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RMAP

Regional Riparian Mapping Project

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Abstract

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Vegetation mapping helps to facilitate the research, assessment, and management of natural resources. Advances in GIS and remote sensing technologies have enabled more efficient, accurate, and precise mapping capabilities. This project leveraged recently developed technical capabilities to map riparian plant communities across Forests and Grasslands of the US Forest Service Southwestern Region. Valley bottom models provided spatial hypotheses from which to base photo interpretation of riparian vegetation types and to map the total extent of riparian communities at the scale of 1:12,000, with a map legend of 24 map units, nine subclasses, one provisional map unit, and two provisional subclasses. High resolution infrared photography and other ancillary references were used to develop and corroborate inferences of riparian settings. Local partners provided riparian data, field validation, and review as a key part of map development. Also, of the approximately 819,000 acres (332,000ha) in the final map product, over 266,000 acres (108,000ha) were adopted and normalized from previous mapping projects including the Terrestrial Ecological Unit Inventory. An independent accuracy assessment of the new mapping was completed to determine overall map performance in regards to map themes and spatial accuracy by errors of omission and commission. Based on a random sample of 258 map polygons, the overall area-weighted user accuracy was estimated at 77%, while the net error in map extent was about 6% commission at local scales. At the watershed scale, an additional assessment was made to determine the overall spatial accuracy of mapped riparian communities across the landscape, with a resulting gross omission error of approximately 2%. The final riparian map is embedded in the Region's mapping of Ecological Response Units (www.fs.usda.gov/detailfull/r3/landmanagement/gis/?cid=stelprdb5201889&width=full). The mapping provides managers and analysts spatial and thematic information of sufficient quality to develop sustainability analysis, base inventory and monitory schemes, and support related studies.

Key Words

Riparian mapping, valley bottom model, riparian plant community, base-level mapping, riparian zone.

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Cover: Photo taken by Max Wahlberg of a riparian corridor in Horseshoe Canyon, on the Lincoln National Forest, in southeastern New Mexico. The photo represents the Little Walnut - Ponderosa Pine RMAP unit.

Introduction

Riparian habitats are among the most critical elements of biodiversity within the landscape. In Arizona and New Mexico, 80 percent of all vertebrate species use riparian areas for at least half their life cycles, and more than half of these are totally dependent on riparian areas (Chaney et al. 1990). According to the Arizona Riparian Council 60 to 70 percent of the state's wildlife species depend on riparian areas to sustain their populations, even though riparian habitats occupy less than half a percent of the land area (Arizona Riparian Council 1995). Likewise, aquatic habitats and fish productivity are directly related to properly functioning riparian systems (Washington Dept. Fish and Wildlife 1995).

Vegetation mapping and classification are fundamental to the management and study of natural resources. Analyses of aquatic systems require basic information on the distribution of riparian vegetation. To meet the needs of the US Forest Service (USFS) and other partner organizations, a base-level map of riparian plant communities was developed using concepts of Ecological Systems (Comer et al. 2003) and potential vegetation (Hansen et al. 1995). This document outlines the Regional Riparian Mapping Project (RMAP) and the development of map data for riparian corridors of the USFS Southwestern Region.

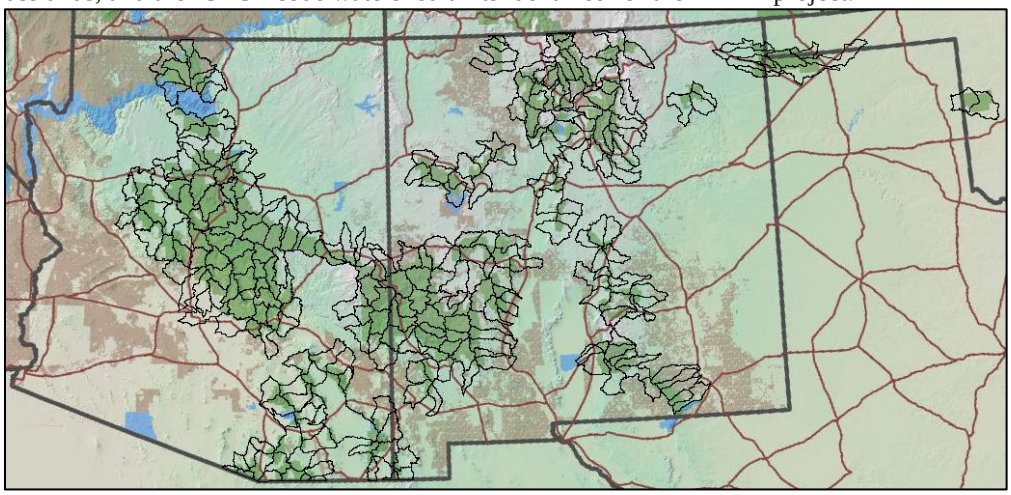
The goal of the project was to provide resource specialists and planners with spatial data on riparian features of sufficient quality to support ecological sustainability analyses and planning at both landscape and project levels. The mapping is consistent with concepts and themes of *Ecological Response Units* (USDA Forest Service, in draft), and conventions familiar to resource specialists of the Southwest. Our objective was to produce riparian mapping based on coarse potential vegetation themes at the base map scale of 1:12,000 (Brohman and Bryant 2005), for all 5th-code HUC watersheds that intersect US Forest Service lands of the Southwestern Region (Figure 1).

Methods

Area of Interest and Timeline

The RMAP project was funded as a Forest Service Regional Leadership Team commitment for two years, following the initial scoping and proposal. Much of the ongoing watershed assessment and prioritization work of the Southwest is organized by watershed units (Seaber et al. 2007), as is common to other broad-scale efforts (e.g., Hann et al. 2010, USDA Forest Service 2011). Watersheds were likewise adopted as part of the RMAP framework, consistent with conventions of assessment for riparian resources in the region. While the original goal was to map across all 4th-code subbasins that intersect Forest Service lands, early scoping suggested that the breadth of this extent could jeopardize the project given available resources. As a result 5th-code watersheds became the focus of RMAP work. All 5th-code units for mapping were identified in GIS according to a criterion that only watersheds with at least 10% of their extent on USFS lands would be mapped. While 396 5th-code units intersect lands of the Southwestern Region in total, only 297 units met the 10% threshold. For the remaining 99 watersheds, mapping occurred only on USFS lands within the 5th-code watershed.

Figure 1. Extent of USFS Southwestern Region, including 11 National Forests and two sets of National Grasslands, and the 297 5th-code watershed units identified for the RMAP project.



Operational Definition of Riparian

The Federal Geographic Data Committee (FGDC) provides standards for the development of geographic data and for data quality for federal agencies (FGDC 2009). The FGDC has likewise established standards for wetland and riparian resources and has tentatively adopted the US Fish & Wildlife Service definition for riparian (FGDC 2012, US FWS 2009):

> *Riparian areas are plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies (rivers, streams, lakes, or drainage ways). Riparian areas have one or both of the following characteristics: 1) distinctly different vegetative species than adjacent areas, and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms.*

For operations it was necessary to qualify "distinctively different vegetative species", and the following criterion was developed:

> *Riparian mapping is conducted where riparian/wetland plant species are common.*

Aside from early successional communities where plant indicators can be sparse or absent, riparian mapping was conducted where designated wetland plant species were common; that is, where "obligate wetland" and "facultative wetland" national indicator taxa, designated by the US Fish and Wildlife Service (Lichvar 2013), comprised at least 1% canopy cover. See Appendix D for definitions of obligate and facultative taxa.

The second part of the US FWS definition, "…more vigorous or robust growth forms", was problematic. While we recognize the need for consistency with FGDC and other agencies, we found the subjectivity required of the definition in regard to plant vigor to be an issue, not to mention the uncertainty in determining relative differences in vigor through remote sensing. This portion of the US FWS definition also represents a significant discontinuity with regional conventions (USDA Forest Service 1991), and may be more fitting for subsequent generations of riparian mapping. As a result the second part of the definition concerning "more vigorous or robust growth forms" was disregarded.

Finally, it was necessary to include a proviso for recently scoured and non-vegetated sites, where plant indicators are sparse or non-existent (USDA Forest Service 2012):

> *Where indicator plants may be temporarily absent, riparian areas are identified by signs of fluvial processes and/or fluvial features created under the current flow and climatic regimes.*

The three modifications to the US FWS standard resulted in the following operational definition for RMAP:

> ***Riparian areas are plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies. Riparian areas have distinctively different vegetative species than adjacent areas; specifically, riparian mapping is conducted where riparian/wetland plant species are common. Where indicator plants may temporarily absent, riparian areas are identified by signs of fluvial processes and/or fluvial features created under the current flow and climatic regimes.***

This operational definition is consistent with the Southwestern Region Riparian Area Handbook (FSH 2509.23) and with the Forest Service Manual definition (FSM 2526.05):

> Riparian Areas: Geographically delineable areas with distinctive resource values and characteristics that are comprised of the aquatic and riparian ecosystems.
>
> Riparian Ecosystems: A transition area between the aquatic ecosystem and the adjacent terrestrial ecosystem; identified by soil characteristics or distinctive vegetation communities that require free or unbound water.

Bounding the project

When RMAP was conceptualized a number of sideboards were identified consistent with the business needs of the natural resource managers, the technical specifications of potential vegetation mapping (USDA Forest Service 2008), and the time and resource limitations of the project. The follows factors were used to bound the RMAP work:

- Regional map extent – Riparian was mapped across 5th-code hydrologic unit watersheds (USGS 2012) intersected by USFS lands (Figure 1). A stipulation was made that only watersheds with at least 10% extent occurring on USFS lands would be mapped. While 396 5th-code units intersect USFS in the Southwestern Region, only 297 units have at least 10% area on USFS. For the remaining watersheds that did not meet the 10% criterion, riparian was mapped only on USFS lands.
- Watershed map extent – Within the identified watersheds, mapping was focused on riparian corridors including riparian plant communities and intervening stream channels.
- Map scale – Map scale is 1:12,000, with a horizontal accuracy of approximately plus-or-minus 6m, and minimum map feature (MMF) size of 1ha. This scale represents the limit of the available remote sensing resources used to support the map work.
- TEUI mapping – The RMAP project included mapping of riparian communities not already mapped and classified with the Terrestrial Ecological Unit Inventory (TEUI 2005b). The Southwestern Region has been conducting TEUI (formerly Terrestrial Ecosystem Survey) since the 1980s. Many of the ecological units for this work were subset from various TEUI datasets and embedded in RMAP, both in classification and line work. Relational tables for TEUI-RMAP are included in appendices A and C. The TEUI project and map unit number are included as table attributes with the RMAP geodataset.

Additional thematic guidelines applied with RMAP:

- US FWS wetland species – As mentioned, mapping was only carried out where designated wetland plant species were common, where “obligate wetland” and “facultative wetland”, designated by the US FWS (appendices B and C), comprised at least 1% canopy cover (aerial extent). This criterion was applied on areas larger than 1ha, the MMF standard for 1:12000-scale mapping.
- Historic riparian – Many plant communities that fall within riparian corridors of the Southwest have lost their potential to sustain wetland species. For purposes of this project these plant communities were designated separately under “historic” themes of either agriculture, residential/urban, or natural/semi-natural upland.

- Lentic wetlands – The RMAP project was primarily concerned with lotic wetlands contiguous to perennial or ephemeral steam courses. Lentic, herb-dominated wetlands were mapped with this project where they were integrated with riparian plant communities. The bulk of herb-dominated wetlands in the Southwest have been previously mapped with the National Wetlands Inventory (Dahl et al. 2009).

Map Unit Design

Map unit design is an iterative process that reflects an optimization among mapping objectives, vegetation classifications, technological capabilities, and available resources (Triepke et al. 2008). In the case of RMAP operational limits precluded a one-to-one relationship with individual units from regional classification systems (e.g., Muldavin et al. 2000, NatureServe 2004, USDA Forest Service 1986), so that RMAP is represented by bona fide map units, thematic groupings of available classification works to represent broad ecosystem units of similar site potential, disturbance regime, and successional dynamics. Two RMAP units (360, 370) reflect provisional vegetation classes not represented by any current classification system, but have since been brought to the attention of NatureServe (pers. comm. F.J. Triepke 2012). As mentioned RMAP units are thematically consistent with the USFS Ecological Response Units (ERUs)(USDA Forest Service, in draft), an organization of map unit themes that represent major ecosystems of the Southwest. The ERUs are conceptually similar to NatureServe Ecological Systems and LANDFIRE Biophysical Settings: "ecological systems represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding" (Comer et al. 2003). Also, ERUs are somewhat coarser than Ecological Systems and include some important vegetation types not currently represented by NatureServe. The RMAP units have since been adopted as riparian ecosystem types within the ERU framework.

A provisional map unit legend was developed based on major themes included in available community classifications of the region, including Muldavin et al. (2000) and the vegetation *subseries* derived through Terrestrial Ecological Unit Inventory (USDA Forest Service 2005b). Collectively these two sources are fairly comprehensive in respect to previous classification work of the region. The two sources are cross-referenced in appendices A and D. Over the course of the project the map unit legend was iteratively revised as a result of new information gained from mapping, field reconnaissance, and literature and internet sources. Available mapping from the San Pedro River (Stromberg et al. 2010), in southeastern Arizona, was also instrumental to the project in terms of both map themes and line work. Other more elemental map sources (e.g., Akasheh et al. 2008) including the National Wetlands Inventory (Dahl et al. 2009), though not incorporated directly into RMAP, served as key ancillary references during our map development. Following the accuracy assessment of draft mapping, the legend was finalized to reflect 24 map units, 1 provisional unit, and four subclasses (Table 1). Map units were organized into riparian ERU groups for landscape analysis.

Historic riparian was included as an RMAP unit, applying the following operational definition: *Historic Riparian map features represent plant communities that were riparian in the past but that currently lack the potential to sustain obligate or facultative wetland vegetation due to permanent or temporary conversion of the site due to agricultural, rural, or urban development*. These communities can no longer sustainably regenerate riparian vegetation, yet possess strong inferences of past site potential including residual wetland vegetation, valley bottom settings, relative greenness, obvious dewatering or downcutting of the channel, or other indicators. Historic riparian was mapped as either Agriculture, Residential/Urban, or Natural/Semi-Natural Upland according to the dominant land use by aerial extent. Also, each feature mapped as historic riparian was also given a subclass assignment for the putative RMAP unit of the past. However, RMAP is not intended to approximate historical riparian extent.

Table 1. Final map unit legend of the Regional Riparian Mapping Project.

Map Unit Legend	RMAP Code	System Type
Cottonwood Group (CWD)		
Cottonwood / Hackberry	160	riparian
Fremont Cottonwood – Oak	170	riparian
Fremont Cottonwood / Shrub	180	riparian
Narrowleaf Cottonwood / Shrub	230	riparian
Rio Grande Cottonwood / Shrub	260	riparian
Sycamore - Fremont Cottonwood	270	riparian
Elm - Eastern Cottonwood	310	riparian
Eastern Cottonwood / Shrub	320	riparian
Cottonwood –Evergreen Tree Group (CEG)		
Fremont Cottonwood – Conifer	150	riparian
Narrowleaf Cottonwood – Spruce	240	riparian
Desert Willow Group (DWG)		
Desert Willow	130	riparian
Oak / Desert Willow	250	riparian
Little Walnut / Desert Willow	360	riparian
Montane-Conifer Willow Group (MCWG)		
Arizona Alder – Willow[1]	110	riparian
Upper Montane Conifer / Willow	280	riparian
Willow - Thinleaf Alder	290	riparian
Walnut-Evergreen Tree Group (WEG)		
Little Walnut - Chinkapin Oak	210	riparian
Arizona Walnut	300	riparian
Ponderosa Pine / Willow	350	riparian
Little Walnut - Ponderosa Pine	370	riparian
Wetland Group (WET)		
Herbaceous Wetland	190	wetland
Shrub Wetland*	140	riparian/wetland
Historic Riparian Group (HRG)		
Historic Riparian – Agriculture	400	riparian
Historic Riparian – Residential/Urban	410	riparian
Historic Riparian – Natural/Semi-Natural Upland	420	riparian

Map Unit Subclasses	Subclass Codes	
Upland Wet Meadow*	4 (mead)	riparian/wetland
Russian Olive*	5 (oliv)	riparian
Mesquite Bosque	6 (mesq)	riparian
Tamarisk[2]	8 (tamx)	riparian/wetland
Constructed Riparian	9 (cnst)	riparian/wetland
Alkali Herbaceous Wetland	7 (play)	wetland
Herbaceous Wetland, Upper	10 (uppr)	wetland
Herbaceous Wetland, Mid	11 (mid)	wetland
Herbaceous Wetland, Lower Mild	12 (lwrm)	wetland
Herbaceous Wetland, Lower Cold	13 (lwrc)	wetland
Herbaceous Wetland, Great Plains	14 (grpl)	wetland

* – Provisional units (Muldavin et al. 2000) not included with RMAP
1 – A dash symbol (-) between two plant species in the map unit name indicates plants that share the dominant stratum of the plant community. A forward slash (/) is used to separate dominant vegetation of the overstory and understory strata, respectively.
2 – In the RMAP geodataset Tamarisk is the mapped subclass for a map unit representing the previous site potential (e.g., , with a decimal value to code the putative type (e.g., 400.180 to indicate a plant community that was historically Fremont Cottonwood/Shrub).

Valley Bottom Modeling

Valley bottom models were developed by the Geospatial Technology and Applications Center (GTAC) of the Forest Service Washington Office, as the principal ancillary information to support riparian mapping. Since the initial digital model used to infer riparian (Goetz 2001, Williams et al. 2000), valley bottom models have become increasingly sophisticated and effective, and for many areas the models themselves are being used to represent riparian plant communities (Walterman et al. 2006). For our work, GTAC valley bottom models (VBMs) served as hypotheses for subsequent photo interpretation and mapping, providing an initial approximation of maximum riparian extent at the levels of watersheds and individual plant communities.

GTAC Valley Bottom Model Technical Description

The development of GTAC valley bottom models occurred in four stages. First, a valley bottom map is generated to reflect the maximum spatial extent of potential riparian zones. Second, a raster layer of wetness index values is prepared for the specific watershed of interest (e.g., Upper Hassayampa River on the Prescott NF). Third, using the valley bottom map as a mask, the wetness index layer is segmented into polygons using the eCognition program (Definiens Imaging 2003). The final modeling step involves the classification of each polygon based on the plurality of wetness index values contained.

The initial valley bottom model delineations were based on a flood-fill algorithm and 10m digital elevation models (DEMs). Hydrologic modeling techniques and existing models provide the basis for the valley bottom model. The analysis uses three topographic parameters that are defined by the technician and governed by Strahler stream order: 1) buffer distance; 2) change in height; and 3) slope threshold. These parameters simulate a flood on the DEMs and create a variable-width delineation of the valley bottoms. The ArcGIS program, USFS cartographic feature files (vector files representing rivers, streams, lakes and ponds), and 10m DEMs are required to build the model.

The wetness index is derived using the System for Automated Geoscientific Analyses (SAGA)(Cimmery 2010). A 10m DEM is preprocessed to remove any sinks (sink removal by channel deepening). The SAGA Wetness Index is similar to the Topographic Wetness Index (TWI)(Beven and Kirkby 1979), but is based on a modified catchment area calculation which does not consider flow as a thin film. As a result, for cells situated in valley floors with a small vertical distance to a channel, it predicts those extents as having a more realistic, higher potential soil moisture compared to the standard TWI calculation. For our purposes, the SAGA index has also taken the place of the Compound Topographic Index (Moore et al. 1991) that depends on hydrography data as input.

Using the valley bottom as a mask (i.e., only consider wetness index values that are inside the valley bottom delineation), polygons are developed within the valley bottom through segmentation such that the wetness values within the polygon are statistically more similar to each other than wetness values among surrounding polygons – minimizing variance within polygons, maximizing variance among polygons. The Definiens Developer software suite provided the segmentation model (Definiens Imaging 2003).

Finally, the valley bottom polygons are classified using the mean wetness value of each polygon and the closest of nine wetness classes (4, 6, 8, 10, 12, 14, 16, 18, 20)(Figure 2). Each classified set of polygons was exported in ESRI shapefile format and assessed in ArcMap where one or more models served as the principle ancillary information and the initial approximation of maximum riparian extent for the RMAP project.

Valley Bottom Model Application

As mentioned VBMs were generated for all 5th-code HUCs identified for mapping with RMAP, with multiple models for each watershed differing by wetness index value. Each successive wetness class (e.g., 10 versus 8) includes a smaller set of polygons (less total modeled extent), each of which represents surface areas that have higher mean wetness values than do polygons in the next lower class. When beginning the map work for each watershed, a wetness value was selected based on the greatest apparent agreement between the VBM and riparian communities of the watershed. Figure 2 shows three of nine available valley bottoms generated for the Upper Hassayampa River watershed. One model was selected as the most suitable starting point for riparian mapping. This model then became the initial hypothesis to focus photo interpretation and mapping.

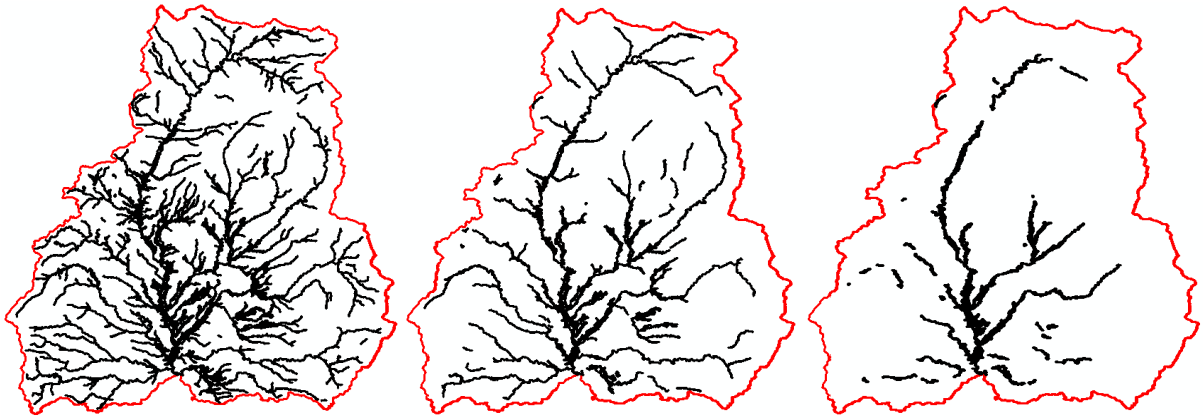


Figure 2. Valley bottom models of the Upper Hassayampa River watershed, Prescott NF, Arizona. Each model represents a different wetness index value and increasing conservative hypotheses for riparian plant communities.

Photo Interpretation and Mapping

Riparian plant communities were mapped using heads-up digitizing in ArcMap, while utilizing the valley bottom model delineations, photo interpretation, and the interpretation of various other ancillary references (Table 2). As mentioned, the VBM delineations represented the principle ancillary data and the initial approximation of maximum riparian extent. All riparian features, not previously mapped with TEUI, were drawn at the scale of 1:12,000 scale or finer. Existing TEUI line work and classification themes not only supplemented the RMAP dataset, but served as an ancillary source to convey inferences of contiguous riparian and upland settings. Other ancillary sources supported the delineation and map unit assignments of riparian plant communities.

Table 2. Ancillary references used to support RMAP.

Ancillary Information Source
GTAC valley bottom models (Walterman et al. 2006)
General Ecosystem Survey (USDA Forest Service 1989)
Soil Survey Geographic Database (SSURGO)(NRCS 2011)
USFS resource aerial photography
Proper Functioning Condition assessments (Prichard et al. 1993)
Special/high resolution aerial photography
Digital orthoquad imagery (DOQQ imagery, color IR)
Nation Wetland Inventory (Dahl et al. 2009)
AZ Game & Fish riparian layer (AZGFD 1993)
National Hydrography Dataset (USGS 2011)
Arizona Riparian Inventory and Mapping Project (AZGFD 1993)
Southwest ReGAP (Lowry et al. 2005)

Map delineations were based on the separation of riparian and upland communities and the separation with other riparian map units (Table 1). Delineations were also driven by the minimum map unit criterion and horizontal line accuracy of the target map scale. The TEUI polygons embedded in RMAP were left intact both thematically and spatially except in one instance (see Results), even when contiguous RMAP polygons occurred as the same map unit. Various disjunct riparian features that did not occur in the VBM or as TEUI, were evaluated and mapped when they met project map scale and operational definition of *riparian*. Photo interpretation with the support of ancillary information was used to determine the most suitable map unit. Map unit assignments were made for all map features according to the RMAP legend (Table 1). A rule set was developed to facilitate riparian mapping in response to various circumstances:

- Intervening stream channels that occur between riparian plant communities were not considered when computing MMF.

- Where riparian plant communities existed on only one side of the stream channel, the stream channel was not included in the delineation of riparian features. The stream channel was always included where riparian plant communities, each meeting the MMF requirement, occurred on each side of the channel.
- Lentic wetlands were mapped only where they integrated with mapped riparian features.
- Non-riparian inclusions within riparian map features were delineated separately (donut holes) when they exceeded the MMF. Likewise gaps in riparian were excluded when the gaps exceeded the MMF (gaps being plant communities that did not meet the operational definition of riparian – see Introduction).
- Map unit assignments for each polygon were based on the predominant (plurality) map unit of the polygon.

Accuracy Assessment

Using a probability sample selected from RMAP polygons, an accuracy assessment was developed to provide end users with the most complete description of RMAP data. Many factors influence the accuracy and precision of an ecological map product. Given the extensive geography represented by this mapping effort, and considering that the mapping was largely derived from image interpretation and analysis, the potential for error exists to warrant an accuracy assessment as do most mapping projects. By generating a set of high-quality accuracy samples based on the relatively rigorous protocols described below, we were able to test draft map data that were theoretically less accurate than the accuracy samples (Triepke et al. 2008).

The objective of the accuracy assessment was two-fold: 1) to determine thematic accuracy as measured by *overall area-weighted user accuracy* of map unit assignments, and 2) to determine spatial accuracy according to errors of omission and commission of mapped riparian areas with surrounding upland communities – i.e., how well riparian communities, regardless of map unit, were captured within the context of the landscape. Spatial accuracy was assessed at both local and gross omission scales. The accuracy assessment occurred in three phases – sample design and selection, sampling, accuracy calculation. Draft RMAP polygons were used as a pool of sample units from which to perform a random selection for the assessment of map unit themes and spatial accuracy at the local level. Error of gross omission, on the other hand, was assessed through a separate process and sampling procedure (see following description).

Sample Design and Selection – Thematic and Spatial-Local Accuracy Assessment

In the course of generating a sample design, different stratification themes were considered but deferred in favor of a simple random sample of newly mapped features occurring on USFS lands. The accuracy assessment did not extend to non-USFS, or to lands already mapped through TEUI. Samples were selected with equal probability, and without other criteria that would limit inference of the sample to map quality, with one exception made for the National Grasslands (see following discussion). A target sample number of 270 was arbitrarily derived by multiplying the number of initial map unit concepts (25) times 10 samples per unit, plus an additional ten samples for each set of National Grasslands. Of course, map units are not equitable in extent; nevertheless, the approach allowed us to consider thematic variability in the estimate of an initial sample number.

For the National Grassland extents a minor stratification was used to guarantee a minimum number of at least ten samples in each administrative area – Kiowa-Rita Blanca and the Black Kettle – extremities of the project area that each fall into Great Plains climate gradients of their own. The locations of the remaining accuracy samples were identified through a straight-forward random selection from a listing of draft RMAP polygons in Excel, using the 'sampling' function under 'data analysis tools'.

Sampling – Thematic and Spatial-Local Accuracy Assessment

Data collection for the accuracy samples was carried out in two stages – photo interpretation and field sampling. All samples were initially assessed in GIS using various photography, imagery, and ancillary resources. Photo interpretation *alone* was used for accuracy sampling when the map unit and delineation could both be assessed with high confidence (on a qualitative scale of low, moderate, high). All other samples were field validated. The field work was also used to further validate map unit concepts and to survey for significant riparian associations possibly missed with the initial map unit concepts.

Map unit assignments for each accuracy sample were based on the predominant map unit of the polygon – the unit with the greatest plurality in aerial extent. Samples were tallied in an Excel table according to polygon ID, mapping assignment, and accuracy assessment value for map unit. Map feature delineations were validated according to the degree of overlap in the mapped extent versus the actual riparian plant community (regardless of map unit) using categories of omission and commission error (0: 0%, 1: 0-24.9%, 2: 25-49.9%, 3: 50-74.9%, 4: 75-94.9%, or 5: 95-100% overlap).

Accuracy Calculations

Each accuracy sample was assessed for classification (map unit) and mapping (delineation), eventually leading to two sets of accuracy calculations to characterize data quality at the local scale. A conventional error matrix was used to summarize sample data for map unit assignments and thematic accuracy (Table 5). Area-weighted accuracy values were calculated by weighting each map unit according to its respective proportion of the total map area. Both producer- and user-accuracy values were calculated for each map unit, though it was the user accuracy values that were weighted by area and factored into an overall accuracy value for the RMAP data.

Separate calculations were made to assess spatial accuracy at the local level. To estimate errors of commission and omission, computations were made for the amount of area that was over- and under-mapped to arrive at total percent values for omission and commission errors at the local scale (Table 6), neutral to map unit. Spatial accuracy at the landscape scale extent was calculated separately through a process of determining gross omission.

Gross Omission

Again, the assessment of gross omission represented the overall capture of riparian on the total RMAP landscape, those 297 5th-code watersheds that met the 10% threshold, along with USFS lands in the remaining 99 watersheds. While standard measures of user and producer accuracy can be provided based on an analysis of field samples, it is difficult in a project of this nature to provide an accurate depiction of overall map omission. It was not practical to conduct a systematic sample of all lands to quantify the proportion of riparian sites that were inadvertently omitted from RMAP. However, in an effort to determine the degree to which riparian areas that are readily identifiable using our mapping techniques were not mapped, a gross omission assessment was developed. Through independent image analysis, select sub-watersheds were randomaly selected and systematically gridded and assessed for omission of discernable riparian.

First, using watersheds as bounded sample areas, 6th code watersheds were selected for analysis of gross omission. In an effort to focus accuracy efforts on USFS land, only those 6th code watersheds with at least 90% of their area occurring on proclaimed USFS land were considered. A total of 552 6th code watersheds met this 90% rule. A goal of this assessment was to sample a cross section of the different ecological communities across the region. As a result, a stratified random sample was selected using Ecoregions (Province) to proportionately distribute selected sample watersheds. A total of ten sample watersheds were then selected to represent the sample area. Each selected 6th code watershed was independently assessed by an analyst not involved in the original mapping of that watershed. All areas of each watershed were gridded and carefully assessed, producing a spatial depiction of total discernable riparian within the sample watersheds. Finally, gross omission was calculated as a proportion of omitted riparian area to total discernable riparian area.

Results and Discussion

Riparian plant communities were mapped in over 297 5th-code watersheds for a total of over 819,000 acres (332,000ha). Of that area, over 266,000 acres (108,000ha) of mapping was adopted and normalized from other sources, particularly TEUI (Winthers et al. 2005) which has been generated on nearly all National Forests and Grasslands of the region over the past three decades. As mentioned, the University of Arizona contributed mapping for the San Pedro River basin in southeastern Arizona (Stromberg et al. 2010). The 24 map units in the final RMAP

product range in total area from about 510ac (210ha), for Little Walnut / Desert Willow, to over 165,000 acres (67,000ha) for Fremont Cottonwood / Shrub (Table 3). Subclasses were mapped whenever the primary subclassification themes were evident (subclasses 6, 7, 8, and 9; see Table 1), or when there were historic riparian features (units 400, 410, and 420; see Table 4), for a total of about 119,000ac (48,000ha). Nearly 10% of the RMAP area has lost the potential to sustain riparian plant communities and was mapped as historic riparian.

Approximately 45% of the total area mapped, 370,000ac (150,000ha), occurred on non-USFS ownership. For eight of the units, the majority of area occurs in non-USFS ownership, including two of the historic units (400 and 410). For five map units, area on non-USFS lands comprises less than 10% of the total area of the unit. Of the riparian features on Forest Service lands, the amount of area on a given National Forest ranged from about 4,900ac (2,000ha) for the Kaibab NF, to over 81,000ac (33,000ha) for the Santa Fe NF (Table 3). The number of map units per administrative unit ranged from two map units for the Valles Caldera National Preserve, to 19 units for the Cibola NF. However, when adjusted for area, the Valles Caldera had still had the lowest diversity, with one map unit for every 8,100 (3,300ha), compared to the highest diversity on the Kaibab NF with one unit for every 410ac (170ha). Two of the Cibola units, Elm – Eastern Cottonwood (310) and Eastern Cottonwood / Shrub (320), occur exclusively on the National Grasslands that the Cibola NF administers. Not surprisingly, Herbaceous Wetland (190) is the most ubiquitous unit, occurring on all twelve administrative units. Six units, 210, 250, 320, 360, 370, and 420, occur on only one National Forest.

Subclasses were assigned to a total of about 119,000ac (48,100ha) of the mapped area, and ranged from 25ac (10ha) for one of the three historic map units, Residential / Urban, with a subclass of Narrowleaf Cottonwood – Spruce to over 37,800ac (15,300 ha) for Tamarisk. The Tamarisk subclass occurs among nine parent map units. Again, all historic map features were assigned a subclass according to the putative historic site potential. Table 4 shows the relationships between subclasses and their parent map units.

Table 3. Summary of area for RMAP units in acres, by National Forest*.

RMAP Unit	01	02	03**	04	05	06	07	08	09	10	12	19	non-USFS	TOTAL
110	251	-	75	68	258	2,699	150	120	1,411	-	222	-	304	5,556
130	-	-	57	197	270	11,433	-	93	4,282	-	8,933	-	29,692	54,957
150	75	-	140	181	163	-	-	-	24	-	12,694	-	842	14,119
160	-	-	1,334	-	-	-	-	41	-	-	-	-	1,423	2,798
170	804	-	48	-	516	85	-	-	1	-	483	-	715	2,651
180	1,162	-	76	2,663	2,047	3,117	1,382	1,186	5,925	-	28,939	-	118,960	165,457
190	26,401	36,430	13,685	11,130	11	2,599	3,124	816	45	20,396	310	16,130	28,261	159,338
210	-	-	-	-	-	-	-	321	-	-	-	-	242	562
230	18,548	1,555	1,406	2,256	59	26,629	-	412	-	15,016	1,822	-	20,033	87,736
240	-	4,154	-	19	-	-	-	-	-	-	-	-	286	4,459
250	-	-	-	20	-	-	-	-	-	-	-	-	729	748
260	-	3,016	3,012	-	-	-	-	333	-	6,714	-	-	51,660	64,734
270	9,150	-	-	8,055	3,686	10,191	77	-	6,867	-	15,705	-	20,145	73,876
280	89	1,583	235	9	82	668	26	207	-	495	-	-	802	4,194
290	2,593	9,117	854	1,498	-	1,082	-	170	-	6,959	-	17	10,012	32,302
300	290	-	9	542	473	1,425	17	45	5,995	-	11	-	3,933	12,738
310	-	-	19,866	-	-	-	-	-	-	-	-	-	14,192	34,091
320	-	-	1,430	-	-	-	-	-	-	-	-	-	6,340	7,770
350	175	296	673	4	139	885	86	598	661	665	6,020	-	697	10,897
360	-	-	-	-	-	-	-	313	-	-	-	-	195	508
370	-	-	-	-	-	-	-	835	-	-	-	-	54	889
400	-	541	5,151	1,337	-	-	-	663	903	768	6	-	48,358	57,728
410	351	-	37	415	49	83	-	-	9	1	6,557	-	11,578	19,081
420	-	-	1,432	-	-	-	-	-	-	-	-	-	474	1,906
TOTAL	59,888	56,692	49,537	28,393	7,753	60,906	4,860	6,153	26,122	51,013	81,740	16,147	369,926	819,164

* – Forest codes: 01 – Apache-Sitgreaves NF, 02 – Carson NF, 03 – Cibola NF, 04 – Coconino NF, 05 – Coronado NF, 06 – Gila NF, 07 – Kaibab NF, 08 – Lincoln NF, 09 – Prescott NF, 10 – Santa Fe NF, 12 – Tonto NF, and 19 – Valles Caldera Nat Preserve.

** – Includes Black Kettle and Kiowa-Rita Blanca National Grasslands.

Table 4. Summary of area for RMAP subclasses in acres, with each subclass represented by a row, and associated RMAP units represented in columns.

RMAP Subclass	130	180	190	230	250	260	270	290	320	400*	410*	420*	TOTAL
6*	-	35,221	246	-	-	-	97	-	-	-	-	-	35,564
7*	-	-	7,392	-	-	-	-	-	-	-	-	-	7,392
8*	227	29,994	40	21	729	6,531	23	400	77	-	-	-	37,816
9*	592	1,294	251	154	-	358	17	243	-	-	-	-	2,317
110	-	-	-	-	-	-	-	-	-	31	-	-	31
130	-	-	-	-	-	-	-	-	-	1,319	1,193	-	2,512
180	-	-	-	-	-	-	-	-	-	26,254	14,843	-	41,097
190	-	-	-	-	-	-	-	-	-	1,316	317	-	1,633
210	-	-	-	-	-	-	-	-	-	54	-	-	54
230	-	-	-	-	-	-	-	-	-	2,945	410	-	3,356
240	-	-	-	-	-	-	-	-	-	25	-	-	25
260	-	-	-	-	-	-	-	-	-	15,509	1,834	-	17,343
270	-	-	-	-	-	-	-	-	-	2,665	320	-	2,985
290	-	-	-	-	-	-	-	-	-	285	108	-	393
310	-	-	-	-	-	-	-	-	-	7,325	37	-	7,362
320	-	-	-	-	-	-	-	-	-	-	-	1,906	1,906
TOTAL	819	31,288	290	175	729	6,890	40	644	77	57,728	19,063	1,906	118,830

* – Historic RMAP units for Agriculture (400), Residential/Urban (410), and Natural/Semi-Natural Upland (420). Map unit 400.110, for example, is comprised of 31 acres, where the contemporary vegetation is agricultural and the putative historic riparian vegetation is Arizona Alder – Willow (110).

Accuracy Assessment

The independent accuracy assessment was completed to determine overall map accuracy on USFS lands, both in terms of map unit themes and in terms of spatial accuracy – error of omission and commission. Due to issues of time contraints and the issue of access to private ownerships, the accuracy assessment was focused on USFS lands only. Within USFS lands, the accuracy assessment was further narrowed to areas not previously mapped through TEUI, for a total analysis area of approximately 183,000ac (74,000ha). Based on map unit assignments for the random sample of 258 map polygons, the overall area-weighted user accuracy was estimated at 77% (Table 5). Twelve samples of the initial selection of 270 polygons were not sampled due to inaccessibility and safety concerns, leaving a total sample number of 258. Three map units, 250, 360 and 370, comprise relatively minor extents and had no samples. Columns in the error matrix show the distribution of accuracy samples among RMAP units that the samples fall within, while rows represent the map features themselves. The highlighted diagonal contains samples in agreement with the map features being tested. The samples that occur off-diagonal reflect mapping error, where error of commission is represented in the distribution of samples to either side of the diagonal, and error of omission is represented by the distribution of samples above and below the diagonal. Overall area-weighted user accuracy was calculated by averaging and area-weighting individual user accuracy values for each map unit.

While the majority of map units are represented by low sample numbers of 10 or less samples, six units have mapped area exceeding 10,000ac (4,000ha) with user accuracy values between 54% and 92%. The three map units with the most area, map units 180, 190, and 270, have user accuracy values between 65% and 92%. All three historic map units, 400, 410, 420, show 100% user accuracy owing to the interpretability of these features. Of the three map units with the lowest values, between 0% and 22% accuracy (130, 150, and 170), two are relatively complex mixed tree types (Fremont Cottonwood – Conifer, Fremont Cottonwood – Oak).

Table 5. Error matrix for RMAP, showing user accuracy values for 21 of 24 map units occurring on USFS lands.

RMAP Unit	110	130	150	160	170	180	190	210	230	240	260	270	280	290	300	310	320	350	400	410	420	UPL*	Sample Total	User Accuracy
110	4					2			1						2			1				3	13	31%
130		1													3							1	5	20%
150			2			2			1			4											9	22%
160				3																			3	100%
170	2											3	1									1	7	0%
180		2			1	22			1			2			4							2	34	65%
190						1	58					1										3	63	92%
210								2															2	100%
230	2					2	1		13			1			3							2	24	54%
240										2													2	100%
260											3												3	100%
270						2						26										1	29	90%
280	1								2				3									2	8	38%
290	1						1		1		2			13	1			1				2	22	59%
300												2			3							1	6	50%
310																7							7	100%
320																	2						2	100%
350								1							1			5				3	10	50%
400																			5				5	100%
410																				3			3	100%
420																					1		1	100%
Samp.	10	3	2	3	1	31	60	3	19	2	5	39	4	13	17	7	2	7	5	3	1	21	258	
Acres	3,282	6,208	2,040	477	1,625	21,187	44,287	321	17,331	576	3,409	20,700	2,818	13,385	3,944	17,952	1,260	3,739	9,370	7,503	1,125			
Hect.	1,328	2,513	826	193	658	8,575	17,925	130	7,014	233	1,380	8,378	1,140	5,417	1,596	7,266	510	1,513	3,792	3,037	456			
Area-Weighted User Accuracy					77%																			

* - Upland plant community

As mentioned, each accuracy sample was assessed for the degree of overlap in the mapped extent versus the actual riparian plant community, using categories of omission and commission error (0: 0%, 1: 0-24.9%, 2: 25-49.9%, 3: 50-74.9%, 4: 75-94.9%, or 5: 95-100% overlap). Of the 258 accuracy samples, it was not possible to confidently discern spatial extent on two samples, leaving a total of 256 samples for determining spatial accuracy of RMAP. As before, only riparian on USFS lands was assessed, and then only on areas not previously mapped through the TEUI. Table 6 details spatial accuracy across all map units in error rates of commission and omission. The net error is approximately 6% commission, suggesting overmapping on approximately 10,800ac (4,400ha) of the project area. Overmapping (commission) appears to occur most frequently with map units 180 and 270, and upland plant communities mismapped as riparian account for the majority of commission error. Undermapping (omission) was particularly concentrated in units 190, 260, and 300. Units 190 (Herbaceous Wetland) and 300 (Arizona walnut) are especially difficult to discern with remote sensing from contiguous upland communities of similar physiognomy.

Table 6. Spatial error summary for omission and commission categories (0: 0%, 1: 0-24.9%, 2: 25-49.9%, 3: 50-74.9%, 4: 75-94.9%, 5: 95-100%), with net error rate given for each map unit and for RMAP collectively.

RMAP	Omission Category				Commission Category					Sample	Net
Unit	0	3	4	5	1	2	3	4	5	Total	Error Rate
110		3	1	6		1	1	1	7	10	10.0%
130		1		2				2	1	3	10.0%
150				2					2	2	0.0%
160		1		2				2	1	3	10.0%
170				1			1			1	-35.0%
180		3	6	23			2	4	26	32	60.0%
190		1	9	51			4	22	35	61	-267.5%
210				3				1	2	3	-12.5%
230		1	2	16			2	2	15	18	-35.0%
240				2					2	2	0.0%
260				6	1			1	4	6	-97.5%
270		3	5	32			3	3	34	40	25.0%
280			1	3		1		2	1	4	-72.5%
290		1	3	9				6	7	13	-2.5%
300			3	14		1	1	5	10	17	-120.0%
310			3	5				4	4	8	-12.5%
320				3					3	3	0.0%
350		1	1	5			1		6	7	12.5%
900*			1					1		1	0.0%
999**	21								21	21	(2047.5%**)
Total		15	35	185	1	3	15	56	181	256	5.9%

* - Burned.

** - Non-riparian/upland. Does not reflect true error rate since upland map features are always in complete commission.

Error of Gross Omission

All ten of the sample watersheds, when taken together, were found to have 4,230ac (1,710ha) of total discernable riparian. Of that, 4,150ac (1,680ha) are included within the extent of RMAP, and 79ac (32ha) were inadvertently omitted, resulting in an overall 1.9% gross omission rate. Put another way, this assessment shows that this project is estimated to have accurately captured 98.1% of the discernable or mappable riparian among watersheds of USFS lands. Unfortunately, this assessment cannot quantify the total omission rate as a result of riparian that was not discernable from adjacent or coincident vegetation using the remote sensing techniques employed in this project. The rate of gross omission suggests that approximately 8,540ac (3,460ha) were omitted from USFS watersheds. When considered with the rate of overmapping at local scales (5.9%), the net spatial error suggests commission on about 2,300ac (900ha).

Final Map Unit Development and Processing

The final RMAP legend (Table 1) is identical to the original working legend with the exception of one map unit. Map unit 230 includes all areas that were provisionally mapped as 220, Narrowleaf Cottonwood. The initial accuracy assessment showed that the the two units were often confused, leading to the combination of the two into one map unit, resulting in a minor improvement to overall map accuracy. Also, the concept for 220 implied that shrub strata were missing or sparse which, while often true on contemporary landscapes, runs counter to the project theme of potential vegetation.

Once the map legend was finalized, several processing steps were made to complete the project:

- Boundaries among adjacent polygons of identical map units were dissolved, with the exception of map features derived through the TEUI which were kept separate. All map features were attributed by mapping source.
- The resulting map features that did not meet the MMF threshold were dissolved into the adjacent riparian polygon of the greatest shared boundary. Map features not meeting the MMF with no contiguous riparian were removed from the dataset (as upland).
- A geodatabase was generated to store the processed RMAP data. Data fields for each map feature include project (map project source), TEUI map unit (for map features adopted from TEUI), RMAP code, subclass, and comments.
- FGDC-compliant metadata were added to the geodatabase, and are reflected in this project report.

The RMAP deliverables include the geodatabase mentioned above and this project report. Both products are available online at <http://www.fs.usda.gov/detail/r3/landmanagement/gis>. The RMAP data has since been mosaicked into USFS ERU mapping for the Southwest (Wahlberg et al., in draft).

Summary

The RMAP mapping was developed using valley bottom modeling and photo interpretation, and represents a relatively simple and comprehensive approach commensurate with some business needs of the Forest Service and its partners. When using RMAP, potential applications must be considered in relation to the specifications of the mapping, particular that these data are 1:12,000 in scale, limited in extent to those watersheds that intersect Forest Service lands, and are a *potential* vegetation theme of basic ecosystem types.

The initial version of RMAP data was issued in October of 2011. Occasional updates to the dataset are made with new information and additional needs. For instance, since the release of RMAP the Apache-Sitgreaves National Forest in Arizona submitted a few additions and updates based on reinterpretation of the TEUI data that is embedded in the mapping. Other future updates to RMAP are likely and welcomed, and would undergo similar data quality and processing standards of the original project. Collaborators in Arizona and New Mexico are mapping riparian corridors on non-Forest Service watersheds, which will greatly broaden and improve the capability of ecological assessments and the management of riparian resources. Ongoing changes stemming from anthropogenic factors, including climate change, highlight the importance of capturing the changing extent of riparian plant communities, similar to how historic riparian themes were captured with RMAP.

Of the approximately 819,000ac (332,000ha) included with RMAP, about 79,000ac (32,000ha) was mapped as historic – those plant communities that were historically riparian but that now lack the potential to sustain obligate or facultative wetland vegetation. This represents about 10% of all mapped areas of the project (i.e., the loss of about 1% of riparian per decade), likely a conservative rendering due to the difficulty in detecting and delimiting areas of previous riparian that have been substantially altered. For example, while ground-truthing areas of the Kiowa-Rita Blanca National Grasslands for RMAP, observations of many floodplains revealed *no* remaining riparian wetland vegetation. In these places, riparian is expressed only in residual cottonwood skeletons and similar evidence that is fast fading from the landscape. Where the water table is now over 400ft (120m) below the surface of the floodplain, anecdotal information suggests that the water table may have been within 20ft (6m) historically. Likewise, in some herbaceous wetlands of the area, only the swales now support rushes or sedges, with surrounding areas of historic riparian mapped by inference. Determining the historic site potential in some of these areas is already forensic, underpinning the need to prioritize work in unmapped extents.

Since 2011, RMAP map themes and spatial information have served as an organizational framework for planning, analysis, inventory and monitoring, and related efforts including the Southwestern Region's Riparian and Aquatic Ecosystem Assessment Strategy (https://ems-team.usda.gov/sites/fs-r03-raes/Pages/Home.aspx), the Aquatic-Riparian Inventory (USDA Forest Service 2017), and the Riparian Existing Vegetation Mapping project (e.g., Clark et al. 2016). The Aquatic-Riparian Inventory and Riparian Existing Vegetation Mapping programs are providing quantitative inventory and monitoring information for several key indicators over large extents, to complement

qualitative approaches and more localized assessments such as Proper Functioning Condition (Prichard et al. 1998). Further, RMAP has been integrated with the Southwestern Region's overall Ecosystem Analysis Framework. The Region is integrating with work of agency partners such as the State of New Mexico, Natural Heritage New Mexico, and the Southern Rockies Landscape Conservation Cooperative (e.g., Smith and Friggens 2017, Muldavin et al. 2011) to achieve greater consistency in the indicators that are used for monitoring, inventory, planning, and assessment and the ways in which respective protocols address those indicators.

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Appendix A – Riparian Ecological Response Unit Descriptions

110

Arizona Alder - Willow

Below Dirty Hannah Spring; Clifton RD, Apache NF. Photo by Max Wahlberg.

General Description

Map unit 110 covers approximately 5,600 acres (2,200ha), and occurs on all National Forests in the region with the exception of the Carson and Santa Fe National Forests. It is typically found at elevations ranging from 3,330 to 9,900 feet (1,110-3,020m). While both Arizona alder and willow species are indicative of this unit, some areas of 110 may contain only one species or the other. Common willow species include red willow (*Salix laevigata*) and arroyo willow (*S. lasiolepsis*). Other riparian species commonly found in map unit 110 include Arizona walnut, velvet ash, and Rocky Mountain maple (*Acer glabrum*).

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 110	ALOB2/ACGL/SALA6
	ALOB2/FRVE2/SALA3
	ALOB2/SALIX/JUNCAS/POPR
	POPR/JUNCAS/SALIX
	SALA6
	SALA6/ALOB2
	SALIX/ALOB2

Associated / Similar Types

Map unit 110 is similar to the *Alnus oblongifolia* Community Type described by Szaro (1989) and the Alder type described by Laurenzi et al. (1983) for the Tonto NF. Expressions of existing vegetation in the NVC include the Rocky Mountain & Great Basin Montane Riparian Forest Group (G506) and other non-forest Groups (Appendix C). Map units 230, 240, and 280 are also related to G506.

130

Desert Willow

Unnamed wash near Perkinsville, AZ, Prescott National Forest. Photo by Max Wahlberg.

General Description

Map unit 130 covers approximately 55,000 acres (22,200ha), and occurs on the Cibola, Coconino, Coronado, Gila, Lincoln, Prescott, and Tonto National Forests. It is typically found at elevations ranging from 1,300 to 6,900 feet (400-2,100m), often along ephemeral and drier reaches of interrupted alluvial channels. Other riparian species commonly found in map unit 130 include netleaf hackberry and velvet mesquite.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 130	BASA2/HYMO
	CELAR/CHLI2
	CHLI2/PRVE
	PRVE/BASA2/HYMO
	PRVE/CHLI2/BASA2

Associated / Similar Types

Expressions of existing vegetation in the NVC include the Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541) and other non-forest and ruderal Groups (Appendix C) made up of associations previously described (Muldavin et al. 2000) and others. Map units 250 and 360 are also related to G541.

Map unit 110 is similar to the *Alnus oblongifolia* Community Type described by Szaro (1989) and the Alder type described by Laurenzi et al. (1983) for the Tonto NF. Expressions of existing vegetation in the NVC include the Rocky Mountain & Great Basin Montane Riparian Forest Group (G506) and other non-forest Groups (Appendix C). Map units 230, 240, and 280 are also related to G506.

140

Shrub Wetland

Bluestem Willow/Common Spikerush Community Type on the San Francisco River and Gila NF. Photo by Mike Bradley.

General Description

Map unit 140 is a provisional unit for shrub wetland and riparian plant communities. The provisional status bears on site potential and the differentiation of seral plant associations from those with an indicated climax tree species, in turn indicating another RMAP unit. This unit includes at least three major groups of associations (Muldavin et al. 2000) characterized by key shrub taxa including diamondleaf willow (*Salix planifolia* Pursh), dewstem willow (*Salix irrorata* Andersson), coyote willow (*Salix exigua* Nutt.), and baccharis, either Emory's baccharis (*Baccharis emoryi* A. Gray) or mule-fat (*Baccharis salicifolia* (Ruiz & Pav.) Pers.). This unit is suspected from several National Forests and occurs in all life zones and stream types, from alpine and subalpine streamsides and wetlands to low elevation riparian communities ephemeral and drier reaches of interrupted alluvial channels.

TEUI Potential Vegetation

No subseries from TEUI or the General Ecosystem Survey (USDA Forest Service 1989) have been identified for this type.

Associated / Similar Types

Expressions of existing vegetation in the NVC include the Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541) and other non-forest and ruderal Groups (Appendix C) made up of associations previously described (Muldavin et al. 2000) and others. Map units 250 and 360 are also related to G541.

150

Fremont Cottonwood - Conifer

Photo by Mark W. Skinner @ USDA-NRCS PLANTS Database.

General Description

Map unit 150 covers approximately 14,100 acres (5,700ha), and occurs on the Apache-Sitgreaves, Cibola, Coconino, Coronado, Prescott and Tonto National Forests. It is typically found at elevations ranging from 2,100 to 8,800 feet (640-2,680m). Velvet mesquite and conifers such as juniper are commonly found in this map unit.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 150	JUOS
	PRVE/JUOS
	PRVE/JUOS/POFR2

Associated / Similar Types

Map unit 150 serves as the lower life zone counterpart to map unit 280 – Upper Montane Conifer / Willow. Expressions of existing vegetation in the NVC include the Warm Southwest Riparian Forest & Woodland Group (G797) and other non-forest and ruderal Groups (Appendix C) made up associations previously described (e.g., Muldavin et al. 2000).

160

Cottonwood / Hackberry

Canadian River in Mills Canyon, Kiowa National Grassland. Photo by Max Wahlberg.

General Description

Map unit 160 covers approximately 2,800 acres (1,100ha), and occurs on the Kiowa National Grassland and the Lincoln National Forest. This unit occurs in along the Canadian River in the Mills Canyon area, and can be expected elsewhere in New Mexico on eastern slopes above the Great Plains. It is typically found at elevations ranging from 4,000 to 6,000 feet (1,220-1,830m). The primary streamside vegetation of map unit 160 includes cottonwood and willow species, while the floodplain terraces have higher concentrations of common hackberry (*Celtis occidentalis*). Tamarisk can be common in this map unit.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 160	PODEW*/CEOC

Associated / Similar Types

Map unit 160 is similar to 320 – Eastern Cottonwood / Shrub – though the defining difference is the occurrence of common hackberry within 160. It is not represented well in the current NVC, with Great Plains units G147 (Great Plains Floodplain Forest Group) providing the greatest similarity in terms of existing vegetation, along with other non-forest and ruderal Groups (Appendix C) and non-forest associations previously described by Muldavin et al. (2000).

170

Fremont Cottonwood / Oak

Photo ©Al Schneider, www.swcoloradowildflowers.com.

General Description

Map unit 170 covers approximately 2,700 acres (1,100ha) and occurs on the Apache-Sitgreaves, Cibola, Coronado, Gila, and Prescott National Forests. It is typically found at elevations ranging from 2,200 to 7,500 feet (670-2,290m). Oak species in this map unit include Emory oak and Sonoran scrub oak. Other riparian species commonly found in map unit 170 include Arizona sycamore and velvet ash.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 170	QUEM/POFR2
	QUTU2/ACGR/HYMO
	PLWR2/FRVE2/QUEM/FAPA

Associated / Similar Types

Expressions of existing vegetation in the NVC include the Sonoran-Chihuahuan Warm Desert Riparian Woodland Group (G508) and other non-forest Groups (Appendix C).

180

Fremont Cottonwood / Shrub

Photo by Debbie Cress.

General Description

Map unit 180 covers approximately 165,500 acres (67,000ha), and occurs on all National Forests of the region except the Carson and Santa Fe NFs. It is typically found at elevations ranging from 1,000 to 7,600 feet (300-2,320m). Some areas of this map unit are dominated by Gooding's willow (*Salix gooddingii* C.R. Ball) and velvet ash (*Fraxinus velutina*) and have the potential for cottonwood regeneration. Other riparian species commonly found in map unit 180 include willow species, boxelder, and desert willow. Map unit 180 also supports a mesquite bosque subtype, mapped as map unit 180.6. Lanceleaf cottonwood, which is a hybrid between Fremont cottonwood and narrowleaf cottonwood, may occur in place of Fremont cottonwood in some places as this map unit transitions with map unit 230 – Narrowleaf Cottonwood / Shrub. In these transitional areas, narrowleaf cottonwood may also be found, and differentiating map unit 180 from 230 can be difficult.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 180	POFR2
	CHLI2/POFR2
	PAFL6/POFR2
	POFR2/ACNE2
	POFR2/SAGO
	POFR2/SAGO/HYME
	POFR2/SALIX
	PRVE
	PRVE/ACGR
	SAGO/FRVE2

Associated / Similar Types

Map unit 180 is similar to the following community types described by Szaro (1989): *Acer negundo*-Mixed Deciduous Community Type; *Fraxinus pennsylvanica* Community Type; *Populus fremontii* Community Type; *Populus fremontii-Fraxinus pennsylvanica* Community Type; *Populus fremontii-Salix goodingii* Community Type; and the *Salix gooddingii* Community Type. This unit is also similar to the Fremont Cottonwood-Willow type described by Laurenzi et al. (1983) for the Tonto NF. Expressions of existing vegetation in the NVC include the Sonoran-Chihuahuan Warm Desert Riparian Woodland Group (G508) and other non-forest and ruderal Groups (Appendix C) made up of associations previously described by Muldavin et al. (2000) and others.

190

Herbaceous Wetland

Unnamed tributary to San Antonio Creek, Tres Piedras RD, Carson NF. Photo by Max Wahlberg.

General Description

Map unit 190 covers approximately 159,300 acres (64,500ha), and occurs on the all National Forests and Grasslands of the project area. It is found at nearly all elevations in the region, ranging from 2,100 to over 12,000 feet (640-3,700m). This map unit supports a whole host of riparian and wetland herbaceous species, and species occurrence varies greatly with elevation and climate. As of 2018 map unit 190 includes nine subclasses and one provisional subclass. Further local refinements of this map unit using TEUI and other information may be necessary to differentiate between the highly variable constituent vegetation associated with Southwest wetlands.

2018 Subclassification

For purposes such as the assessment of New Mexico meadow jumping mouse habitat, unit 190 was thematically too general. In RMAP there are over 3,100 polygons of 190, and subclassification of these map features was made through interpretation of TEUI and, where TEUI was not available, through association of neighboring map features to arrive at five additional subclasses:

- **Herbaceous Wetland, Upper (10, uppr)** – Upper life zones within mild and cold gradients (mostly mixed conifer and spruce-fir life zones), associated with 110, 230, 240, 280, 290
- **Herbaceous Wetland, Mid (11, mid)** – Middle life zones within mild and cold gradients (mostly life zones woodland and ponderosa pine life zones), associated with 160, 210, 300, 350*
- **Herbaceous Wetland, Lower Mild (12, lwrm)** – Lower life zones within mild gradients (mostly life zones desert and semi-desert life zones), associated with RMAP units 130, 150, 170, 180, 250, 260, 270, 360
- **Herbaceous Wetland, Lower Cold (13, lwrc)** – Lower life zones within cold gradients (mostly cold temperature grassland and woodland life zones), associated with 280, 350*, 370
- **Herbaceous Wetland, Great Plains (14, grpl)** – In and near National Grasslands, associated with 310, 320, and Alkali Herbaceous Wetlands

  * Unit 350 can occur in either lower or mid riparian zones

Subclassification by association was made in GIS by attributing the surrounding ERU map features into life zones and then into initial riparian subclass assignments. The same process was repeated for riparian map features other than 190, before applying the Eliminate tool in ArcGIS on ambiguous classifications to find the most common adjacent life zone and subclass in which to infer subclass. The Eliminate tool was applied iteratively to all remaining polygons by surrounding ERU classes and then with RMAP units, overwriting any type that was based on upland ERUs. Fourteen unclassed polygons were manually classed based on surrounding vegetation and the most likely subclass.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 190	BOGR2/CAREX	DAFL3/DECA18/POPR
	FETH/DAIN/FEAR2	DAFL3/POPR/DECA18/FEOV
	POPR	KOMY/GEROT/MIOB2
	POPR/FEAR2/BRAN/MUMO	POPR/CAAQ
	POPR/IRMI	POPR/JUBA
	POTR5/POPR/JUBA	SPAI/ DISP
	CAAQ/CALE4	SPAI/DISP
	CAAQ/ELPA3/POLA4/ALGE	TRDA3/ DISP/ PAVI2
	CAAQ/JUAR2/POPR	TRDA3/DISP/PAVI2/SCPU10
	CARE/ELEO/POLA4/ALGE	TYPHA
	CAREX	POPR/FEAR2
	CAREX/JUNCUS	FETH/DAIN/FEAR2
	CAVE6/DECA18	

Associated / Similar Types

Because of its generic nature, map unit 190 is coincident with numerous existing vegetation associations previously described (e.g., Muldavin et al. 2000) and at least eight NVC Groups (Appendix C).

210

Little Walnut – Chinkapin Oak

Above Sitting Bull Falls, Guadalupe RD, Lincoln NF. Photo by Max Wahlberg.

General Description

Map unit 210 covers approximately 560 acres (230ha), and occurs on the only on the Guadalupe Ranger District of the Lincoln National Forest and surrounding areas. This unit was formerly known as 'Little Walnut – Lanceleaf Buckthorn' but was renamed given the diagnostic value of Chinkapin oak. Map unit 210 occurs within life zones 4 and 5 (and possibly 3) within mild gradients of the Guadalupe Mountains of southeastern New Mexico. It is typically found at elevations ranging from 4,600 to 5,500 feet (1,400-1,680m). Willow species are also commonly found in this map unit.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 210	JUMI/RHLA

Associated / Similar Types

Map unit 210 is similar to the *Juglans microcarpa* Community Type described by Szaro (1989). In terms of the NVC it is not currently represented, with associations of the Southern Plateau Dry-Mesic Hardwood Forest Group (G028) being the most similar forested units in terms of community dominants. The most similar non-forest Groups are listed in Appendix C.

230

Narrowleaf Cottonwood / Shrub

Unnamed Tributary of los Pinos River, Tres Piedras RD, Carson NF. Photo by Max Wahlberg.

General Description

Map unit 230 covers approximately 87,700 acres (35,000ha), and occurs on all National Forests of the region except the Kaibab and Prescott NFs. It is typically found at elevations ranging from 1,900 to 10,000 feet (580-3,050m). Map unit 230 includes all areas that were provisionally mapped as map unit 220, 'Narrowleaf Cottonwood'. While evidence exists for the ecological presence of these two separate map units on the contemporary landscape, the two units were combined to better reflect the potential riparian concept of the RMAP project. Other riparian species commonly found in map unit 230 include boxelder, willow species, Arizona alder, and Arizona walnut. Lanceleaf cottonwood, which is a hybrid between Fremont cottonwood and narrowleaf cottonwood may occur in place of narrowleaf cottonwood in some places as this map unit transitions with map unit 180 – Fremont Cottonwood / Shrub.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 230	POAN3	POAN3/ALOB2/SAGO/SALIX
	POPR/POAN3	POAN3/JUMA
	POAN3/ACNE2	POAN3/JUMA/PSME
	POAN3/ACNE2/SAIR	POAN3/JUMA/QUEM
	POAN3/ALOB2/ACNE2/JUMA	POAN3/SABE2
	POAN3/ALOB2/JUMA	

Associated / Similar Types

Map unit 230 is similar to the *Populas angustifolia* Community Type described by Szaro (1989), and the Narrowleaf-Cottonwood type described by Laurenzi et al. (1983) for the Tonto NF. In terms of existing vegetation it is related to associations previously described by Muldavin et al. (2000), and in the NVC by the Rocky Mountain & Great Basin Montane Riparian Forest Group (G506), and other non-forest and ruderal Groups (Appendix C).

240

Narrowleaf Cottonwood - Spruce

Photo ©Al Schneider, www.swcoloradowildflowers.com.

General Description

Map unit 240 covers approximately 4,500 acres (1,800ha) and occurs on the Carson and Coconino National Forests. It is typically found at elevations ranging from 6,300 to 10,800 feet (1,920-3,290m). Map unit 240 is distinguished from map unit 230 by the dominance of evergreen species, a plurality of which are spruce species.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 240	POAN3/ALINT/PIPU

Associated / Similar Types

In term of existing vegetation, map unit 240 is related to associations previously described by Muldavin et al. (2000), and in the NVC by the Rocky Mountain & Great Basin Montane Riparian Forest Group (G506) and other non-forest and ruderal Groups (Appendix C).

250

Oak / Desert Willow

Photo by T. Beth Kinsey @ www.fireflyforest.com.

General Description

Map unit 250 covers approximately 750 acres (300ha), and occurs on the Coconino National Forest. It is typically found at elevations ranging from 4,600 to 5,400 feet (1,400-1,650m), often along ephemeral and drier reaches of interrupted alluvial channels. Oak species found in this map unit include Emory oak and Arizona white oak.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 250	QUEM/CHLI2

Associated / Similar Types

In expressions of existing vegetation and the NVC, map unit 250 is represented by the Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541) and other non-forest and ruderal Groups (Appendix C), as are map units 130 and 360.

260

Rio Grande Cottonwood / Shrub

Rio Grande River. Photo by Max Wahlberg.

General Description

Map unit 260 covers approximately 64,700 acres (26,200ha), and occurs on the Carson, Cibola, Lincoln and Santa Fe National Forests. It is typically found at elevations ranging from 3,300 to 8,500 feet (1,010-2,590m). While multiple willow species occur in 260, narrowleaf willow is the most common.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 260	PODEW*
	PODEW*/ FAPA
	PODEW*/ PASM/ BOGR2
	PODEW*/ SAEX
	PODEW*/PASM/BOGR2/HECO26
	PODEW*/SAEX/ERNAN5
	PODEW*/SAEX/POPR

Associated / Similar Types

Map unit 260 is similar to map unit 320, Eastern Cottonwood / Shrub, in physiognomy. The main distinguishing factor between the two units is the occurrence of Rio Grande Cottonwood (*Populus deltoides* ssp. *Wislizeni*) in 260, versus the occurrence of Eastern Cottonwood (*Populus deltoides*) in 320. Map unit 260 is also similar to 180, Fremont Cottonwood / Shrub, where cottonwood species are again the key differentia. Rio Grande cottonwood is differentiated geographically from Fremont cottonwood, with the approximate distribution of Rio Grande cottonwood being in plant communities east of the divide on the Lincoln NF and in the upper Rio Grande River and immediate tributaries.

For expressions of existing vegetation map unit 260 is represented in the NVC by the Sonoran-Chihuahuan Warm Desert Riparian Woodland Group (G508) and other non-forest and ruderal Groups (Appendix C), made up of previously described associations (e.g., Muldavin et al. 2000). Map units 160, 170, 210, 270, 300 , and 180 (in part) are also related to G508.

270

Sycamore – Fremont Cottonwood

West Clear Creek, Red Rock RD, Coconino NF. Photo by Max Wahlberg.

General Description

Map unit 270 covers approximately 73,900 acres (29,900ha), and occurs on the Apache-Sitgreaves, Coconino, Coronado, Gila, Kaibab, Prescott, and Tonto National Forests. This map unit is typically found at elevations ranging from 1,400 to 7,700 feet (430-2,350m). The primary cottonwood species in map unit 270 is Fremont cottonwood, while narrowleaf cottonwood (*Populus angustifolia*) occurs occasionally, including along Mogollon Creek on the Gila National Forest. Other riparian species commonly found in the map unit include boxelder, velvet ash, Arizona walnut, and willow species.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 270	PLWR2
	PLWR2/FRVE2/QUEM/FAPA
	PLWR2/JUMA/ACGR3/PAQU2
	PLWR2/POFR2/FRVE2
	PLWR2/POFR2/SAGO/SAEX
	PLWR2/POFR2/SALA3/FRVE2
	POFR2/JUMA/PLWR2
	POFR2/PLWR2/CUAR
	POFR2/PLWR2/JUDE2/QUGR3
	POFR2/PLWR2/SAEX
	POFR2/PLWR2/SALIX
	PRFR2/PLWR2/SAEX/barren

Associated / Similar Types

Map unit 270 is similar to the following community types described by Szaro (1989): *Juglans major-Platanus wrightii* Community Type; *Platanus wrightii* Community Type; and the *Platanus wrightii-Fraxinus pennsylvanica* Community Type. This unit has some overlap with the Sycamore type described for the Tonto NF by Laurenzi et al. (1983), but is lower in elevation with greater abundance of Fremont cottonwood. Other expressions of existing vegetation include the NVC Group 508 (Sonoran-Chihuahuan Warm Desert Riparian Woodland Group) and other non-forest and ruderal Groups (Appendix C), made up of similar associations described by Muldavin et al. (2000). Map units 160, 170, 210, 260, 300 , and 180 (in part) are also related to G508.

280

Upper Montane Conifer / Willow

Photo by Mike Bradley, from Muldavin et al. (2000).

General Description

Map unit 280 covers approximately 4,200 acres (1,700ha), and occurs on the all National Forests of the region with the exception of the Prescott and Tonto NFs. It is typically found at elevations ranging from 6,100 to 11,400 feet (1,860-3,470m). Conifer species include spruce, subalpine fir, white fir, and Douglas-fir. Quaking aspen (*Populus tremuloides*) can be present to codominant. Other riparian species commonly found in map unit 280 include thinleaf alder and boxelder.

TEUI Potential Vegetation

GES Subseries Included in Map Unit 280*	ALINT/SABE2/PIEN
	PIEN/ABLA – SAPL2/CAAQ/CALE4
	SAMO2/PIEN

* - No TEUI Subclasses support this unit. Reference classes from the General Ecosystem Survey (USDA Forest Service 1989) have been listed, here.

Associated / Similar Types

Map unit 280 is similar to the *Alnus tenuifolia*-Mixed Deciduous Community Type described by Szaro (1989). In terms of existing vegetation and the NVC, it is represented by the Rocky Mountain & Great Basin Montane Riparian Forest Group (G506) and other non-forest and ruderal Groups (Appendix C), comprised of associations previously described by Muldavin et al. (2000) and others. Map units 110, 230, and 240 are also related to G506.

290

Willow – Thinleaf Alder

Canada de Chacon Creek, El Rito RD, Carson NF. Photo by Max Wahlberg.

General Description

Map unit 290 covers approximately 32,300 acres (13,100ha), and occurs on the Apache-Sitgreaves, Carson, Cibola, Coconino, Gila, Lincoln, and Santa Fe National Forests. It is typically found at elevations ranging from 5,400 to 11,900 feet (1,650-3,630m). While both thinleaf alder and willow species are indicative of this unit, some locations may contain only one species or the other. This map unit frequently occurs in wet drainages associated with ponderosa pine and mixed conifer forests. Common willow species include dewystem willow (*Salix irrorata*), Drummond's willow (*S. drummondiana*), park willow (*S. monticola*), and grayleaf willow (*S. glauca*).

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 290	ACNE2/SAIR
	ALINT/SADR
	ALINT/SAMO2
	SADR
	SAGL/CALE4/CAAQ

Associated / Similar Types

Map unit 290 is similar to the following community types described by Szaro (1989): *Alnus tenuifolia* Community Type; *Salix bebbiana* Community Type; *Salix exigua* Community Type; and the *Salix irrorata* Community Type. In terms of existing vegetation units and the NVC, 290 is represented by the Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group (G527) and other non-forest and ruderal Groups (Appendix C), for associations previously described (e.g., Muldavin et al. 2000).

300

Arizona Walnut

Jacks Canyon, Coconino National Forest. Photo by Max Wahlberg.

General Description

Map unit 300 covers approximately 12,700 acres (5,200ha), and occurs on the all National Forests of the region except the Carson and Santa Fe NFs. It is typically found at elevations ranging from 4,000 to 8,300 feet (1,220-2,530m), within life zones 3-5, and typically within mild climate gradients of central Arizona, southeastern Arizona, and southwestern New Mexico. This highly diverse unit tends to occur in dryer drainages than other riparian types and often also includes species such as willows, boxelder (*Acer negundo*), ponderosa pine (*Pinus ponderosa var. scopulorum*), pinyon pines, juniper, and various species of oak.

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 300	JUMA

Associated / Similar Types

Map unit 300 is similar to both the *Juglans major* Community Type and the *Sapindus saponaria-Juglans major* Community Type described by Szaro (1989). Expressions of existing vegetation units in the NVC include it is represented by the Sonoran-Chihuahuan Warm Desert Riparian Woodland Group (G508) and other non-forest Groups (Appendix C).

310

Elm – Eastern Cottonwood

Washita River, Black Kettle National Grassland. Photo by Max Wahlberg.

General Description

Map unit 310 covers approximately 34,100 acres (13,800ha), and occurs on the Black Kettle National Grassland. It is typically found at elevations ranging from 1,800 to 2,500 feet (550-760m). This unit reflects a high degree of anthropogenic influence, as much of the natural hydrography of the Black Kettle has been altered. Flood control and water storage damming has occurred on many tributaries of the Washita River, which serves as the major drainage system in the area that this unit occurs. There is speculation that this modification of the natural hydrograph may have allowed for additional riparian development in some areas. Map unit 310 may be dominated by either trees or shrubs. Nearly all of the native American elm (*Ulmus americana L.)* has been replaced by the non-native Siberian elm (*Ulmus pumila L.*), and extensive black locust thickets are common. Other riparian species commonly found in map unit 310 include common hackberry (*Celtis occidentalis*), netleaf hackberry (*C. laevigata*), and little walnut (*Juglans microcarpa*).

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 310	PODE3/ULAM/CEOC
	PODE3/ULAM/DIVI5/SYOR
	PODE3/ULAM/JUNI
	ULAM/CELAR/JUMI
	ULAM/SANI/PAVI2/SPCL

Associated / Similar Types

In terms of the NVC and existing vegetation, map unit 310 is represented by the Great Plains Floodplain Forest Group (G147) and other non-forest Groups (Appendix C). Map unit 320 is also related to G147.

320

Eastern Cottonwood / Shrub

Rita Blanca National Grasslands. Photo by Max Wahlberg.

General Description

Map unit 320 covers approximately 7,800 acres (3,100ha), and occurs on the Kiowa and Rita Blanca National Grasslands. This map unit is restricted to the high plains (ecoregion 331B; Cleland et al. 2007). It is typically found at elevations ranging from 4,400 to 7,000 feet (1,340-2,130m). Other riparian species commonly found in map unit 320 include black willow (*Salix nigra*) and narrowleaf willow (*S. exigua*).

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 320	SANI/ SCPU10/ DISP
	PODE3/JUSC2/ARTR2
	PODE3/SAEX

Associated / Similar Types

In terms of physiognomy, map unit 320 is similar to map unit 260, Rio Grande Cottonwood / Shrub, with the main distinguishing feature being the occurrence of eastern cottonwood (*Populus deltoides*) in 320, versus the occurrence of Rio Grande cottonwood (*Populus deltoides* ssp. *Wislizeni*) in 260. This map unit is also similar to map unit 180, Fremont Cottonwood / Shrub. In terms of existing vegetation and the NVC, map unit 320 is related to the Great Plains Floodplain Forest Group (G147) and other non-forest Groups (Appendix C). Map unit 310 is also related to G147.

350

Ponderosa Pine / Willow

Photo by Debbie Cress.

General Description

Map unit 350 covers approximately 10,900 acres (4,400ha), and occurs on the all National Forests of the project area as well as the Kiowa National Grassland. It is typically found at elevations ranging from 4,500 to 9,700 feet (1,370-2,960m), and is typified by an overstory of ponderosa pine with an understory of shrub-form willow species. As a result of the pine overstory, this map unit is particularly hard to distinguish by remote sensing from pine-oak systems of similar physiognomy, and therefore is believed to be under-represented in the mapping. Other riparian species commonly found in map unit 350 include Arizona walnut (*Juglans major*), boxelder (*Acer negundo*), and velvet ash (*Fraxinus velutina*).

TEUI Potential Vegetation

TEUI Subseries Included in Map Unit 350	JUMA/PIPO/QUAR
	PIPO

Associated / Similar Types

Map unit 350 is somewhat similar to map unit 370, Little Walnut - Ponderosa Pine, which has only been mapped on the Guadalupe Ranger District of the Lincoln National Forest. Map unit 350 overlaps the Maple type described for the Tonto NF by Laurenzi et al. (1983), also characterized by the dominance of montane conifers and codominance of boxelder. In terms of existing vegetation units and the NVC, it is represented by the Rocky Mountain & Great Basin Montane Riparian Forest Group (G506) and other non-forest and ruderal Groups (Appendix C), as are map units 150 and 370.

360

Little Walnut / Desert Willow

Last Chance Canyon, Guadalupe RD, Lincoln NF. Photo by Max Wahlberg.

General Description

Map unit 360 covers approximately 510 acres (210ha), and occurs only on the Guadalupe Ranger District of the Lincoln National Forest and surrounding areas. It is typically found at elevations ranging from 4,500 to 5,600 feet (1,370-1,710m). Velvet mesquite is commonly found in this map unit.

TEUI Potential Vegetation

No subseries from TEUI or the General Ecosystem Survey (USDA Forest Service 1989) have been identified for this type.

Associated / Similar Types

Map unit 360 is similar to the "Chilopsis linearis" phase of the Julgans microcarpa/Bouteloua curtipendula association described in Muldavin et al. (2003). It is also similar to the *Juglans microcarpa* Community Type described by Szaro (1989). In terms of the NVC it does not appear to be represented, with the most similar expressions of existing vegetation being G531 (Arid West Interior Emergent Marsh Group), G541 (Warm Semi-Desert Shrub & Herb Wash-Arroyo Group), G533 (North American Warm Desert Riparian Low Bosque & Shrubland Group, and G510 (Southwest North American Ruderal Riparian Scrub Group).

370

Little Walnut – Ponderosa Pine

Turkey Canyon, Guadalupe RD, Lincoln NF. Photo by Max Wahlberg.

General Description

Map unit 370 covers approximately 890 acres (360ha), and is known only from the Guadalupe Ranger District of the Lincoln National Forest. It is typically found at elevations ranging from 5,000 to 6,800 feet (1,520-2,070m). Boxelder (*Acer negundo*) and bigtooth maple (*Acer grandidentatum* Nutt.) are also commonly found in this map unit.

TEUI Potential Vegetation

No subseries from TEUI or the General Ecosystem Survey (USDA Forest Service 1989) have been identified for this type.

Associated / Similar Types

Despite differences in geography, this unit may overlap the Maple type described for the Tonto NF by Laurenzi et al. (1983), also characterized by the dominance of montane conifers and by the codominance of bigtooth maple and boxelder. In terms of the NVC and existing vegetation, map unit 370 is represented by the Warm Southwest Riparian Forest & Woodland Group (G797) and other non-forest Groups (Appendix C), as are map units 150 and 350.

400

Historic Riparian - Agriculture

Near Taos, New Mexico. Photo by Max Wahlberg.

General Description

Map unit 400 covers approximately 57,700 acres (23,400ha), and occurs on the majority of National Forest and Grasslands of the project area (Table 3). This map unit is a land use theme (sensu Anderson et al. 1976) representing areas that likely supported riparian communities historically, but where contemporary anthropogenic disturbance has altered the site potential. Map unit 400 represents areas that historically supported riparian vegetation, but current land use is agricultural in nature; that is, this unit represents areas of farming and ranching agriculture in the historic riparian influence zone. An effort was made to determine the historic riparian type using ancillary data and historic site potential, where the putative type was attributed as a subclass (Table 1) according to the most likely RMAP unit expressed under natural/historic conditions.

TEUI Potential Vegetation

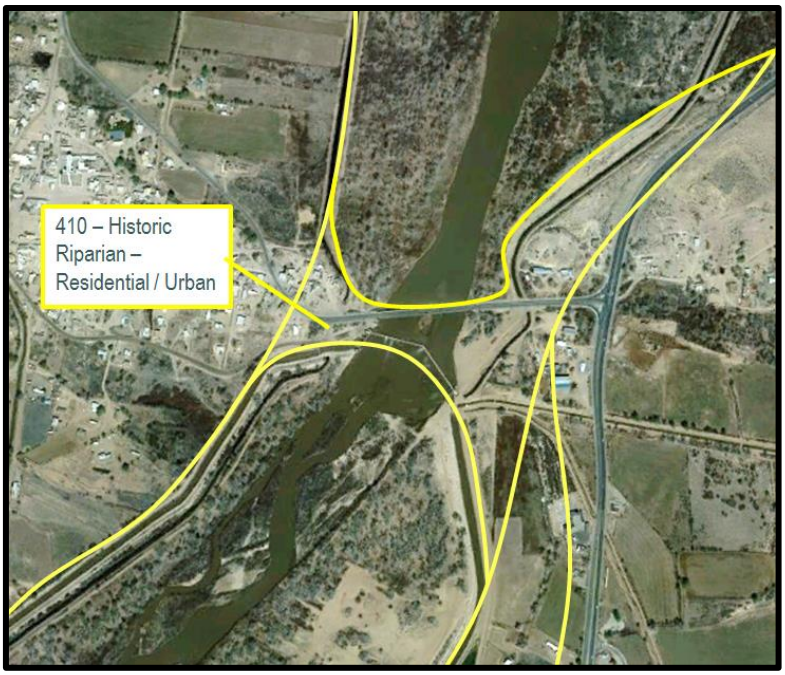
There are no TEUI subseries described for this unit, per se. These vegetation types are typically made up of anthropogenic or zootic disclimax communities, sometime represented in TEUI vegetation classification by seral vegetation (e.g., *Poa pratensis*).

Associated / Similar Types

Map unit 400 is consistent with the Anderson land use classification of 'agricultural land' (Anderson et al. 1976). In the NVC, this unit is sometimes represented by the Southwest North American Ruderal Riparian Scrub Group (G510).

410

Historic Riparian – Residential / Urban



Mapping of 410, historic riparian – residential/urban, middle Rio Grande River, NM.

General Description

Map unit 410 covers approximately 19,100 acres (7,700ha), and occurs on the majority of National Forests and Grasslands of the project area (Table 3). This map unit is essentially a land use theme (sensu Anderson et al. 1976) representing areas that likely supported riparian communities historically, but where contemporary anthropogenic disturbance has altered the site potential, and vegetation is urban or residential in nature. Most often this unit represents areas of housing and urban development in the historic riparian influence zone. An effort was made to determine the historic riparian type using ancillary data and historic site potential, where the putative type was attributed as a subclass (Table 1) according to the most likely RMAP unit expressed under natural/historic conditions.

TEUI Potential Vegetation

There are no TEUI subseries described for this unit, per se. These vegetation types are typically made up of anthropogenic or zootic disclimax communities, sometime represented in TEUI vegetation classification by seral or ruderal vegetation (e.g., *Poa pratensis*).

Associated / Similar Types

Map unit 410 is consistent with the Anderson land use classification of 'urban or built-up land' (Anderson et al. 1976). In the NVC, this unit is sometimes represented by the Southwest North American Ruderal Riparian Scrub Group (G510).

420

Historic Riparian – Natural / Semi-Natural Upland

Kiowa National Grassland. Photo by Max Wahlberg.

General Description

Map unit 420 covers approximately 1,900 acres (770ha), and occurs on the Kiowa and Rita Blanca National Grasslands. This rather unique map unit is a land use theme (sensu Anderson et al. 1976) representing areas which historically supported riparian vegetation, but currently support only upland vegetation. It is speculated that extensive ground water utilization for adjacent agricultural may be affecting the ability of these systems to support riparian species due to the lowering of the water table beyond the reach of riparian root structures. In the absence of contemporary anthropogenic influences, vegetation in these areas would be similar to that of map unit 320, Eastern Cottonwood / Shrub, and RMAP subclasses were assigned accordingly. In many places, old remnant cottonwood skeletons can still be found (see photo above), indicative of the past site potential.

TEUI Potential Vegetation

Where TEUI subseries have been described for these plant communities, the subseries was helpful in identifying the subclass, typically map unit 320. Without the historic soil moisture levels and associated hydrology, the plant composition of these sites has become similar to surrounding upland settings. It was for map unit 420 that two TEUI polygons were reinterpretated has historic (the only incidence during RMAP development where TEUI values were not taken at face value).

Associated / Similar Types

Map unit 410 is consistent with the Anderson land use classifications of ‘forestland’ or ‘rangeland’ (Anderson et al. 1976), and was used with RMAP to delimit areas recently modified by humans and resulting in a site potential transition from riparian to upland. In the NVC, this unit is sometimes represented by the Southwest North American Ruderal Riparian Scrub Group (G510).

Appendix B – Plant Community Key to RMAP Units

Lead	Argument	Result
1	Streamside environments, obligate or facultative-wetland vegetation common (≥1% canopy cover), go to…	2
1	Upland environments, obligate vegetation scarce (<1% canopy cover)	not riparian (i.e., upland, wetland, or historic riparian)
2	Tree life form ≥ 5% canopy cover, forested systems, go to…	30
2	Tree life form < 5% canopy cover, go to…	3
3	Shrub life form ≥ 5% canopy cover, shrub systems…	Shrub Wetland (140), go to 20
3	Shrub life form < 5% canopy cover, go to…	4
4	Herbaceous life form ≥ 5% canopy cover, wetland systems…	Herbaceous Wetland (190)
4	Herbaceous life form < 5% canopy cover, go to…	sparsely vegetated
Shrub-dominated systems (may be a tree-dominated system, begin key at 20)		
20	Exotic shrub and tree species ≥ 50% of the total woody species cover	exotics
20	Exotic shrub and tree species < 50% of the total woody species cover, go to…	21
21	Occurs on/near the Black Kettle NGs in western OK and northern TX (ecoregions 315F, 332F)	Elm - Eastern Cottonwood (310)
21	Occurs elsewhere in the Southwest (outside ecoregions 315F, 332F), go to…	22
22	Occurs in lower life zones (1, 2, 3, 4) within mild gradients, go to…	23
22	Occurs in upper life zones (5, 6, 7) within mild and cold gradients, go to…	24
23	Cottonwood trees present	Fremont Cottonwood / Shrub (180)
23	Cottonwood trees absent, go to…	25 (desert willow types)
24	Arizona alder nearly always common, thinleaf alder scarce or absent, occurring below the Mogollon Rim (approximately)	Arizona Alder - Willow (110)
24	Arizona alder absent or scarce, thinleaf alder often present to codominant, occurring above the Mogollon Rim (approximately)	Willow - Thinleaf Alder (290)
25	Desert willow co-occurring with little Walnut, south-central NM including Lincoln NF	Little Walnut / Desert Willow (360)
25	Desert willow co-occurring with evergreen oaks, southeastern AZ and southwestern NM, potentially elsewhere	Oak / Desert Willow (250)
25	Little walnut absent and evergreen oaks absent or sparse	Desert Willow (130)
Tree-dominated systems – evergreen and mixed evergreen-deciduous types		
30	Spruce, subalpine fir, white fir, and Douglas-fir trees collectively ≥ 75% of the total tree canopy cover. Willow common, life zones 6 and 7 (and possibly 5)…	Upper Montane Conifer / Willow (280)
30	Ponderosa pine (and sometimes Douglas-fir trees) collectively ≥ 75% of the total tree canopy cover. Willow or other riparian deciduous hardwoods common, life zones 4 and 5…	Ponderosa Pine / Willow (350)
30	Montane conifer trees collectively < 75% of the total tree canopy cover, go to…	31
31	Deciduous trees ≥ 75% of the total tree canopy cover, deciduous tree-dominated types, go to…	35
31	Deciduous trees < 75% of the total tree canopy cover, mixed evergreen-deciduous tree-dominated types, go to…	32
32	Plurality of evergreen trees are oak, only in mild gradients and lower life zones 1-4, go to…	34
32	Plurality of evergreen trees are ponderosa pine, in mild and cold gradients and life zones 4 and 5, go to…	33
32	Plurality of evergreen trees are spruce, life zones 6 and 7 (and possibly 5)	Narrowleaf Cottonwood - Spruce (240)
32	Plurality of evergreen trees not oak, spruce, or ponderosa pine, concentrated in lower life zones, 3, 4, and 5.	Fremont Cottonwood - Conifer (150)

Lead	Argument	Result
33	Little walnut co-occurring in the overstory, south-central NM including Lincoln NF	Little Walnut - Ponderosa Pine (370)
33	Little walnut sparse or absent, overstory shared by trees other than little walnut	Ponderosa Pine / Willow (350)
34	Cottonwood absent or sparse	Oak / Desert Willow (250)
34	Cottonwood present to abundant	Fremont Cottonwood - Oak (170)
Tree-dominated systems – various deciduous types		
35	Exotic tree and shrub species ≥ 95% of the total woody species cover	exotics
35	Exotic tree and shrub species < 95% of the total woody species cover, go to…	36
36	Occurs on/near the Black Kettle NGs and surrounding ecoregions (315F, 332F) in western OK and northern TX	Elm - Eastern Cottonwood (310)
36	Occurs in high plains (ecoregion 331B) including Kiowa-Rita Blanca NGs in northeastern NM, and panhandles of OK and northern TX, go to…	43
36	Occurs elsewhere in Southwest outside the Great Plains ecoregions, go to…	37
37	Cottonwood and sycamore each < 5% cover, go to…	38
37	Cottonwood or sycamore ≥ 5% cover, go to…	45
38	Occurs in lower life zones of mild gradients, approximately 1-3, go to…	39
38	Occurs in upper life zones of both mild and cold gradients, approximately 4-7, go to…	40
39	Desert willow co-occurring with little Walnut, south-central NM including Lincoln NF	Little Walnut / Desert Willow (360)
39	Desert willow co-occurring with evergreen oaks, southeastern AZ and southwestern NM, potentially elsewhere	Oak / Desert Willow (250)
39	Little walnut absent	Desert Willow (130)
40	Arizona walnut common	Arizona Walnut (300)
40	Arizona alder nearly always common, thinleaf alder scarce or absent, occurring below the Mogollon Rim (approximately)	Arizona Alder - Willow (110)
40	Arizona alder absent or scarce, thinleaf alder often present to codominant, occurring above the Mogollon Rim (approximately)	Willow - Thinleaf Alder (290)
40	Chinkapin oak ≥ 5% cover, eastern slope of Guadalupe Mtns, potentially elsewhere in south-central NM	Little Walnut - Chinkapin Oak (210)
40	Netleaf hackberry ≥ 5% cover	Cottonwood / Hackberry (160)
40	Arizona walnut, Arizona alder, thinleaf alder, chinkapin oak, and netleaf hackberry each absent or sparse, go to…	45
43	Overstory codominated by netleaf hackberry, Mills Canyon area of Kiowa-Rita Blanca NGs	Cottonwood / Hackberry (160)
43	Overstory codominanted by trees other than netleaf hackberry, Mills Canyon and elsewhere on the Kiowa-Rita Blanca NGs	Eastern Cottonwood / Shrub (320)
Tree-dominated systems – cottonwood and sycamore types		
45	Shrubs ≥ 5% cover, shrub layer well-developed in tree canopy gaps, go to…	46
45	Shrubs < 5% cover, shrub layer poorly developed, go to…	50
46	Sycamore ≥ 5% cover, occurs only in low to mid life zones (3-6) within mild gradients of central and southeastern AZ and southwestern NM	Sycamore - Fremont Cottonwood (270)
46	Sycamore < 5% cover, go to…	47
47	Plurality of cottonwood species comprised of narrowleaf cottonwood, occuring with life zones 5, 6, and 7 in NM and AZ	Narrowleaf Cottonwood / Shrub (230)
47	Plurality of cottonwood species made up of Fremont or Rio Grande cottonwood, occuring within life zones 2, 3, and 4 across much of the region, go to…	48
48	Plurality of cottonwood species made up of Rio Grande cottonwood, occurring along the Rio Grande River, San Juan River, and possibly the Canadian River (Kiowa NGs, Mills Canyon).	Rio Grande Cottonwood / Shrub (260)
48	Plurality of cottonwood species made up of Fremont cottonwood, occurring in AZ and southwestern NM	Fremont Cottonwood / Shrub (180)

Lead	Argument	Result
Tree-dominated systems – deciduous tree types with sparse shrub component		
50	Sycamore ≥ 5% cover, occurs only with low to mid life zones (3-6) within mild gradients of central and southeastern AZ and of southwestern NM	Sycamore - Fremont Cottonwood (270)
50	Sycamore < 5% cover, go to…	51
51	Plurality of cottonwood species comprised of narrowleaf cottonwood, and occuring with life zones 5, 6, and 7 in AZ and NM	Narrowleaf Cottonwood / Shrub (230)
51	Plurality of cottonwood species made up of Fremont cottonwood and occuring with life zones 2, 3, and 4 across AZ and southern NM	Fremont Cottonwood / Shrub (180)

Appendix C – Relationships of RMAP Units and Groups of the National Vegetation Classification (NVC)

RMAP UNIT	ERU CODE	NVC HERB GROUP	NVC SHRUB GROUP	NVC TREE GROUP
Herbaceous Wetland	190	Great Plains Freshwater Marsh Group (G325) Rocky Mountain Acidic Fen Group (G515) Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow & Dwarf-Shrubland Group (G520) Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521) Western North American Ruderal Wet Meadow & Marsh Group (G524) Arid West Interior Emergent Marsh Group (G531) Intermountain Basins Alkaline-Saline Herbaceous Wetland & Playa Group (G538) Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	n/a	n/a
Desert Willow	130	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541) Arid West Interior Emergent Marsh Group (G531)	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541) North American Warm Desert Riparian Low Bosque & Shrubland Group (G533) Southwest North American Ruderal Riparian Scrub Group (G510)	Southwest North American Ruderal Riparian Scrub Group (G510)
Shrub Wetland (provisional)	140	Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521) Western North American Ruderal Wet Meadow & Marsh Group (G524) Arid West Interior Emergent Marsh Group (G531) Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541) North American Warm Desert Riparian Low Bosque & Shrubland Group (G533) Southwest North American Ruderal Riparian Scrub Group (G510) Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland Group (G526) Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group (G527)	Southwest North American Ruderal Riparian Scrub Group (G510)

RMAP UNIT	ERU CODE	NVC HERB GROUP	NVC SHRUB GROUP	NVC TREE GROUP
Oak / Desert Willow	250	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Southwest North American Ruderal Riparian Scrub Group (G510)
		Arid West Interior Emergent Marsh Group (G531)	North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)	
			Southwest North American Ruderal Riparian Scrub Group (G510)	
Little Walnut / Desert Willow	360	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Southwest North American Ruderal Riparian Scrub Group (G510)
		Arid West Interior Emergent Marsh Group (G531)	North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)	
			Southwest North American Ruderal Riparian Scrub Group (G510)	
		Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521)		
		Western North American Ruderal Wet Meadow & Marsh Group (G524)		
Fremont Cottonwood – Oak	170	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Sonoran-Chihuahuan Warm Desert Riparian Woodland Group (G508)
		Arid West Interior Emergent Marsh Group (G531)	North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)	Southwest North American Ruderal Riparian Scrub Group (G510)
			Southwest North American Ruderal Riparian Scrub Group (G510)	
Fremont Cottonwood / Shrub	180	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Sonoran-Chihuahuan Warm Desert Riparian Woodland Group (G508)
		Arid West Interior Emergent Marsh Group (G531)	North American Warm Desert Riparian Low Bosque & Shrubland Group (G533)	Southwest North American Ruderal Riparian Scrub Group (G510)
			Southwest North American Ruderal Riparian Scrub Group (G510)	
Fremont Cottonwood – Conifer	150	Arid West Interior Emergent Marsh Group (G531)	Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland Group (G526)	Warm Southwest Riparian Forest & Woodland Group (G797)
		Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Warm Semi-Desert Shrub & Herb Wash-Arroyo Group (G541)	Southwest North American Ruderal Riparian Scrub Group (G510)
			Southwest North American Ruderal Riparian Scrub Group (G510)	
Little Walnut - Chinkapin Oak	210	Arid West Interior Emergent Marsh Group (G531)	Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland Group (G526)	Southern Plateau Dry-Mesic Hardwood Forest Group (G028)

RMAP UNIT	ERU CODE	NVC HERB GROUP	NVC SHRUB GROUP	NVC TREE GROUP
Arizona Walnut	300	Arid West Interior Emergent Marsh Group (G531)	Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland Group (G526)	Sonoran-Chihuahuan Warm Desert Riparian Woodland Group (G508)
Cottonwood / Hackberry	160	Great Plains Freshwater Marsh Group (G325)	Great Plains Shrub & Herb Riparian Group (G337) Southwest North American Ruderal Riparian Scrub Group (G510)	Great Plains Floodplain Forest Group (G147) Southwest North American Ruderal Riparian Scrub Group (G510)
Sycamore - Fremont Cottonwood	270	Arid West Interior Emergent Marsh Group (G531)	Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland Group (G526)	Sonoran-Chihuahuan Warm Desert Riparian Woodland Group (G508)
Rio Grande Cottonwood / Shrub	260	Arid West Interior Emergent Marsh Group (G531)	Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland Group (G526) Southwest North American Ruderal Riparian Scrub Group (G510)	Sonoran-Chihuahuan Warm Desert Riparian Woodland Group (G508) Southwest North American Ruderal Riparian Scrub Group (G510)
Little Walnut - Ponderosa Pine	370	Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521) Western North American Ruderal Wet Meadow & Marsh Group (G524)	Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group (G527)	Warm Southwest Riparian Forest & Woodland Group (G797)
Ponderosa Pine / Willow	350	Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521) Western North American Ruderal Wet Meadow & Marsh Group (G524)	Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group (G527)	Rocky Mountain & Great Basin Montane Riparian Forest Group (G506)
Narrowleaf Cottonwood / Shrub	230	Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521) Western North American Ruderal Wet Meadow & Marsh Group (G524)	Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group (G527)	Rocky Mountain & Great Basin Montane Riparian Forest Group (G506)
Narrowleaf Cottonwood – Spruce	240	Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521) Western North American Ruderal Wet Meadow & Marsh Group (G524)	Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group (G527)	Rocky Mountain & Great Basin Montane Riparian Forest Group (G506)
Willow - Thinleaf Alder	290	Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521) Western North American Ruderal Wet Meadow & Marsh Group (G524)	Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group (G527)	Rocky Mountain & Great Basin Montane Riparian Forest Group (G506)
Arizona Alder – Willow	110	Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521)	Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group (G527)	Rocky Mountain & Great Basin Montane Riparian Forest Group (G506)

RMAP UNIT	ERU CODE	NVC HERB GROUP	NVC SHRUB GROUP	NVC TREE GROUP
		Western North American Ruderal Wet Meadow & Marsh Group (G524)		
Upper Montane Conifer / Willow	280	Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow & Dwarf-Shrubland Group (G520) Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521) Western North American Ruderal Wet Meadow & Marsh Group (G524)	Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group (G527)	Rocky Mountain & Great Basin Montane Riparian Forest Group (G506)
Eastern Cottonwood / Shrub	320	Great Plains Freshwater Marsh Group (G325)	Great Plains Shrub & Herb Riparian Group (G337)	Great Plains Floodplain Forest Group (G147)
Elm - Eastern Cottonwood	310	Great Plains Freshwater Marsh Group (G325)	Great Plains Shrub & Herb Riparian Group (G337)	Great Plains Floodplain Forest Group (G147)

Appendix D – National USFWS Wetland Species (Lichvar 2013)

Wetland Type	Description
Obligate Wetland	Occurs almost always (estimated probability 99%) under natural conditions in wetlands.
Facultative Wetland	Usually occurs in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
Facultative	Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
Facultative Upland	Usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found on wetlands (estimated probability 1%-33%).
Obligate Upland	Occurs in wetlands in another region, but occurs almost always (estimated probability 99%) under natural conditions in non-wetlands in the regions specified. If a species does not occur in wetlands in any region, it is not on the National List.