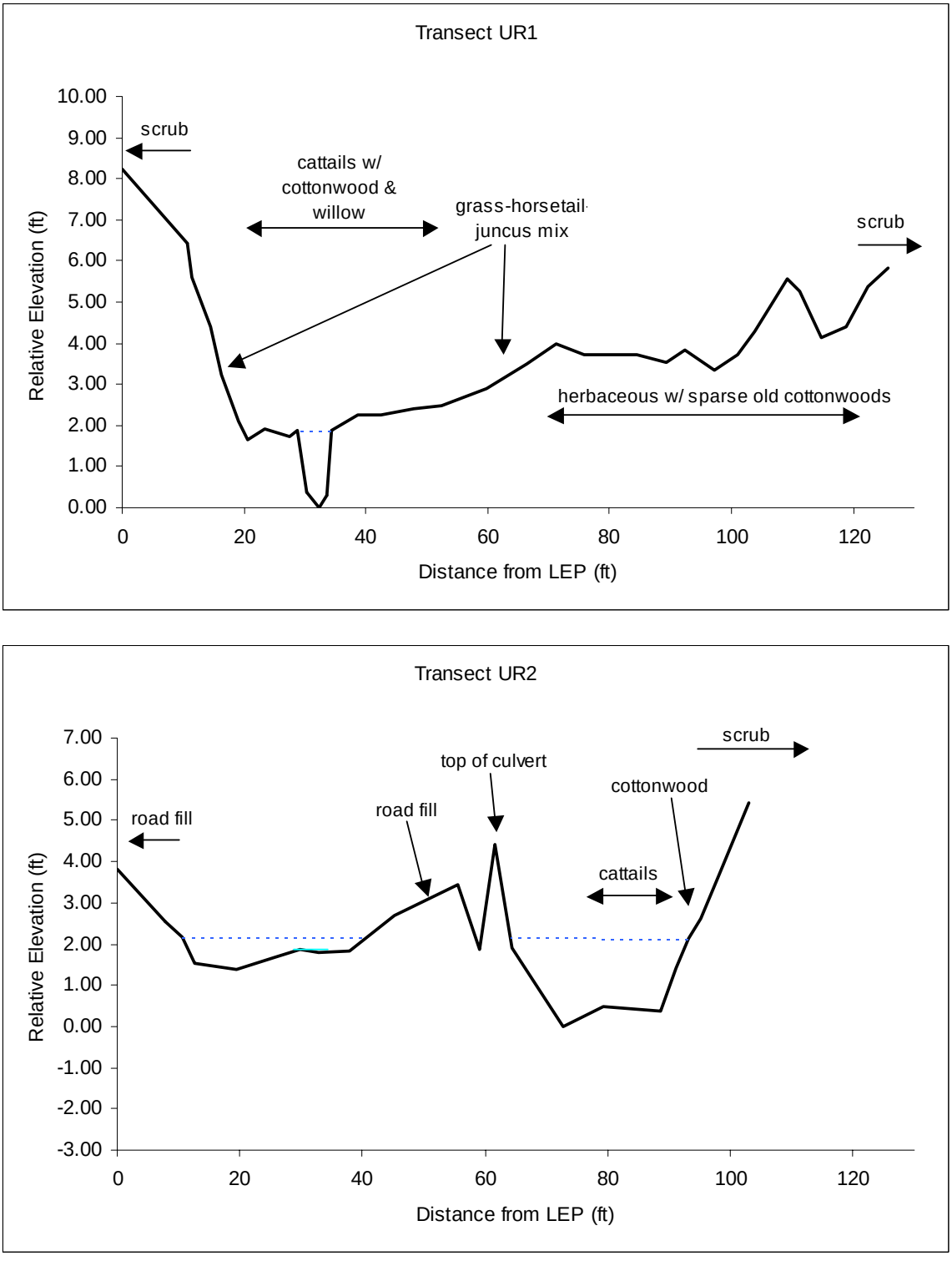
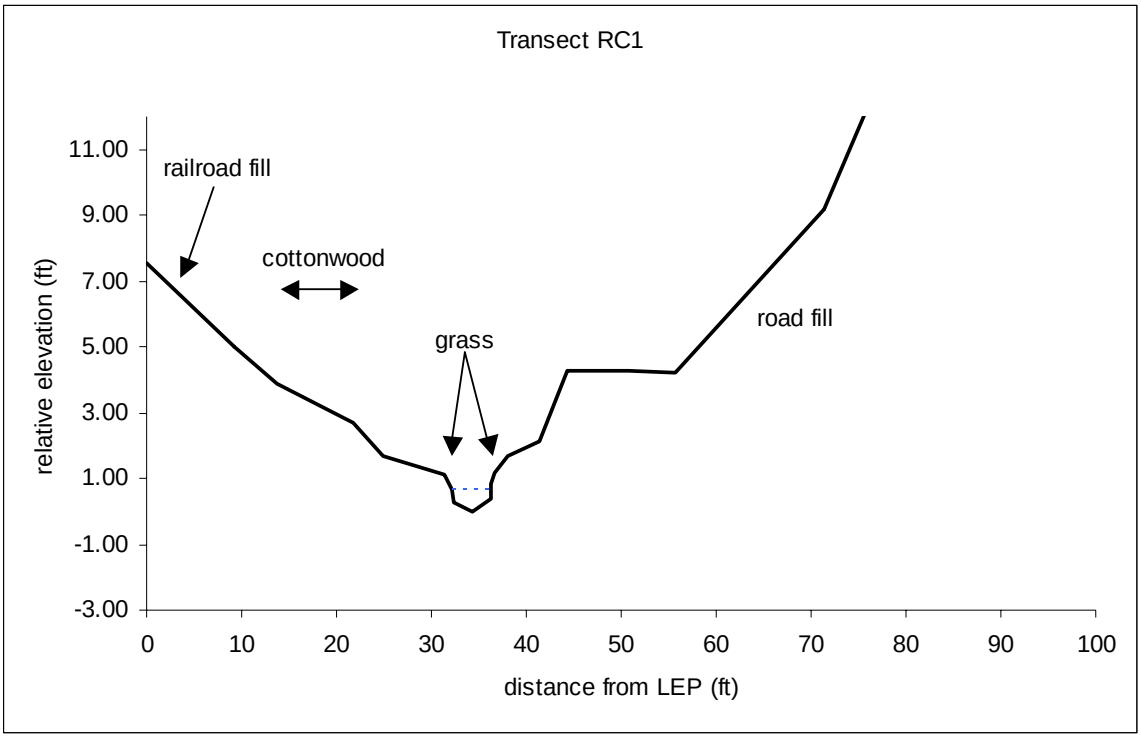


Figure A3. Upper Rainbow Reach transect plots. Dashed blue line indicates water surface at time of survey.



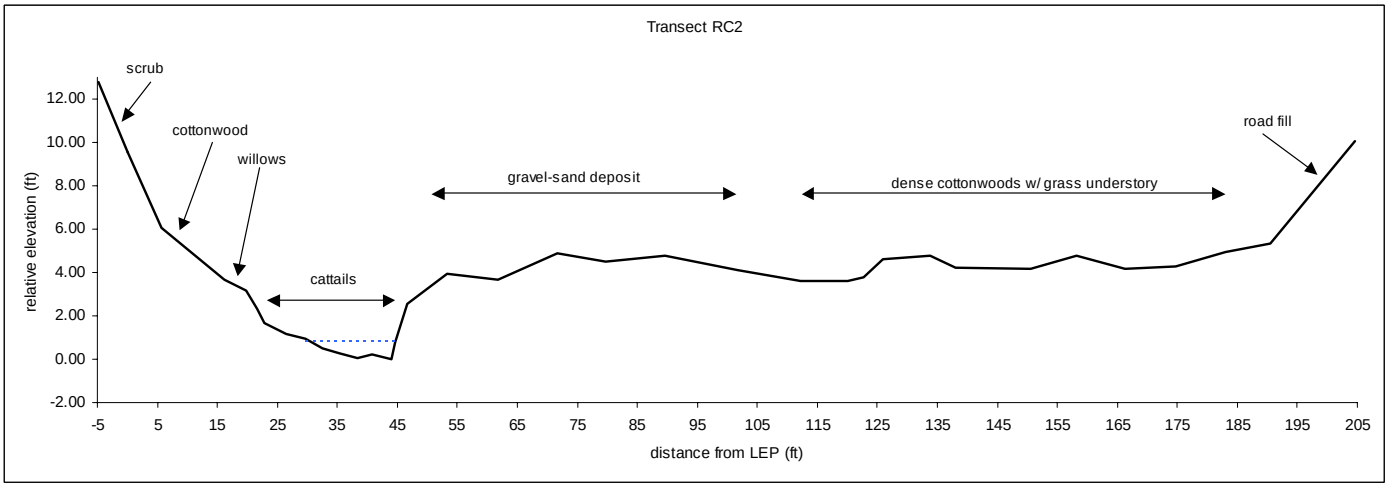
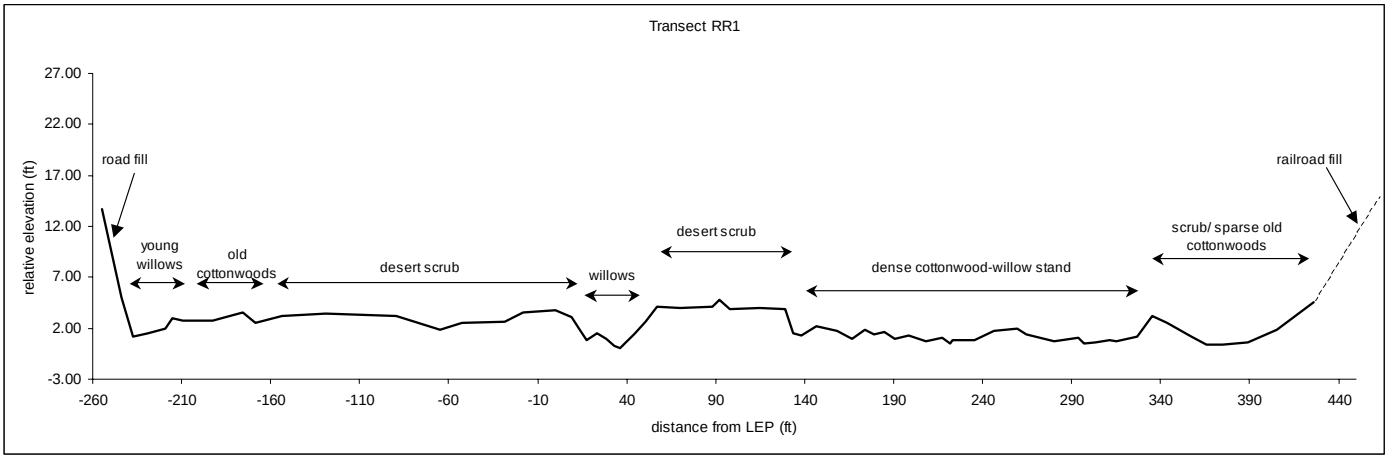


Figure A4. Rainbow Canyon Reach transect plots. Dashed blue line indicates water surface at time of survey.



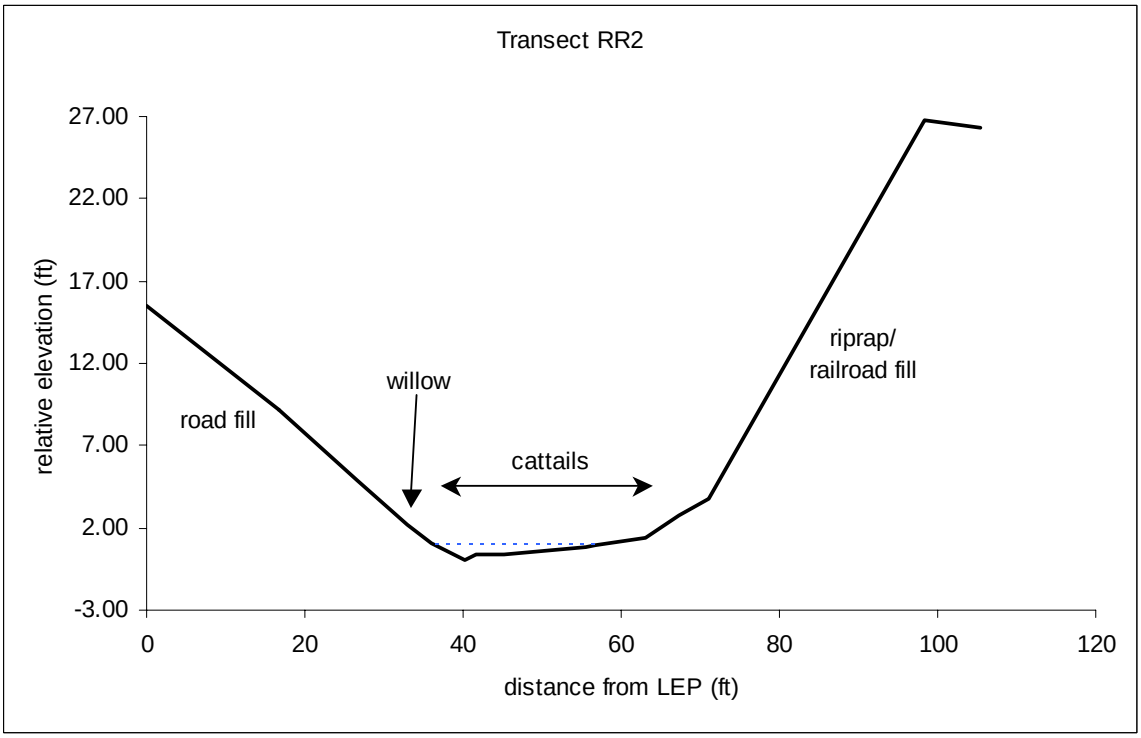


Figure A5. Elgin Reach transect plots. Dashed blue line indicates water surface at time of survey.

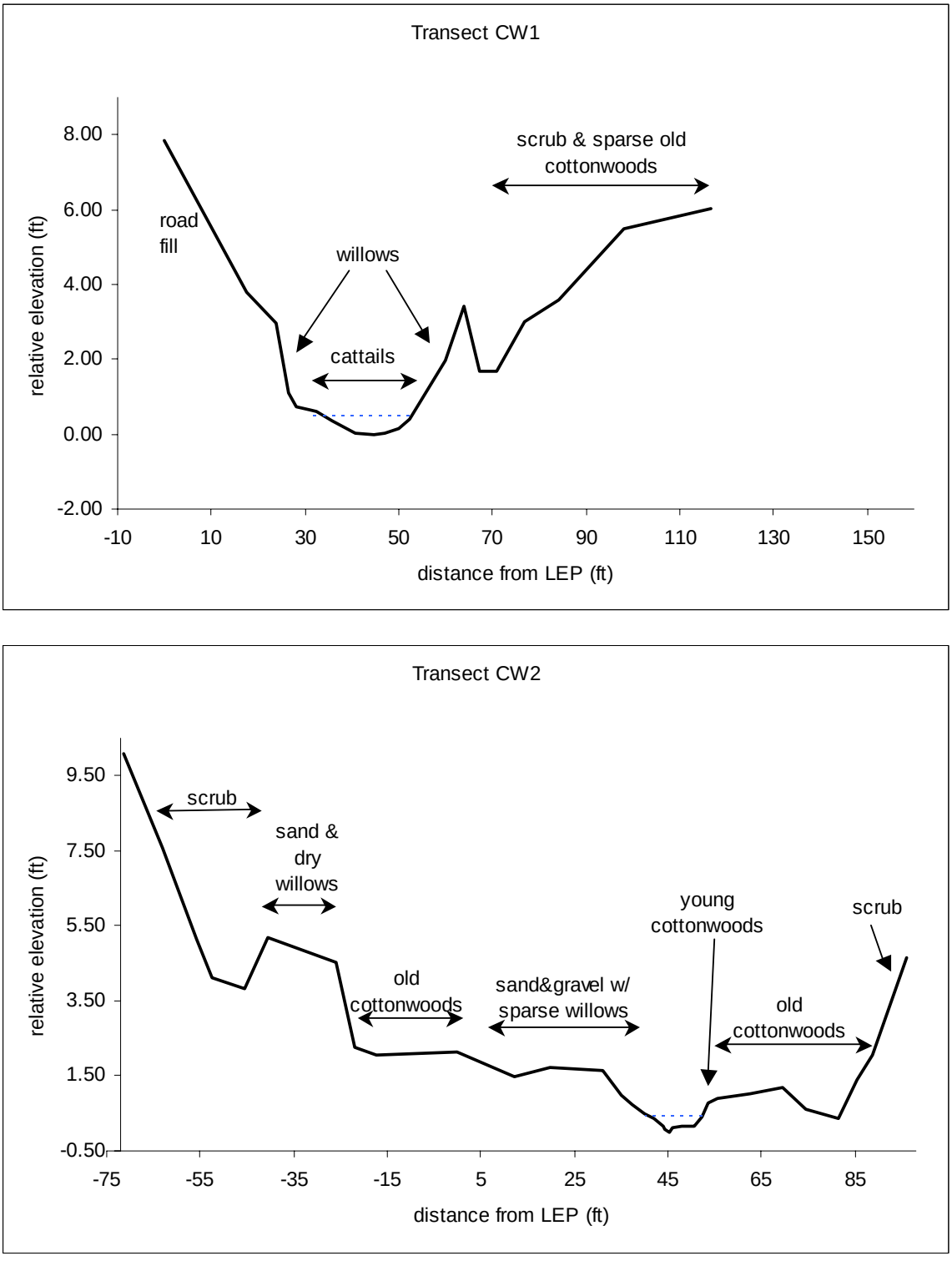
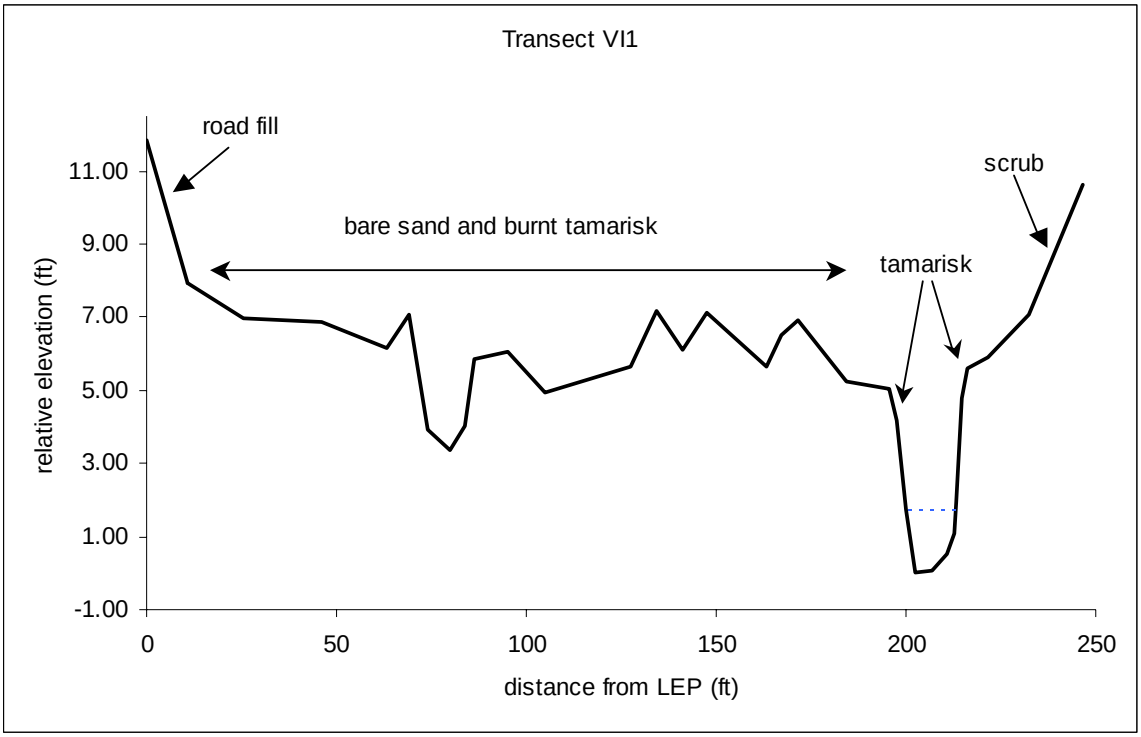


Figure A6. Cottonwood Reach transect plots. Dashed blue line indicates water surface at time of survey.



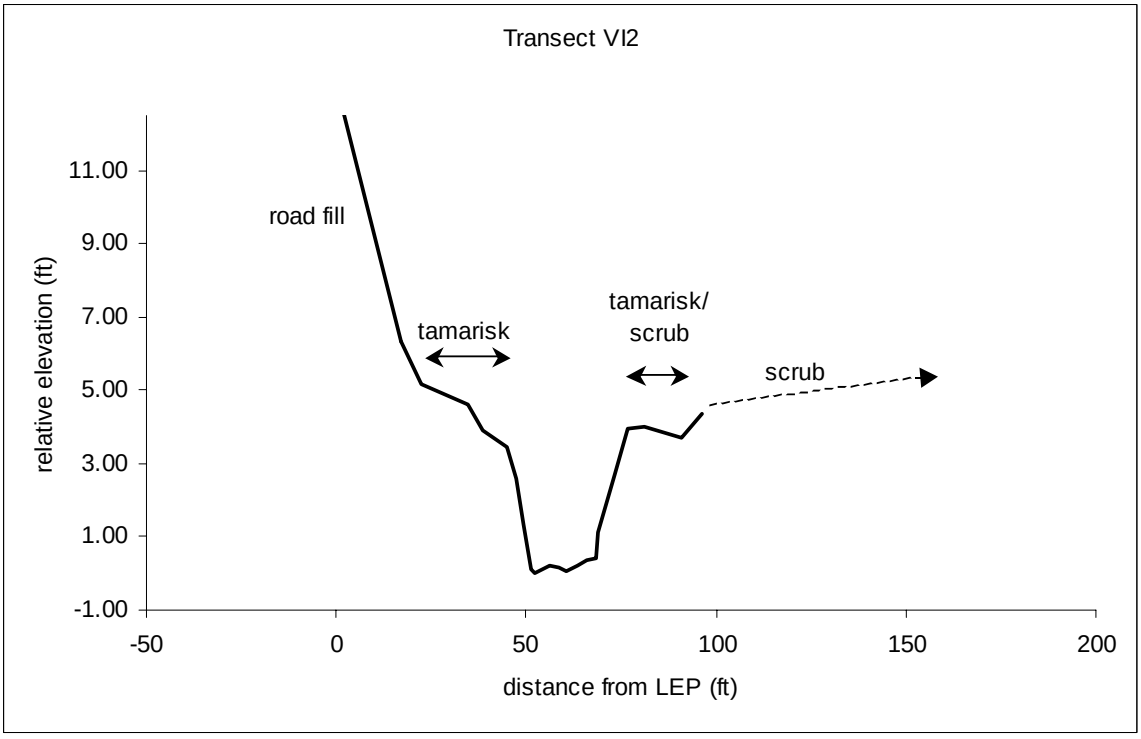


Figure A7. Vigo Reach transect plots. Dashed blue line indicates water surface at time of survey.

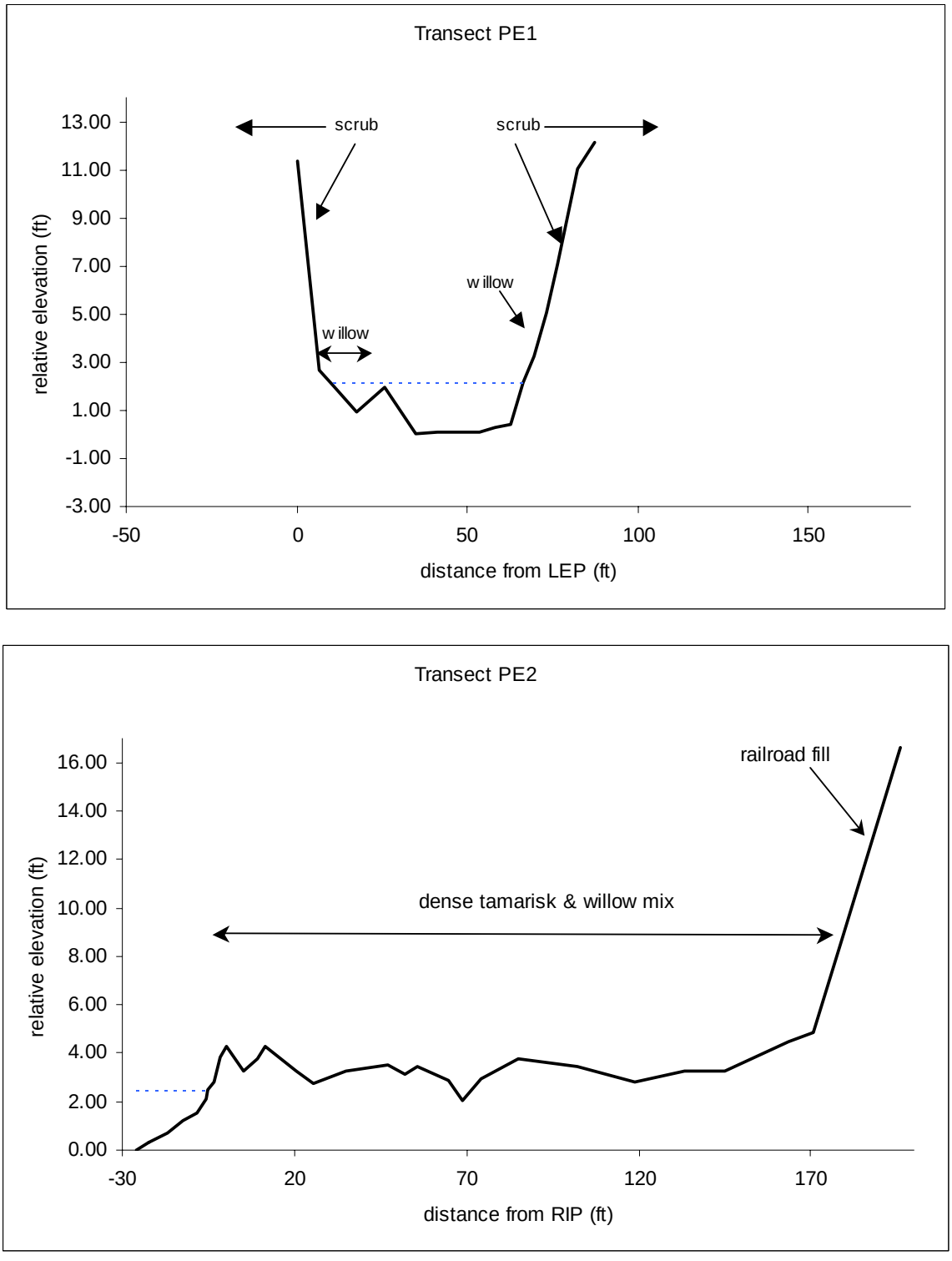


Figure A8. Rox Reach transect plots. Dashed blue line indicates water surface at time of survey.

APPENDIX B
Transect and Cross-section Photographs

Transect CA1 from LEP

Transect CA2 from LEP

Transect ET1 –view downstream

Transect ET2 from REP

Transect UR1 from LEP

Transect UR2 from LEP

Transect RC1 – view downstream

Transect RC2 from LEP

Transect RR1 from REP

Transect RR2 –view downstream

Transect CW1 – downstream view

Transect CW2 – upstream view

Transect VI1 – downstream view

Transect VI2 –downstream view

Transect PE1 – downstream view

Transect PE2 from REP