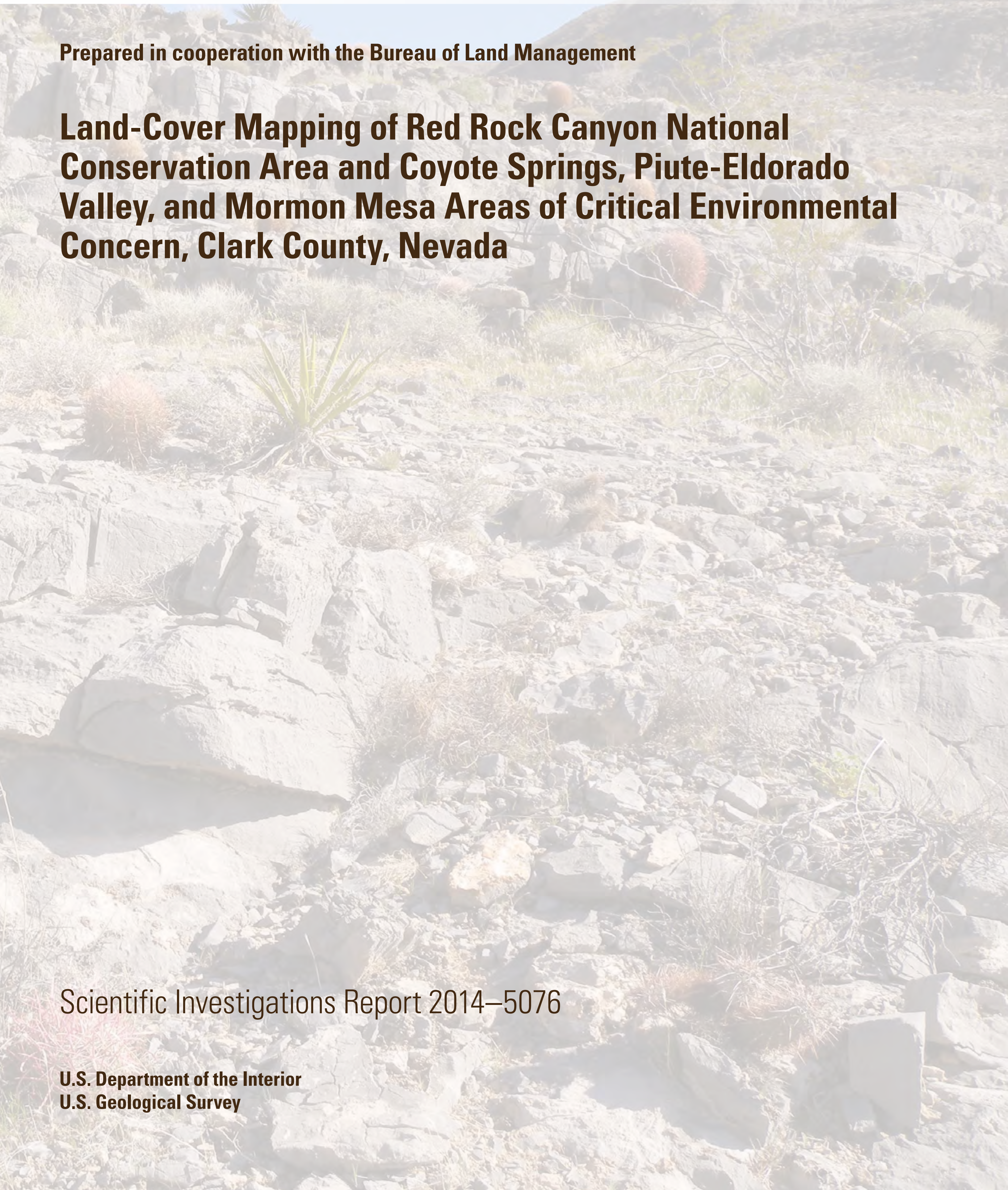
Prepared in cooperation with the Bureau of Land Management

Land-Cover Mapping of Red Rock Canyon National Conservation Area and Coyote Springs, Piute-Eldorado Valley, and Mormon Mesa Areas of Critical Environmental Concern, Clark County, Nevada



Scientific Investigations Report 2014–5076

U.S. Department of the Interior
U.S. Geological Survey

Cover. *Ferocactus cylindraceous* Limestone Bedrock Shrubland Alliance at sample 2004 in Coyote Springs Area of Critical Environmental Concern. Photo by David A. Charlet.

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By J. LaRue Smith, Nancy A. Damar, David A. Charlet, and Craig L. Westenburg

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SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
	Area	
square meter (m^2)	0.0002471	acre
hectare (ha)	2.471	acre
square hectometer (hm^2)	2.471	acre
square kilometer (km^2)	247.1	acre
square centimeter (cm^2)	0.001076	square foot (ft^2)
square meter (m^2)	10.76	square foot (ft^2)
square centimeter (cm^2)	0.1550	square inch (ft^2)
square hectometer (hm^2)	0.003861	section (640 acres or 1 square mile)
hectare (ha)	0.003861	square mile (mi^2)
square kilometer (km^2)	0.3861	square mile (mi^2)

Vertical coordinate information is referenced to North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate North American Datum of 1983 (NAD 83).

Elevation, as used in this report, refers to distance above the vertical datum.

Glossary

This report uses geographic information system (GIS) and remote sensing terminology, including some terms specific to ArcGIS software. These definitions were modified from ESRI (2013).

Term	Definition
Image/imagery	A representation or description of a scene, typically produced by an optical or electronic device. Common examples include remotely sensed data (for example, satellite data), scanned data, and photographs.
Raster	A GIS data set that defines space as an array of equally sized cells, called pixels, arranged in rows and columns. Each pixel contains an attribute value and location coordinates.
Pixel	The smallest unit of information in a raster, usually square. A pixel is represented in a remotely sensed image as a cell in an array of data values. Often used synonymously with cell.
Vector	A GIS data set that uses a coordinate-based data model to represent geographic features as points, lines, or polygons. Types of vector data sets include shapefiles and geodatabase feature classes.
Shapefile	One type of vector data set.
Attribute	Nonspatial information about a geographic feature in a GIS. In raster data sets, the information is associated with the pixel value. In vector data sets, the information is usually stored in a table and linked to the feature by a unique identifier.

ESRI, 2013, GIS dictionary, accessed September 29, 2013, *http://support.esri.com/en/knowledgebase/gisdictionary/browse*.

Acknowledgments

The authors express their appreciation to the Bureau of Land Management for assistance with property access for data collection. The authors acknowledge efforts of many professors and students of the College of Southern Nevada who helped David Charlet establish vegetation sample plots.

A special thanks to Angela Pitt who worked for the USGS after field mapping with David Charlet.

Land-Cover Mapping of Red Rock Canyon National Conservation Area and Coyote Springs, Piute-Eldorado Valley, and Mormon Mesa Areas of Critical Environmental Concern, Clark County, Nevada

By J. LaRue Smith, Nancy A. Damar, David A. Charlet, and Craig L. Westenburg

Abstract

DigitalGlobe's QuickBird satellite high-resolution multispectral imagery was classified by using Visual Learning Systems' Feature Analyst feature extraction software to produce land-cover data sets for the Red Rock Canyon National Conservation Area and the Coyote Springs, Piute-Eldorado Valley, and Mormon Mesa Areas of Critical Environmental Concern in Clark County, Nevada. Over 1,000 vegetation field samples were collected at the stand level. The field samples were classified to the National Vegetation Classification Standard, Version 2 hierarchy at the alliance level and above. Feature extraction models were developed for vegetation on the basis of the spectral and spatial characteristics of selected field samples by using the Feature Analyst hierarchical learning process. Individual model results were merged to create one data set for the Red Rock Canyon National Conservation Area and one for each of the Areas of Critical Environmental Concern. Field sample points and photographs were used to validate and update the data set after model results were merged. Non-vegetation data layers, such as roads and disturbed areas, were delineated from the imagery and added to the final data sets. The resulting land-cover data sets are significantly more detailed than previously were available, both in resolution and in vegetation classes.

Introduction

The Bureau of Land Management (BLM) administers more than half of the approximately 2 million hectares of land in Clark County, Nevada (fig. 1). Federal lands are often designated for specific uses or protection, requiring management plans tailored to those designations. In 1990, the Red Rock Canyon National Conservation Area (NCA; fig.2) was designated as Nevada's first National Conservation Area to protect and preserve geological, archaeological, ecological, cultural, scenic, scientific, wildlife, riparian, wilderness, endangered species, and recreation resources. The Coyote Springs (fig. 3), Piute-Eldorado Valley (fig. 4), and Mormon Mesa (fig. 5) Areas of Critical Environmental Concern (ACEC) were designated to protect critical habitat for the desert tortoise (*Gopherus agassizii*).

Regional and national land-cover and vegetation data sets are available that include these areas. These data sets are based on mid-resolution (30-meter) satellite imagery and delineate generalized vegetation communities. The available resolution and level of vegetation detail are not sufficient to support local resource management in these areas.

In 2006, the U.S. Geological Survey (USGS), in cooperation with the BLM, began a 4-year study of the Red Rock Canyon NCA to produce a land-cover data set from DigitalGlobe's QuickBird high-resolution (2.4-meter) satellite imagery and field vegetation data. In 2010, the study was extended to include the Clark County portion of Mormon Mesa, and Coyote Springs and Piute-Eldorado Valley ACECs. Visual Learning Systems' feature extraction software, Feature Analyst, was used to classify the imagery on the basis of detailed field data (Visual Learning Systems, Inc., 2008). A minimum mapping unit of 0.1 hectares was used, or about one-quarter the size of previously available data. Vegetation data collection included more than 1,000 field samples that were used as possible training sites in the feature extraction process. Sampling protocol and naming conventions for the field data collection followed the National Vegetation Classification Standard, Version 2 (NVC; Federal Geographic Data Committee, 2008). The imagery and field data were used to map vegetation communities at the stand level, in which the dominant species in each canopy layer are identified. Non-vegetated data layers were also derived from the imagery.

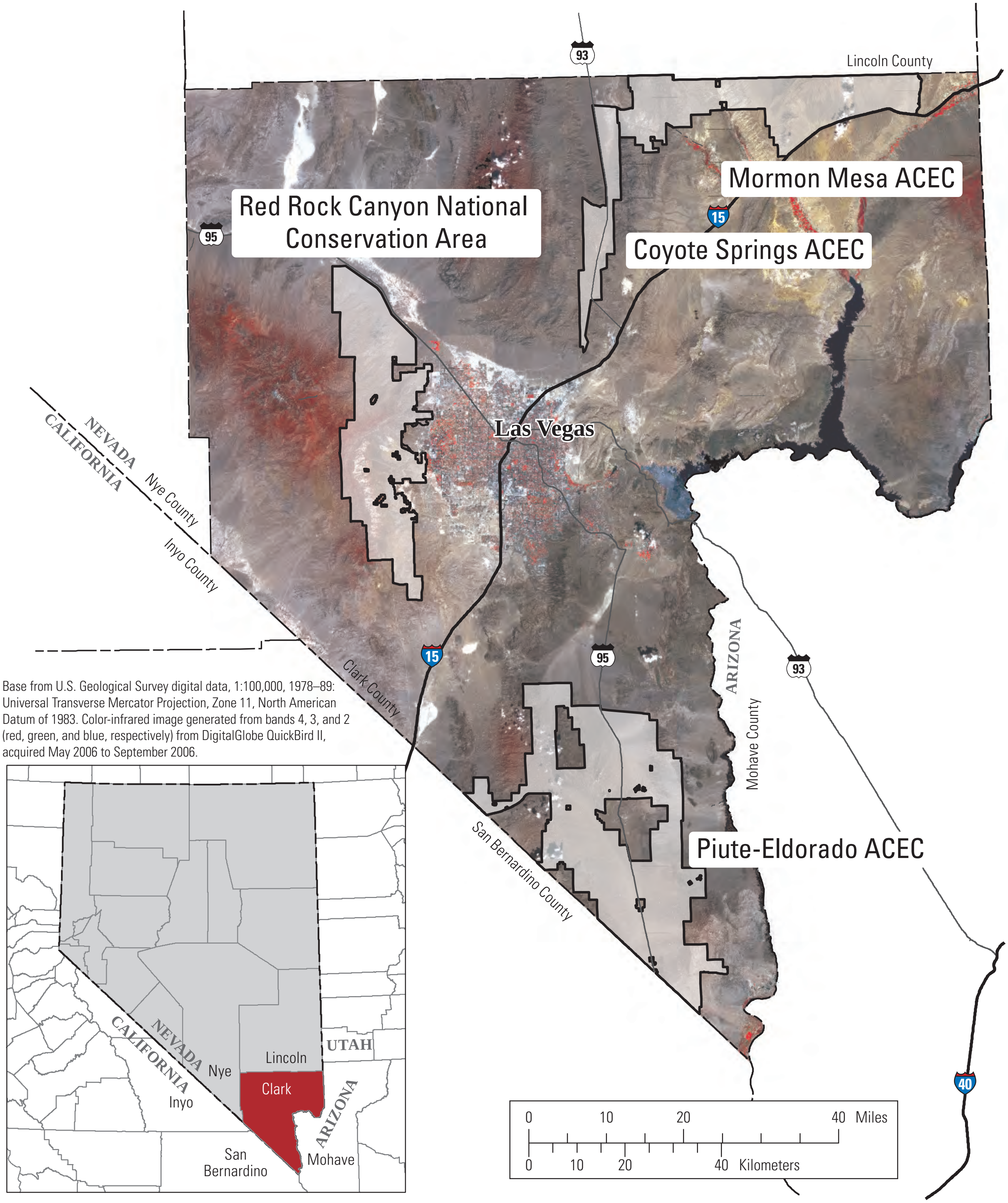

Figure 1. Clark County, Nevada, and the study areas. ACEC, Areas of Critical Concern.

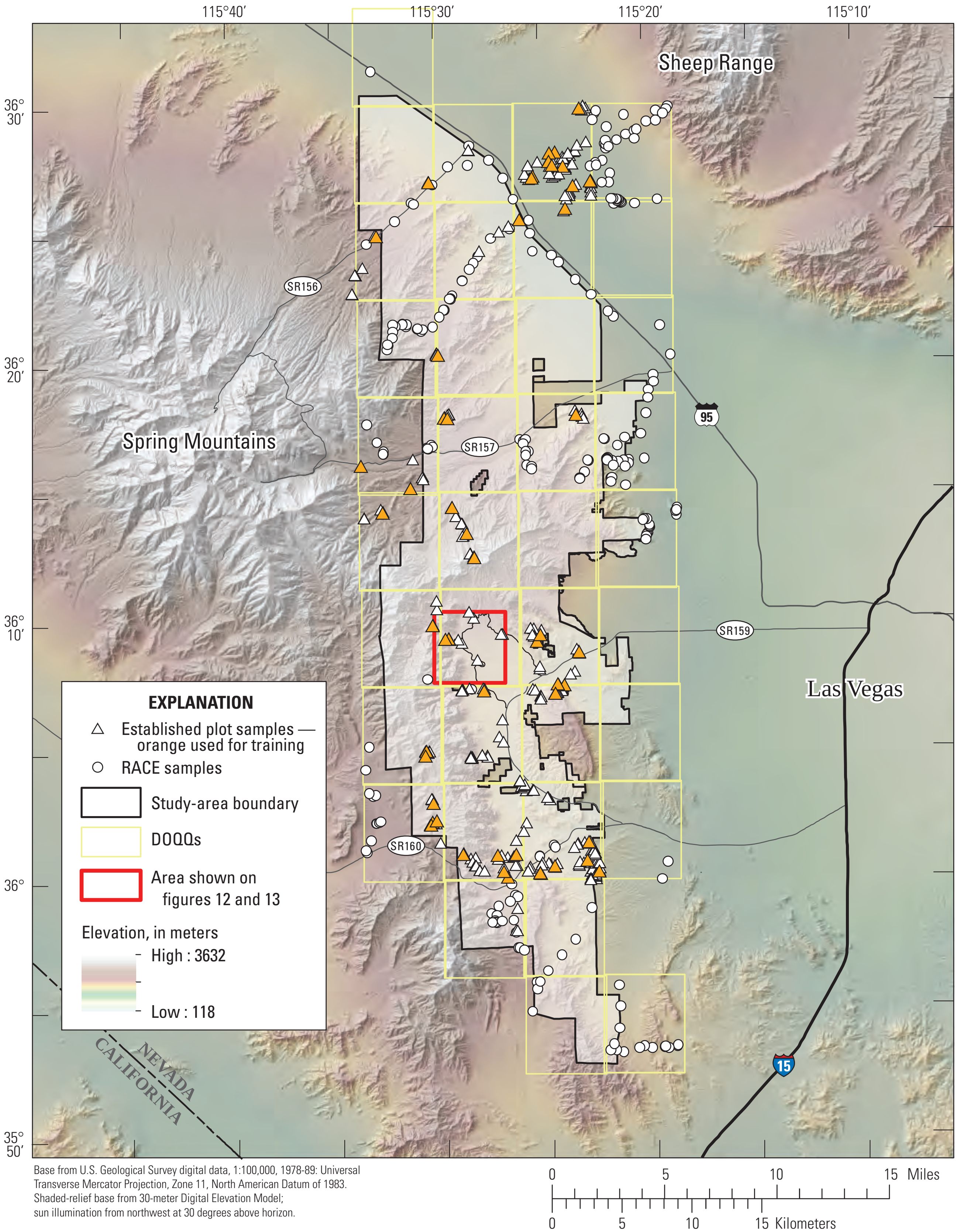

Figure 2. Red Rock Canyon National Conservation Area, and surrounding area. DOQQ, digital orthophoto quarter-quadrangle; RACE, rapid assessment community ecology.

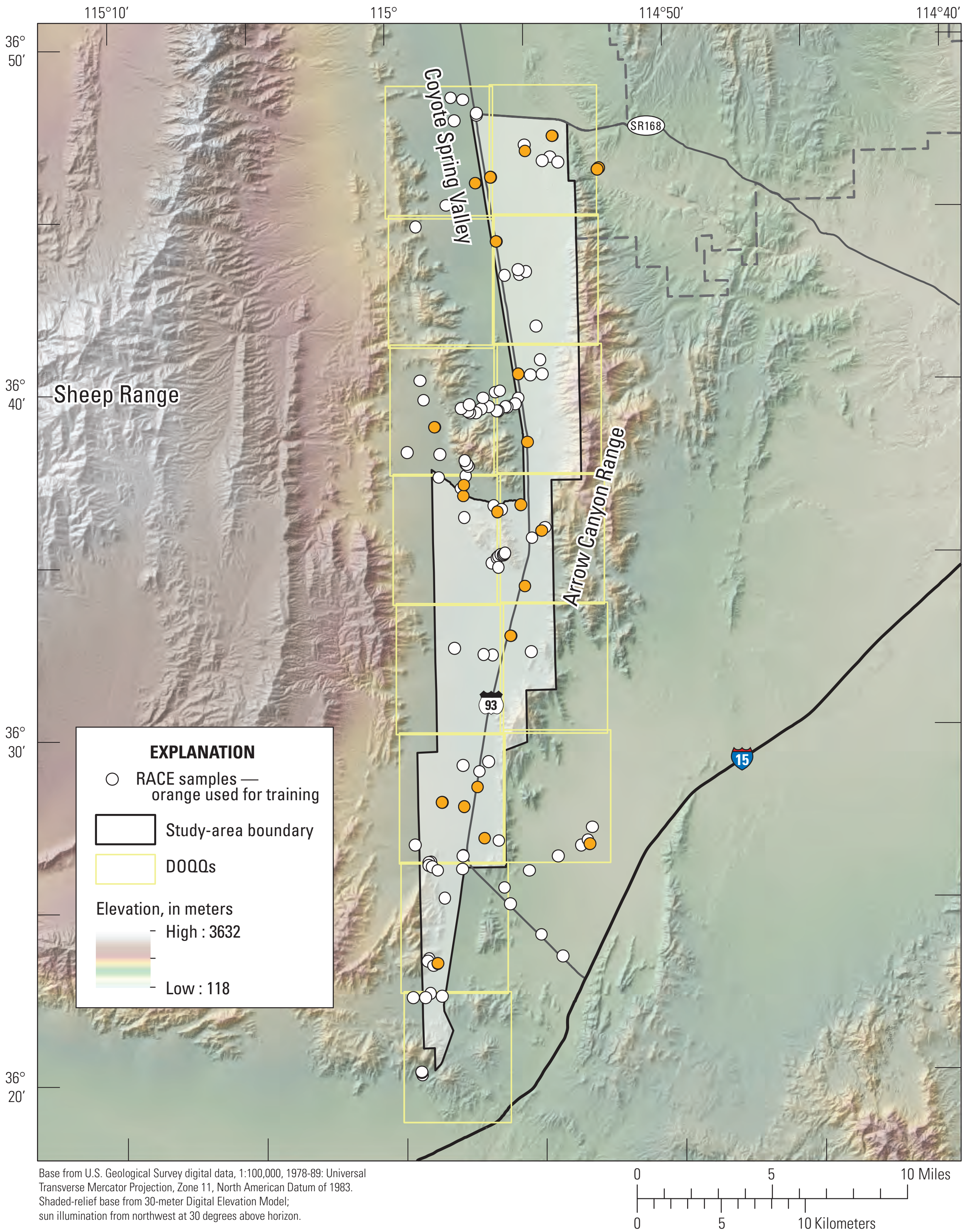

Figure 3. Coyote Springs Area of Critical Environmental Concern, and surrounding area. DOQQ, digital orthophoto quarter-quadrangle; RACE, rapid assessment community ecology.

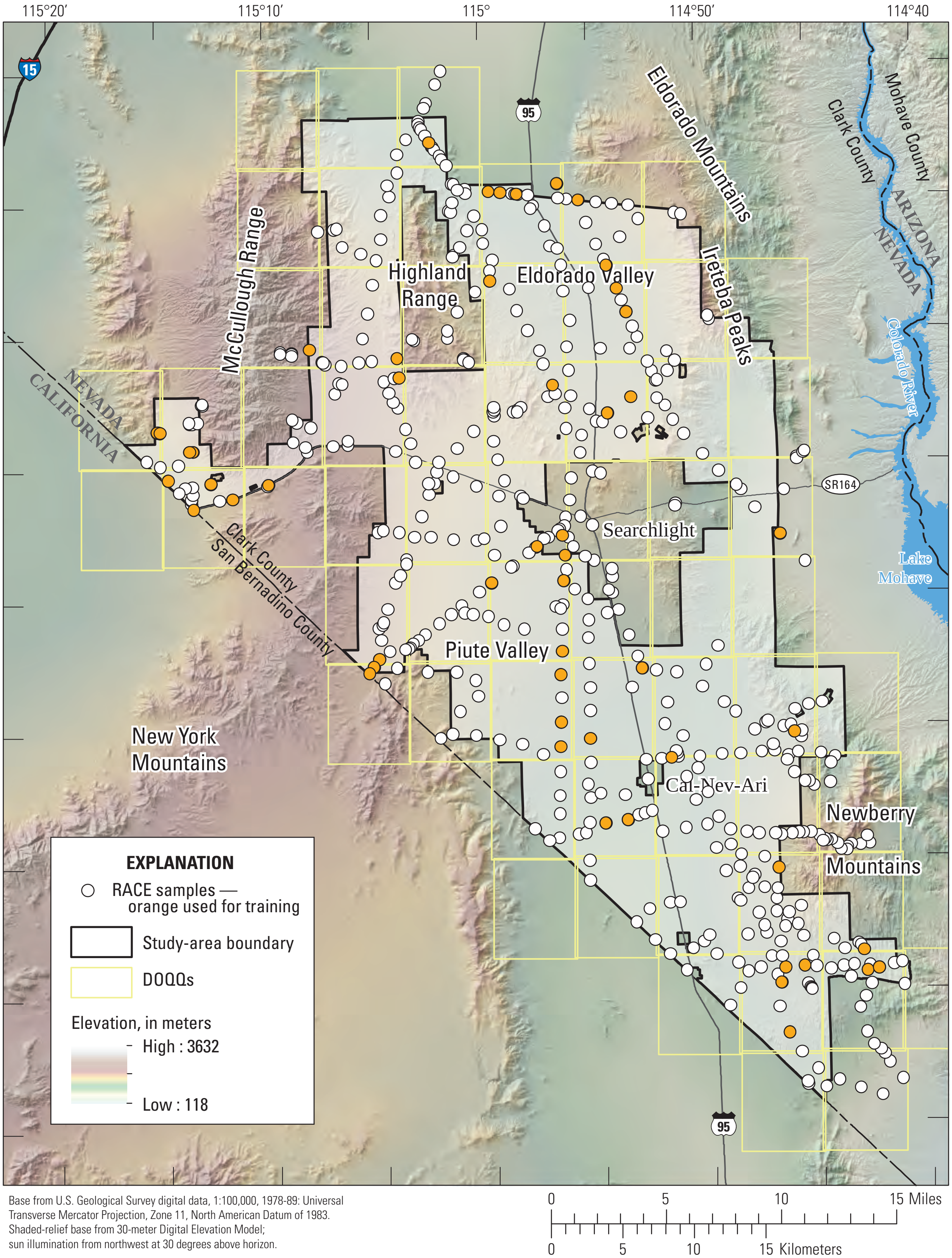

Figure 4. Piute-Eldorado Valley Area of Critical Environmental Concern, and surrounding area. DOQQ, digital orthophoto quarter-quadrangle; RACE, rapid assessment community ecology.

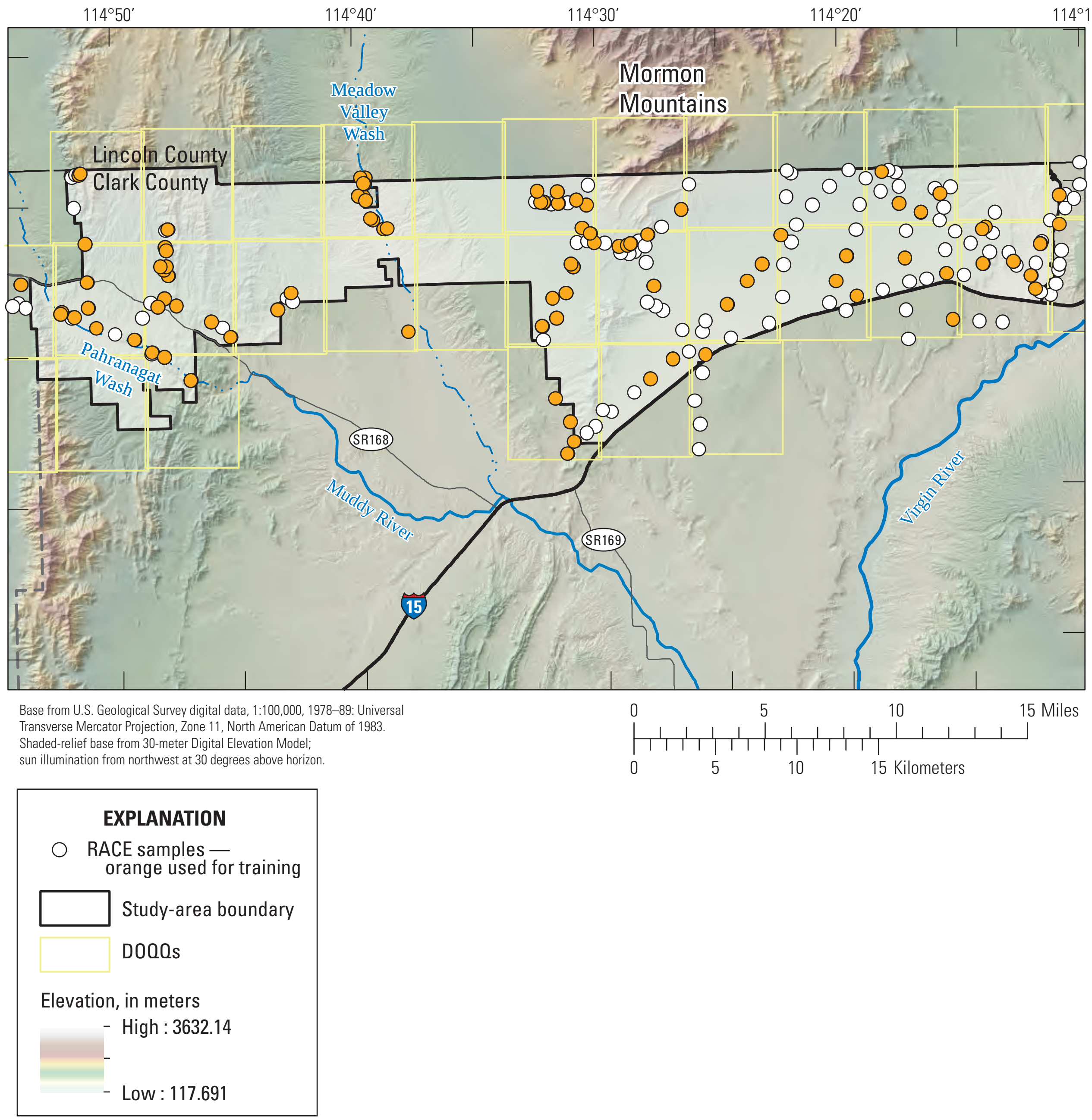

Figure 5. Mormon Mesa Area of Critical Environmental Concern, and surrounding area. DOQQ, digital orthophoto quarter-quadrangle; RACE, rapid assessment community ecology.

Purpose and Scope

The purpose of this study was to produce detailed, high-resolution land-cover data sets of the Red Rock Canyon NCA and the Coyote Springs, Piute-Eldorado Valley, and Mormon Mesa ACECs. This report documents the methods used in the land-cover mapping process. Field data collection techniques are briefly summarized. Full documentation of the data collection techniques and a database of the field samples are available in Charlet and others (2014). Land-cover data are presented as vector geographic information system (GIS) data sets with attributes for map class code attribute and a table of the associated NVC hierarchy from the alliance to the class level. Vegetation communities are summarized for each study area.

For the purpose of this report, the Red Rock Canyon NCA is referred to as the NCA and the Coyote Springs, Piute-Eldorado Valley, and Mormon Mesa ACECs jointly as the ACECs. All areas are referred to collectively as the study areas.

Study Area Description

Clark County is in the transition between the Mojave and Great Basin deserts, in the southern Great Basin region of the Basin and Range physiographic area (fig. 6; Shreve, 1942, and Fenneman and Johnson, 1946). The topographic relief of the region is responsible for strong elevation gradients evident in the vegetation communities present (Brussard and others, 1999). At the highest elevations, juniper, pinyon, and bristlecone pines are found. At mid-elevations, which characterize most of the study area, there are Joshua trees, Mojave yucca, creosote bush, often associated with white bursage, or black brush. Phreatophytes can be found at the lowest elevations, where depth to groundwater is shallow. In general, vegetation is typical of the semiarid desert southwest, sparse and shrubby (Longwell and others, 1965). Total annual precipitation ranges from 5 to 33 centimeters, with a mean of 12 centimeters per year (Daly and others, 2004). The majority of precipitation falls in the winter as rain; consequently, spring is the primary growing season. Most perennial species go at least partially dormant in the summer months, when temperatures can exceed 40° Celsius (Smith and Nowak, 1990).

Previous Land-Cover Mapping

Most previous mapping efforts that include the study areas are at a national or regional scale, such as the National Land-Cover Database (NLCD; Homer and others, 2012) and the National Gap Analysis Programs (GAP; Maxwell and others, 2010). Because they cover large areas, they use mid-resolution satellite data and broad land-cover classes.

The NLCD is a Landsat-derived, 30-meter (m) resolution, land-cover database for the United States. The minimum mapping unit is 0.4 hectares. There have been three major data releases: circa 1992, circa 2001, and circa 2006. The data releases are standardized so that changes in land cover over time can be assessed. The vegetation-related land-cover classes describe very general physiognomy, for example, Evergreen Forest or Shrub/Scrub. This level of detail can be equated to the upper levels of the NVC hierarchy (table 1).

The GAP National Land Cover Data is a national program with the mission of developing key datasets to assess biological diversity across the nation. Like NLCD, it is based on 30-meter resolution Landsat imagery and has a minimum mapping unit of 0.4 hectares. It combines land-cover data generated by many regional GAP programs, such as the Southwest ReGAP (SWReGAP) program that covers Arizona, Colorado, Nevada, New Mexico, and Utah (Prior-Magee and others, 2007). The SWReGAP data use NatureServe's Ecological Systems Classification (Comer and others, 2003). The BLM has correlated the Ecological Systems to the macrogroup level of the NVC hierarchy and uses these data as input for mid-scale management priorities (Bureau of Land Management, 2013).

Clark County, Nevada, further refined the SWReGAP data by using local data as part of its Multiple Species Habitat Conservation Plan (MSHCP). The purpose of MSHCP was to develop a county-wide, multiple species, ecosystem-based habitat conservation strategy and management plan for threatened, endangered, or locally sensitive species. The MSHCP Ecosystem Map for Clark County was produced in 2000 and was updated in 2011 (RECON Environmental, Inc., 2000; Heaton and others, 2011). Ecological zones and vegetation types are the primary bases of organization for habitat conservation planning. Field methods developed and data collected for the 2011 update of the MSHCP Ecosystem Map were also used in this study.

The BLM published an environmental assessment for the NCA in response to increased interest in oil and gas exploration in the late 1970s (Bureau of Land Management, 1980). This assessment includes maps and descriptions of geology, soil, hydrology, and other environmental features, including vegetation types. The vegetation map was compiled from an unpublished internal range inventory at a scale of 1 to 62,500. The map included land-cover units of pinyon-juniper, Joshua tree, rabbitbrush, oak brush, blackbrush, manzanita, desert shrub, unique vegetation, and barren rock. This study is the only known local effort to map vegetation in any of the study areas previous to this report.

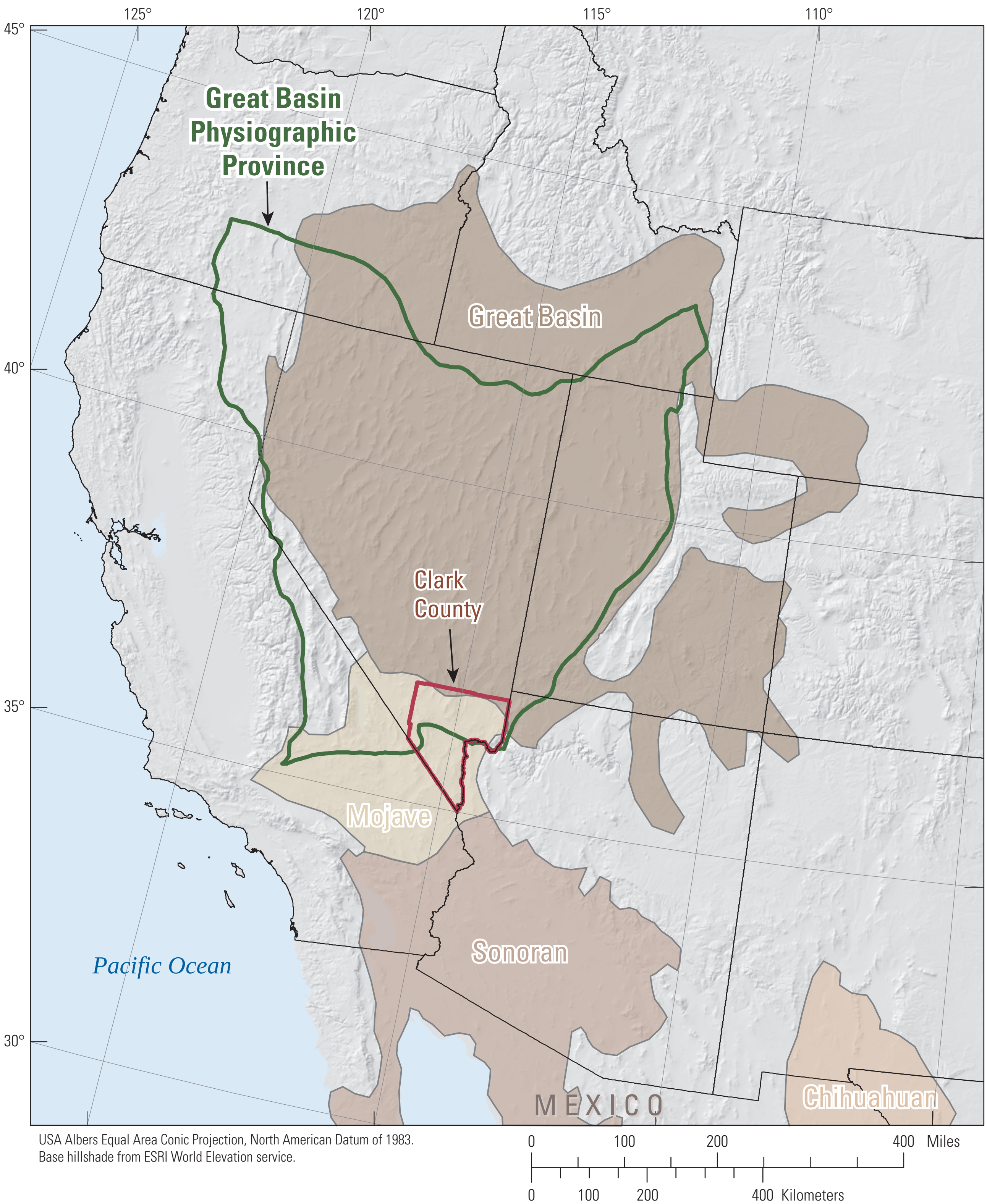

Figure 6. Western United States, including the Great Basin Physiographic Province (Fenneman and Johnson, 1946) and the major deserts of North America (Shreve, 1942).

Table 1. The National Vegetation Classification Standard (NVC) naming hierarchy and criteria.

[Source: Federal Geographic Data Committee, 2008, National vegetation classification standard, version 2, FGDC-STD-005-2008: accessed December 6, 2012, *http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/NVCS_V2_FINAL_2008-02.pdf*.]

NVC Hierarchy Level	Criteria
	Upper: Physiognomy plays a predominant role.
L1–Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and/or substrate or aquatic conditions.
L2–Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions.
L3–Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.
	Middle: Both floristics and physiognomy play a significant role.
L4–Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L5–Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and subcontinental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L6–Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
	Lower: Floristics plays a predominant role.
L7–Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate substrates, hydrology, moisture/nutrient factors, and disturbance regimes.
L8–Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

Methods

Imagery

DigitalGlobe's QuickBird satellite acquired high-resolution imagery covering all of Clark County between May and September of 2006. The imagery was acquired in strips oriented from north to south that correspond to the path flown over the Earth by the satellite (fig. 7). The QuickBird satellite is equipped with two sensors (multispectral and panchromatic) to measure reflected solar radiation, also called spectral reflectance. The multispectral sensor records the reflectance as four discreet bands in the blue (0.45–0.52 micrometers, or µm), green (0.52–0.60 µm), red (0.63–0.69 µm), and near infrared (0.76–0.89 µm) regions of the electromagnetic spectrum with a spatial resolution of 2.4 meters. The panchromatic sensor records a single band from the visible to near infrared (0.445–0.90 µm) region of the electromagnetic spectrum with a spatial resolution of 0.6 m. The imagery was delivered as two sets of orthorectified tiles organized by acquisition strip, one set each for the multispectral and panchromatic data. Tiles are referenced to USGS 1 to 24,000-scale map quadrangles. Each tile represents a quarter of a quadrangle and is referred to as a digital orthophoto quarter-quadrangle (DOQQ). A third, pan-sharpened, data set was created that combined the 0.6-meter panchromatic tiles with the 2.4-meter multispectral tiles by using a wavelet resolution merge (ERDAS, Inc., 2010). The pan-sharpened data set was used to delineate non-vegetation features and to aid in map validation.

The individual multispectral DOQQs that cover each study area were used as input for the feature extraction process (figs. 2–5). The feature extraction process relies on the assumption that a feature on the ground in one place will have the same spectral reflectance as that same feature on the ground in a different place. Many variables can interfere with this assumption, often relating to the temporal aspect of the imagery. For example, imagery collected on different days will be affected differently by varying atmospheric conditions on each day. The multispectral DOQQs covering the NCA were acquired on two dates: June 10 and 23, 2006. These DOQQs were atmospherically corrected using the ERDAS IMAGINE software plugin ATCOR (for ATmospheric CORrection; Geosystems, 2013). ATCOR uses information about the satellite sensors, atmospheric conditions at the time of acquisition, and the altitude of the land surface to correct for the effects of the atmosphere on the spectral reflectance values measured by the satellite sensor. Ground spectral reflectance from plants and soils in the NCA was measured with a field spectrometer from July 11 to 17, 2006, and was used to aid the atmospheric corrections.

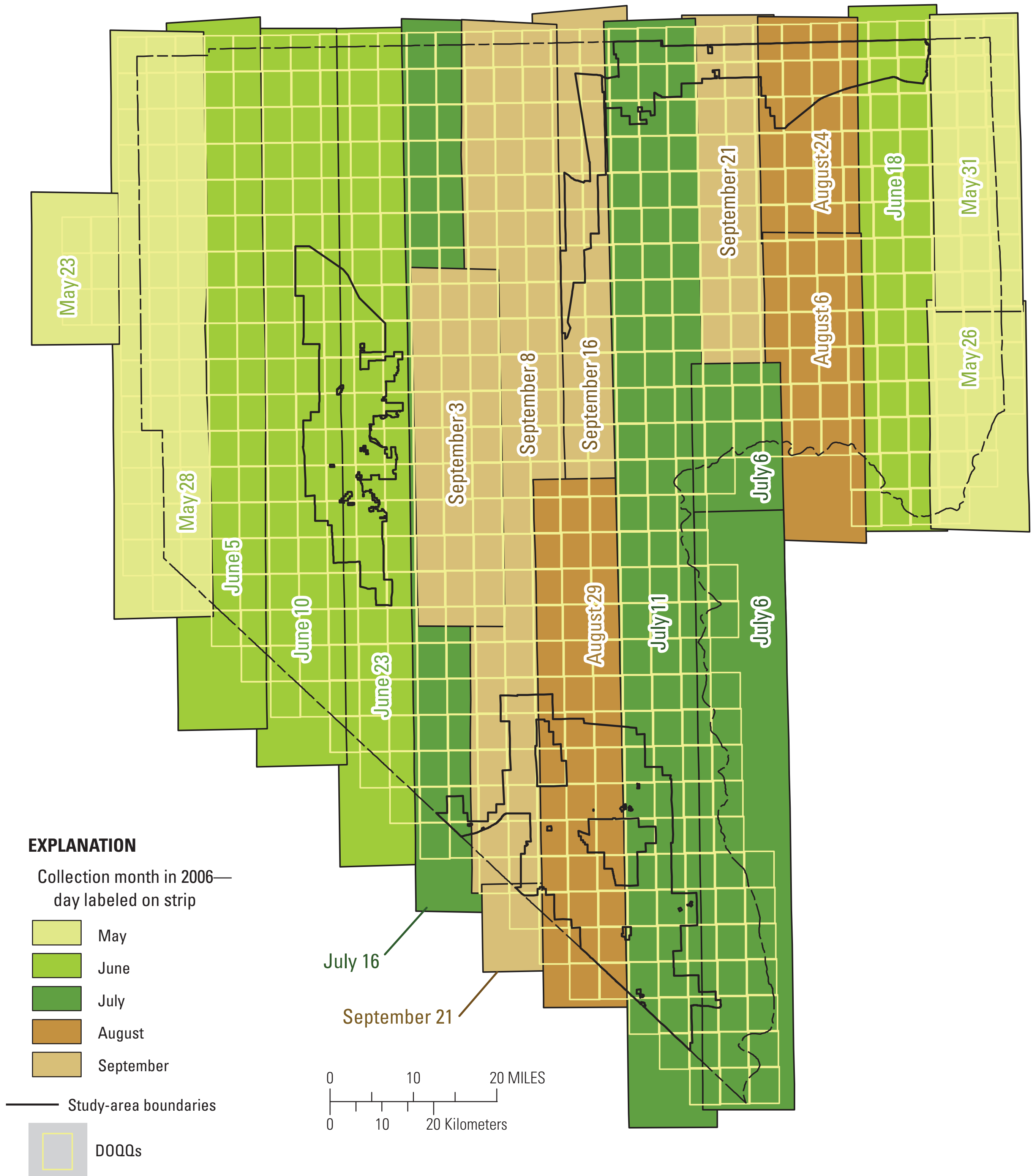

Figure 7. Locations and dates of QuickBird imagery acquisition strips and digital orthophoto quarter-quadrangle (DOQQ) tiles over Clark County, Nevada.

The DOQQs covering the ACECs were not atmospherically corrected. When the study was extended in 2010, it was too late to collect additional field spectrometer data in the ACECs to bolster corrections made there. More importantly, the broad range of acquisition dates of the strips covering the ACECs meant that ground conditions, and therefore spectral reflectance values, likely were not comparable across all strips as a result of variance in the growing season. To account for the variable ground conditions across the range of dates, DOQQs from some strips were modeled separately during the feature extraction process. Table 2 shows the dates of the strips for each study area and the modeling required.

Vegetation Data

National Vegetation Classification Standard

The National Vegetation Classification Standard, Version 2 (NVC), was developed by the U.S. Federal Geographic Data Committee (FGDC) to support a consistent naming hierarchy and sampling protocol for vegetation data collected at local, regional, and national levels. The naming hierarchy consists of eight levels. The upper levels are based on physiognomy and macroclimate. The levels become progressively more defined by floristics (table 1). Vegetation data were collected in the field at a level that allowed the samples to be worked through the NVC hierarchy at the alliance level and above (Charlet and others, 2014).

Field Data Collection

Vegetation data were collected in the field to identify training areas for the feature extraction process. Sample sites were selected to ensure that the extent of each site represented a homogenous stand and so that as many stands as possible could be sampled. Data were collected by a team of botanists in two formats: established plot samples and Rapid Assessment Community Ecology (RACE; Charlet and others, 2014) samples. Established plot samples generally followed the NVC protocol for identification plots; while RACE samples meet the NVC standards for occurrence plots. Identification plots have a more rigorous data collection protocol so that the data can be assessed with probability statistics and then used to confirm the existence of a community. Occurrence plots document one location of a previously confirmed community. Established plot samples were collected in the NCA; RACE samples were collected in the ACECs. The term “field sample” can refer to plot or RACE samples in this report.

The typical established plot sample was 20 m by 20 m square. In some cases, small or narrow vegetation stands did not conform to the square plot. In these cases, a rectilinear plot was designed so that the entire plot would represent the vegetation to be sampled, rather than crossing a boundary and including an adjacent, dissimilar vegetation stand that happened to be inside the square. In this way, linear vegetation features, such as along stream channels, could be sampled regardless of orientation or width. The southeast corner was the base of the plot, and its location was identified with a Global Positioning System (GPS) receiver and marked with rebar and tape. Points were established 20 m away in the true north and west directions.

The RACE sampling method was developed for the MSHCP to provide faster data collection and a greater redundancy of sampling (Charlet and others, 2014). This method was developed after sampling in the NCA, but before sampling began in the ACECs. Instead of marking a plot a few hundred square meters in size, the researcher used a GPS receiver to select a point and then traversed an area around the point within a 100 m radius. The point was the center of a circle with a set of observations that defined the stand present there. As with plots, some RACE sample sites were smaller than the default 100 m radius in order to sample stands that were not 100 m in all directions from the waypoint.

Three types of data were recorded for each field sample: (1) vegetation, (2) physical, and (3) photographic. Vegetation data for established plot samples include a visual estimate of percentage of cover for every species present. Vegetation data for RACE samples include a visual estimate of percentage of cover for any species that appears to have at least 5 percent cover and a list of all other species encountered. Physical data for all samples include coordinates taken with a GPS receiver and estimates of slope and aspect. Photographs capture multiple views of the stand, the ground cover present, and the surrounding landscape.

All samples were assigned a stand name based on the vegetation data collected at the site. The stand name defines the sample by the dominant species in each canopy layer in the sampled stand. A dominant species is any species with at least 5 percent cover in the canopy layer. The species names are placed in order from left to right, corresponding to top to bottom layers in the canopy structure of the stand, and are abbreviated with a four- or five-letter symbol consisting of the first two letters of the genus, followed by the first two letters of the species epithet. A fifth letter is sometimes placed at the end, when necessary, to indicate a specific taxon (subspecies or variety). This symbol naming convention is a simplified version of the taxonomy and nomenclature of the U.S. Department of Agriculture’s PLANTS database (U.S. Department of Agriculture, 2013). The USDA symbols are more complex to account for any repetition of four-letter codes in a nationwide database. See appendix 1 for a complete list of symbols used in the report and data sets.

More than 1,000 established plot and RACE samples were collected in or near (falling within the DOQQs used for analysis) the study areas (figs. 2–5). Complete details about data collection methods and a database of all samples are available in Charlet and others (2014).

Table 2. Number of strips and dates of imagery in each study area.

[**Abbreviations**: ACEC, Area of Critical Environmental Concern; DOQQ, digital orthophoto quarter-quadrangle; NCA, National Conservation Area]

Area	Number of DOQQs	Number of strips	Dates in 2006 (in order from west to east)	Modeling required
Red Rock Canyon NCA	37	2	June 10, June 23	Images atmospherically corrected; all DOQQS modeled together.
Mormon Mesa ACEC	29	5	September 16, July 11, September 21, August 24, June 18	All five strips modeled separately. (September 16 was modeled with Coyote Springs processing.)
Coyote Springs ACEC	14	1	September 16	None needed with single strip.
Piute-Eldorado Valley ACEC	63	5	July 16, September 21, August 29, July 11, July 6	Four July and August strips modeled together. September modeled separately.

Land-Cover Analysis

The first step in the land-cover analysis was feature extraction by using Feature Analyst (FA) software. Feature extraction is a type of image classification in which pixels in an image that represent a particular feature are identified (that is, extracted). In this case, the features extracted were stands of vegetation, as defined by exemplary vegetation field samples. The samples were input into FA independently of each other and resulted in dozens of outputs per study area. Because they were produced independently, the outputs had overlaps with each other and gaps where no pixels were extracted. The outputs were combined into one data set per study area with no overlaps or gaps by using raster processing tools in ArcGIS. The combination data sets were evaluated and improved, if possible, by using all available field samples and other ancillary data during the photo interpretation phase. Lastly, non-vegetation units, such as roads, disturbed areas, and clouds, were produced separately and added to the final data sets.

Vegetation Feature Extraction

FA uses a hierarchical learning process to analyze the spectral reflectance values of input pixels and the spatial distribution of those pixels in the context of an exemplar input, or training area. The result of the hierarchical learning process is an automated feature extraction (AFE) model, which can be used to extract the target feature from multiple images.

Individual field samples were used to create the input training areas for the AFE models. A training area was created on a single DOQQ by delineating a polygon around or very near a field sample. An effort was made to choose an area that appeared to be spectrally homogenous. Along with the input training area, the analyst specified the minimum mapping unit of 0.1 hectares. FA honors this setting throughout the feature extraction process. The pixels of the DOQQ that fall within the polygon are analyzed spectrally and spatially by FA to create an AFE model. In the first step of the hierarchical learning process, FA uses the AFE model to identify the features (that is, pixels) in the DOQQ that fit the model. From this initial set of returned features, the analyst can choose from two methods to provide feedback on the returned features. In the “remove clutter” process, the analyst marks correct and incorrect features. In the “add missing” process, the analyst delineates new polygons around additional features that were missed. With either method, FA uses the feedback to improve the AFE model and return a new set of features (fig. 8). This feedback loop is repeated until the returned set of features is determined to adequately represent the training area. This determination is made by the analyst upon visual evaluation of the results in the context of nearby field samples and knowledge of the area.

The developed AFE model is then run for all of the DOQQs that cover a study area (or part of a study area, depending on the dates of the strips that contain the DOQQs, as discussed in the “Imagery” section) as a batch process. The batch process returns one feature set for every DOQQ as a set of polygon shapefiles. The set of shapefiles for a single AFE model is merged into a single shapefile and edited to clean up edge effects or other artifacts from the merging process. The shapefile is assigned a unique number and labeled with the stand name of the field sample used to produce it. The shapefile is then converted to a raster with a unique number as the pixel value (fig. 9). The pixel size of the raster is 2.4 m (same as the original multispectral data set) with the pixel boundaries equal to the envelope of the input DOQQs. The feature extraction process was repeated for many field samples in each study area. Appendix 2 lists the field samples used for each study area.

The AFE models were also developed without a field sample as the basis for the training area. This method was most often used when it was prohibitive to collect data in the area, but there was strong knowledge of the area. For example, the sandstone cliffs in the NCA and the rugged limestone bedrock in Mormon Mesa ACEC were easily identified from the multispectral imagery and training areas could be directly digitized. This method was also used to “reverse engineer” feature extraction in unclassified portions of a study area. In this case, a training site would be digitized in an unclassified portion of the study area, and an AFE model developed from it. If the shapefiles returned from the batch process overlapped a field sample or previously classified area, the known stand name was assigned to the output.

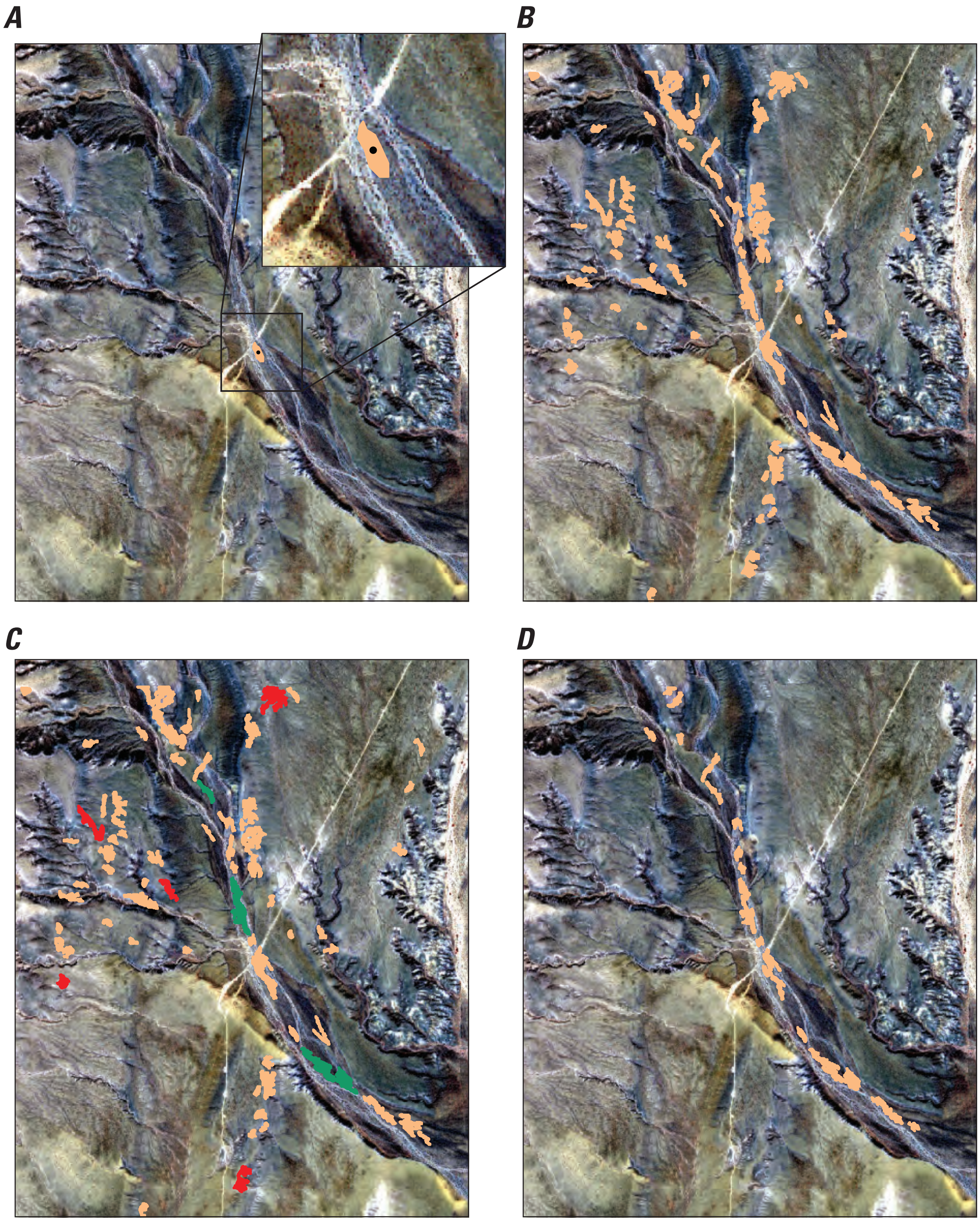

Figure 8. A QuickBird multispectral digital orthophoto quarter-quadrangle showing the hierarchical learning process: *A*, a training polygon around an exemplar field sample; *B*, the results of initial learning (beige); *C*, marking correct (green) and incorrect (red) areas in the "remove clutter" process; and *D*, results of hierarchical learning.

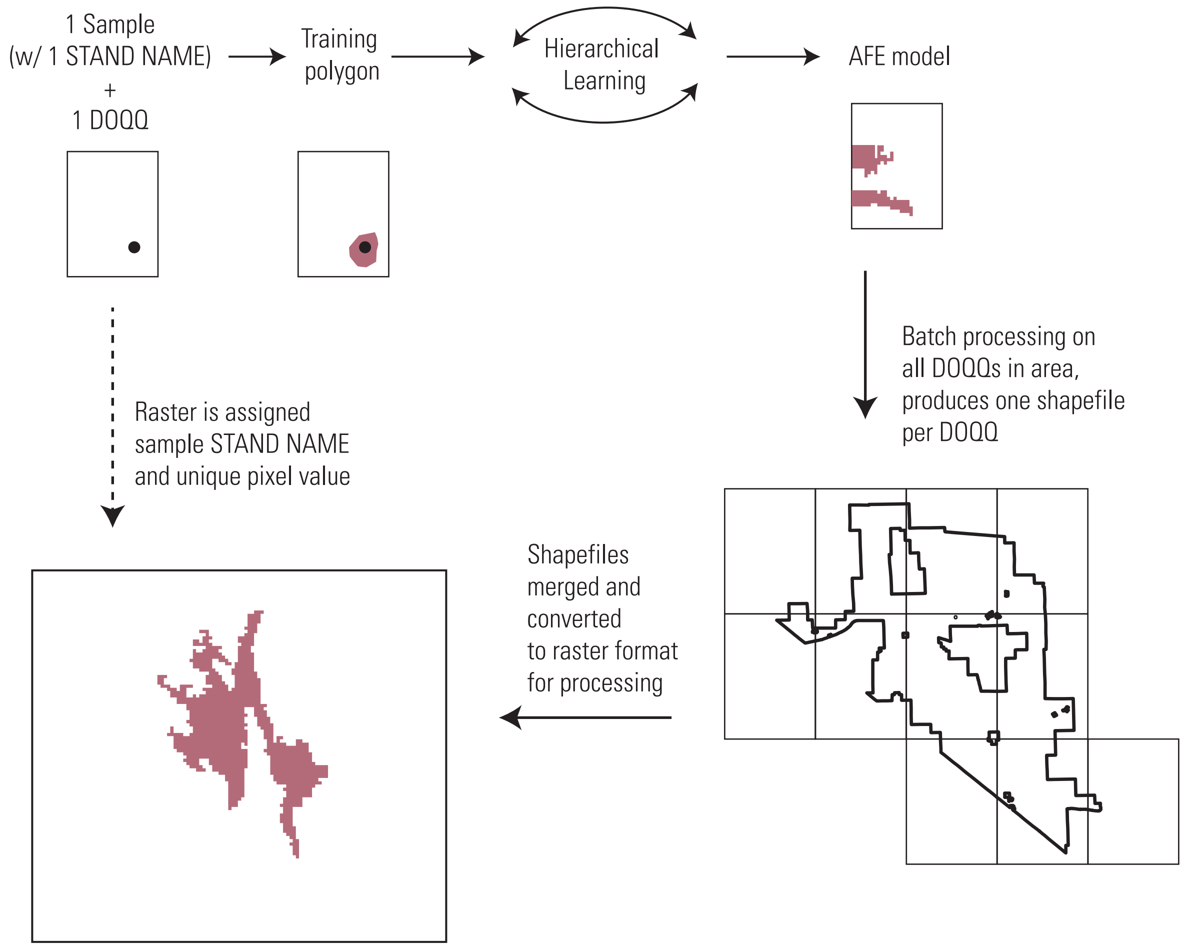

Figure 9. Overview of the feature extraction process. AFE, automated feature extraction; DOQQ, digital orthophoto quarter-quadrangle.

Raster Processing

Raster processing uses ArcGIS tools to combine the individual rasters from the AFE models into a single data set. Between 20 and 100 AFE models were developed for each study area. Because AFE models were developed independently of each other, there was overlap between some rasters. These overlaps, called areas of confusion, resulted when FA identified a pixel with more than one AFE model. Areas of confusion occurred most often with stand names that had the same dominant species in the top canopy layer, but varying understories or soil conditions.

Areas of confusion were addressed by incrementally combining groups of rasters and resolving the confusion among them. First, rasters with the same or similar stand names were combined using the ArcGIS Combine tool (ESRI, 2011). Areas of confusion that were small relative to the mapped area were filtered with the ArcGIS Euclidian distance filter, Nibble (ESRI, 2011). Nibble assigns the pixel value of a pixel's nearest neighbor as measured by Euclidean distance. Larger areas of confusion were evaluated with nearby field samples and assigned one of the pixel values from the confused area (fig. 10).

The resulting rasters, which now contain pixel values from multiple stand names, were then evaluated relative to each other and assigned a confidence level. The confidence order was determined by an examination of the field samples and the analyst's knowledge of the vegetation. In general, a higher confidence was placed on rasters representing unique, infrequently observed stands, such as meadows, marshland, or riparian areas. These stands tend to occupy small areas and have distinct boundaries. Lower confidence was assigned to more frequently observed communities that tend to have broad transitional boundaries, such as shrublands. The rasters were then merged by confidence order, such that pixel values from rasters with high confidence were retained, while pixel values from rasters with low confidence were only retained where

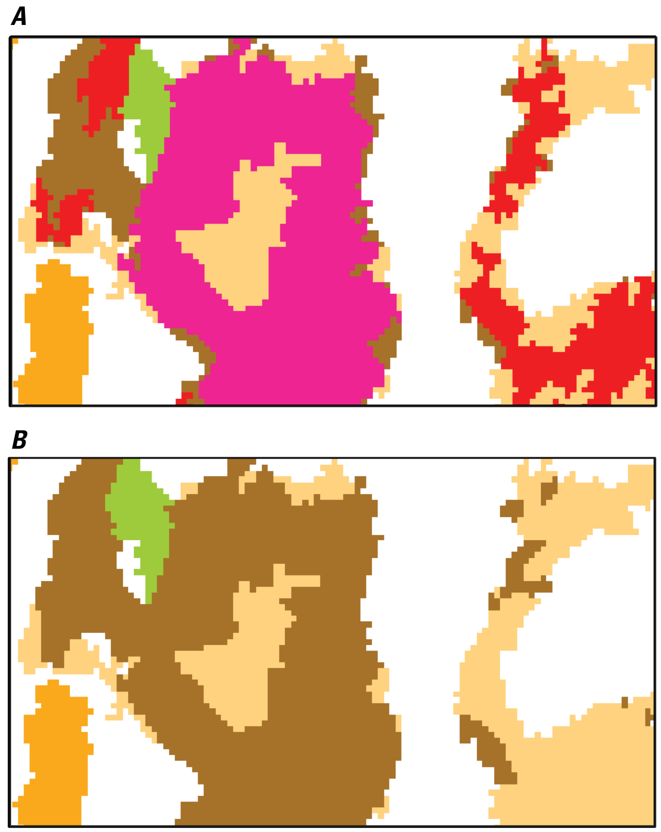

Figure 10. Detail example showing resolution of areas of confusion: *A*, Areas of confusion shown in red and magenta; *B*, Areas in red were resolved by filtering with Euclidian distance filter, Nibble, used to fill in surrounding pixel values. Larger area in magenta was assigned a single pixel value from the confused values.

there were no pixel values from higher confidence rasters (fig. 11). After this merge, one raster with many pixel values remained for each study area. It was examined for pixels with no assigned value, which were pixels that were not classified by any AFE model. Nibble was used to filter out areas smaller than the minimum mapping unit (0.1 hectare or 176 pixels), and the rest of the unclassified pixels were assigned a unique value and labeled as unclassified.

Photographic Interpretation

The final raster for each study area was evaluated through photographic interpretation. The pixels associated with each stand name were examined individually. The stand name was either confirmed as a final map class or changed as needed to better characterize what was known or believed to be correct on the ground.

The general procedure was to review on-screen the pixels associated with each stand name in the context of all field samples and photographs, as well as ancillary data such as topographic maps and digital elevation data. If needed to improve the map, pixels were reclassified to another existing or new stand name. For example, *Quercus gambelii* (QUGA) is unlikely to grow at low elevations. It was determined from field samples and pictures that *Salix lasiolepis* (SALA) was being misclassified as QUGA in the lower elevations of RRCNCA. The reclassification was made by outlining a general polygon to identify the area of incorrect classification. Any pixels within the polygon that had a stand name that contained QUGA were given a new stand name in which SALA replaced QUGA. The new stand names were then confirmed as a final map class. In this way, map classes were introduced that do not necessarily have corresponding field samples of the same name.

In some cases, all pixels of a stand name were assigned a different final map class. For example, some pixels had a stand name that includes *Juniperus osteosperma* (JUOS) and *Pinus monophylla* (PIMO) in the tree canopy layer, *Purshia stansburiana* (PUST) in the shrub canopy layer, and *Artemisia nova* (ARNO) in the grass canopy layer, abbreviated as JUOS-PIMO/PUST/ARNO. After reviewing the pixels, other JUOS-PIMO samples with understories other than PUST or ARNO plotted on the JUOS-PIMO/PUST/ARNO pixels. The stand name was generalized, and the pixels were assigned a final map class of JUOS-PIMO. See table 3 for a summary of changes made in each study area during photo interpretation.

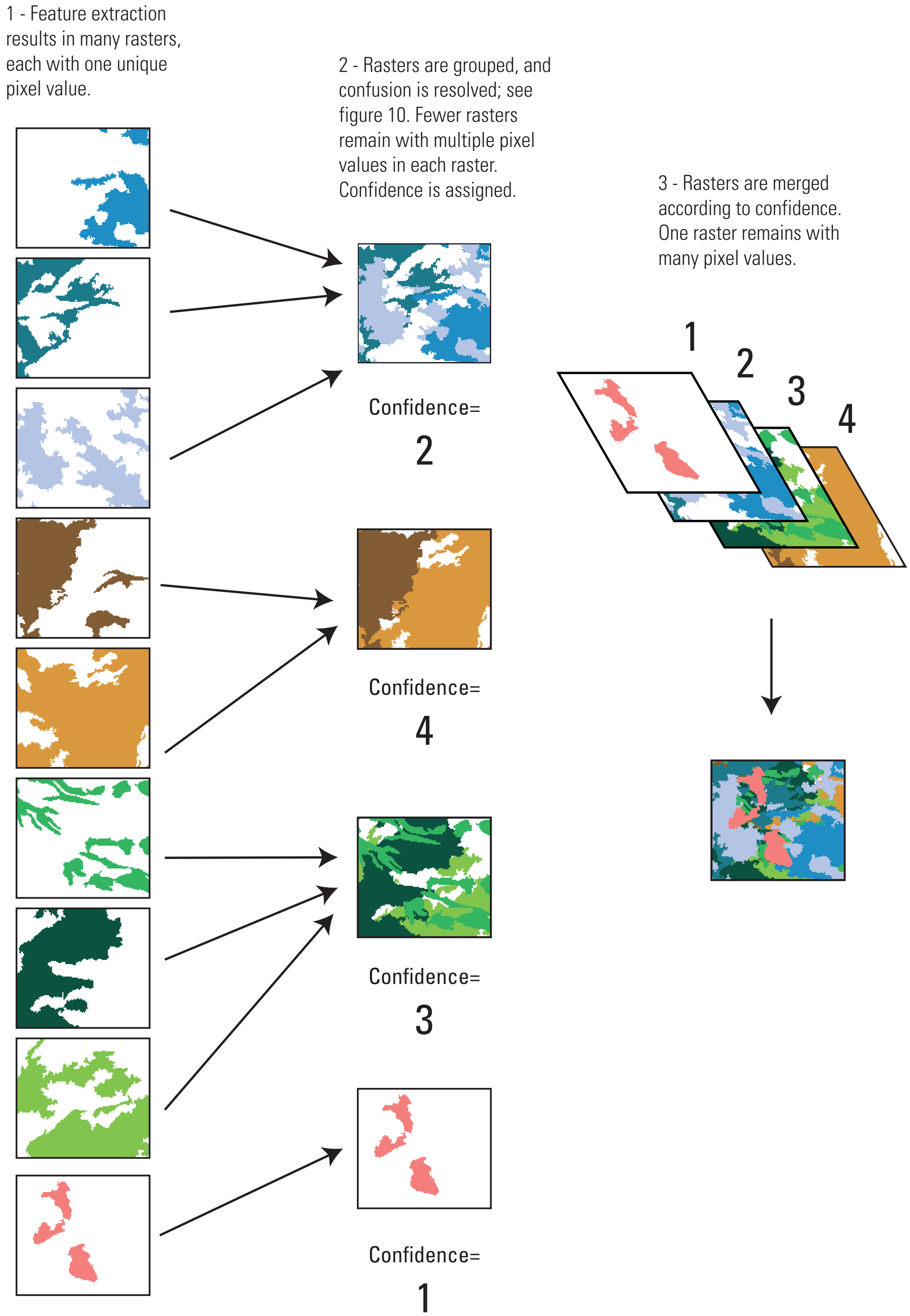

Figure 11. Raster processing workflow.

Table 3. Summary of major reclassifications resulting from photo interpretation by study area.

[See Appendix 1 for explanations of stand names. **Abbreviations**: ACEC, Areas of Critical Environmental Concern; NCA, National Conservation Area]

Stand name	Change	Location
Red Rock Canyon NCA		
Various JUOS and PIMO	JUOS-PIMO/PUST-EPVI	Spring Mountains
Any with top canopy JUOS-PIMO	GAFL-QUGA-ARPU-CEGR	Sandstone bluffs
JUOS	JUOS-PIMO/ARNO	Throughout study area
YUBR/YUSC/CORA	YUBR/CORA or CORA	Throughout study area
CORA + YUSC or LATR	CORA (removed YUSC or LATR)	Throughout study area
YUSC/LATR/AMDU	LATR/ATCO/AMDU	Valley
YUBR/YUSC/LATR-KRER-AMDU	YUSC/CORA	Calico Hills and near Visitor Center
Containing BASE, SALA, or ELRO	QUGA, QUTU, BASE, ELRO	Throughout study area
YUSC/LATR/AMDU	YUBR/CORA or YUSC/CORA	Spring Mountains hills and fans, northwest side of US95
ATCO, ATPO, and ATCA + understory	Removed understory to group	Corn Creek Springs area
QUTU/PRFA/ARTR	JUOS-PIMO/QUGA	Southern Spring Moutains highlands
Containing PLRI or YUBA/ACSP-ACHY	Substitute LATR, CORA, YUBR or YUSC	Above and below sandstone cliffs
Containing PLRI or YUBA/ACSP-ACHY	GUMI-GUSA or other grasses	Bird Springs area
Mormon Mesa ACEC		
Containing YUSC	Remove YUSC	Lower elevations in the southeast
LATR/AMDU	YUSC/LATR/AMDU	Central northern portion where YUSC dominates
YUSC/LATR-BEJU/AMDU_IF	YUSC/LATR/AMDU	Central northern portion where YUSC dominates
Fill	Sparsely vegetated limestone bedrock	West
YUSC/LATR/AMDU_DP	Sparsely vegetated	Meadow Valley Wash
PRFA-MOUT/BUUT-SADO	Sparsely vegetated limestone bedrock	Very western edge
YUSC/LATR/AMDU-KRGR-ENVI_IF	YUSC/LATR/AMDU-KRGR-ENVI	Throughout, mainly occurs in central north
Coyote Springs ACEC		
Fill	LATR/PLRI	Throughout study area
YUSC/PRFA-MOUT/BUUT-SADO	PRFA-MOUT/BUUT-SADO	All but southern mountainous part
YUSC/LATR-PSFR/AMDU	LATR/AMDU	Northern valley
Containing YUBR	Replace with YUSC	Southern valley
Containing YUBR	Remove YUBR	Northeastern valley
LATR/AMDU	MOUT/LEFR-SADO-EPTO_LB	Southern mountains
Piute-Eldorado Valley ACEC		
Containing YUBR	Remove YUBR	Southern part of Piute Valley
LATR/CORA	LATR/AMDU	Newberry Mountains
LATR/AMDU	LATR/CORA	Highland Range and northern Piute Valley
Containing ACGR	Replace with YUBR or other complex	Parts of both valleys
Containing ACGR	Replace with JUCA	Newberry Mountains
CHLI/ACGR/PHCA/HYSA-SEAR	YUSC-NOBI/ERFA	Eldorado Valley
CHLI/ACGR/PHCA/HYSA-SEAR	ACGR/PHCA_IF	Southern part of Piute Valley and in the Highland Range

Non-Vegetation Feature Delineation

Non-vegetation land-cover features were delineated separately from the vegetation classification either by manual delineation or by FA feature extraction with heavy manual editing. Paved roads and disturbed areas were delineated from the pan-sharpened imagery. Center lines for roads were delineated and buffered with known widths depending on the number of lanes. Road-sides are cleared of debris or vegetation and sometimes sprayed with herbicide. Vegetation growing in these areas, where the natural vegetation has been disturbed, are called ruderal (a plant species that is first to colonize disturbed lands). The roads were further buffered by known right-of-way widths to include these ruderal areas. Unpaved roads and one set of railroad tracks were delineated and buffered if their width, as measured on the pan-sharpened imagery, was wider than 8 m. Other disturbed areas that were digitized included parking areas, power lines, and remnants of mining activity.

There were a number of wildfire scars in and around the study areas. Point locations from wildfires prior to 2006 were acquired from the BLM Nevada State Office (2006). AFE models were developed and run where scars were visible on the imagery. The resulting polygons were edited to remove any areas identified as wildfire for which there was no point location from the BLM.

Several AFE models were also developed and run for the clouds and cloud shadows in the August imagery of the Mormon Mesa and Piute-Eldorado Valley ACECs. The resulting polygons were edited to remove features like shadows in the mountains and highly reflective areas in the valley. The light edges of clouds are not well defined. These areas could have incorrect land cover.

Assembly of Final Data Sets

During the final data-set assembly, all polygons from the non-vegetated feature delineation were converted to raster and merged with the final vegetation classification. Pixel values from the non-vegetated rasters replaced pixel values from the vegetation raster in the order of disturbed, wildfire scars, unpaved roads, ruderal, paved roads, and clouds. The final rasters (one for each study area) were filtered with the ERDAS “clump and eliminate” routine to remove any area smaller than the minimum mapping unit of 176 pixels (ERDAS, 2010). To maintain the road widths, the paved road map unit was not used in the filter process. The rasters were then converted to polygon vector data sets (one for each study area) in an ArcGIS geodatabase. The geodatabase contains a table that relates each map class to the NVC hierarchy from alliance to class (table 1).

Results

The final land-cover data sets are based on higher-resolution imagery and more detailed vegetation data and use a smaller minimum mapping unit than previous land-cover analyses available for the study areas. The resulting data sets capture greater local variation in land cover even at equivalent levels of vegetation categorization (fig. 12) and provide previously unavailable floristic information at the finer levels of the NVC hierarchy (fig. 13). The data sets map 155 unique map classes, 67 NVC alliances, 13 NVC macrogroups, and 4 NVC classes. See table 4 for class details for each study area.

Red Rock Canyon NCA

From the 300 plot samples collected in and around the NCA, 52 AFE models were developed. Table 5 lists the map classes and the area they occupy in the final land-cover data set for Red Rock Canyon NCA. The YUBR-YUSC/CORA class is the most commonly mapped in the NCA, occupying 11,250 hectares. At the NVC alliance level, *Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance, *Coleogyne ramosissima* Shrubland Alliance, *Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance, and *Juniperus osteosperma* – (*Pinus monophylla*) Woodland Alliance occupy about 18, 13, 13, and 10 percent of the land cover, respectively. There are 5,400 hectares unclassified, or about 7 percent of the cover.

Mormon Mesa ACEC

From the 211 RACE samples in and around Mormon Mesa ACEC, 98 AFE models were created. Table 6 lists the map classes and the area they occupy in the final land-cover data set for the Mormon Mesa ACEC. The LATR/AMDU class is the most common in the ACEC, occupying 14,890 hectares. At the NVC alliance level, *Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance occupies 29 percent of land cover, followed by *Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance, and *Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance with 14 and 10 percent cover, respectively. There are 9,830 hectares unclassified, or about 16 percent cover.

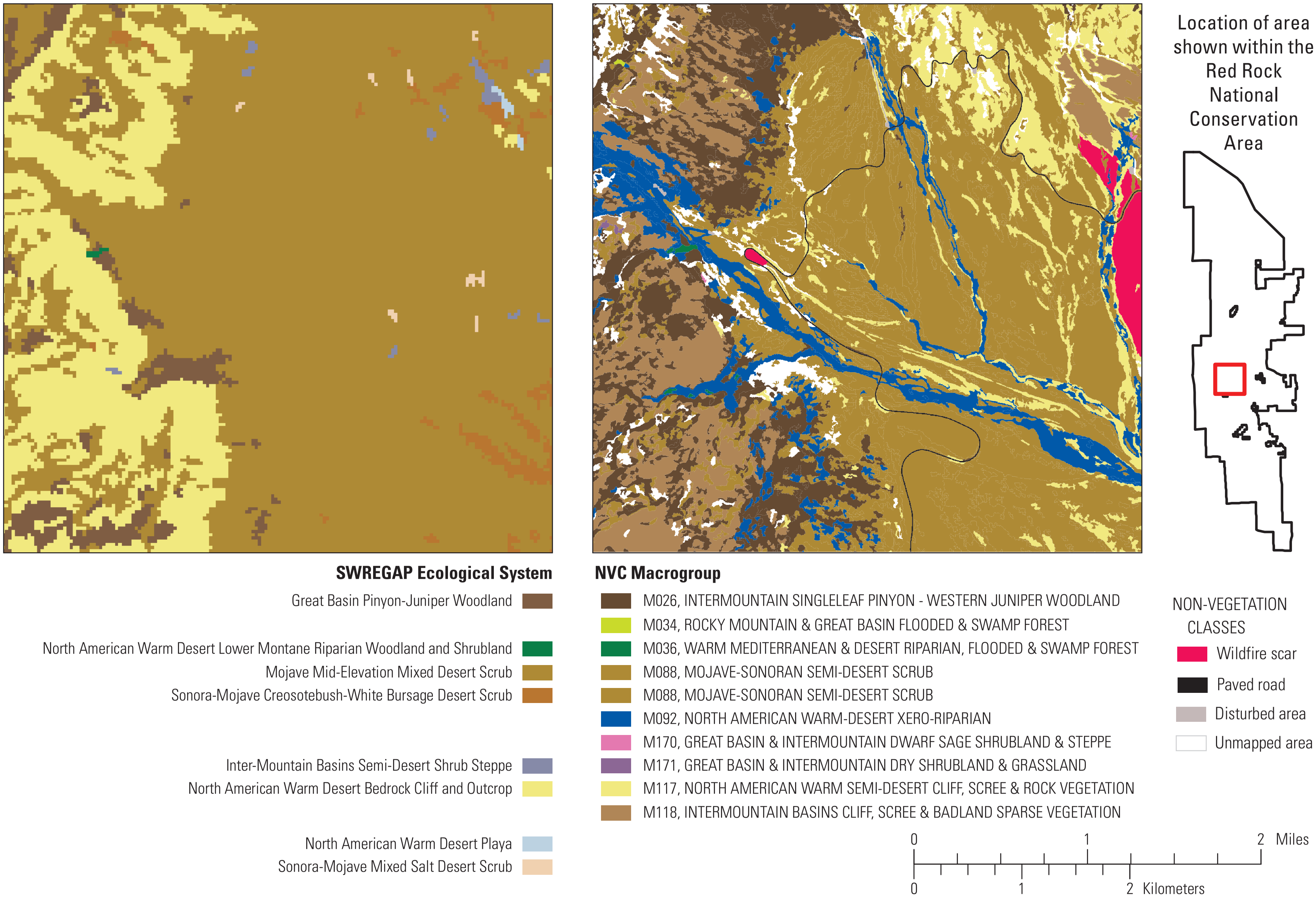

Figure 12. Selected area of Red Rock Canyon National Conservation Area mapped by *A*, Southwest Regional Gap Program (SWREGAP) Ecological System and by *B*, National Vegetation Classification Standard (NVC) macrogroup. Equivalent categories are aligned in explanation (Bureau of Land Management, 2013).

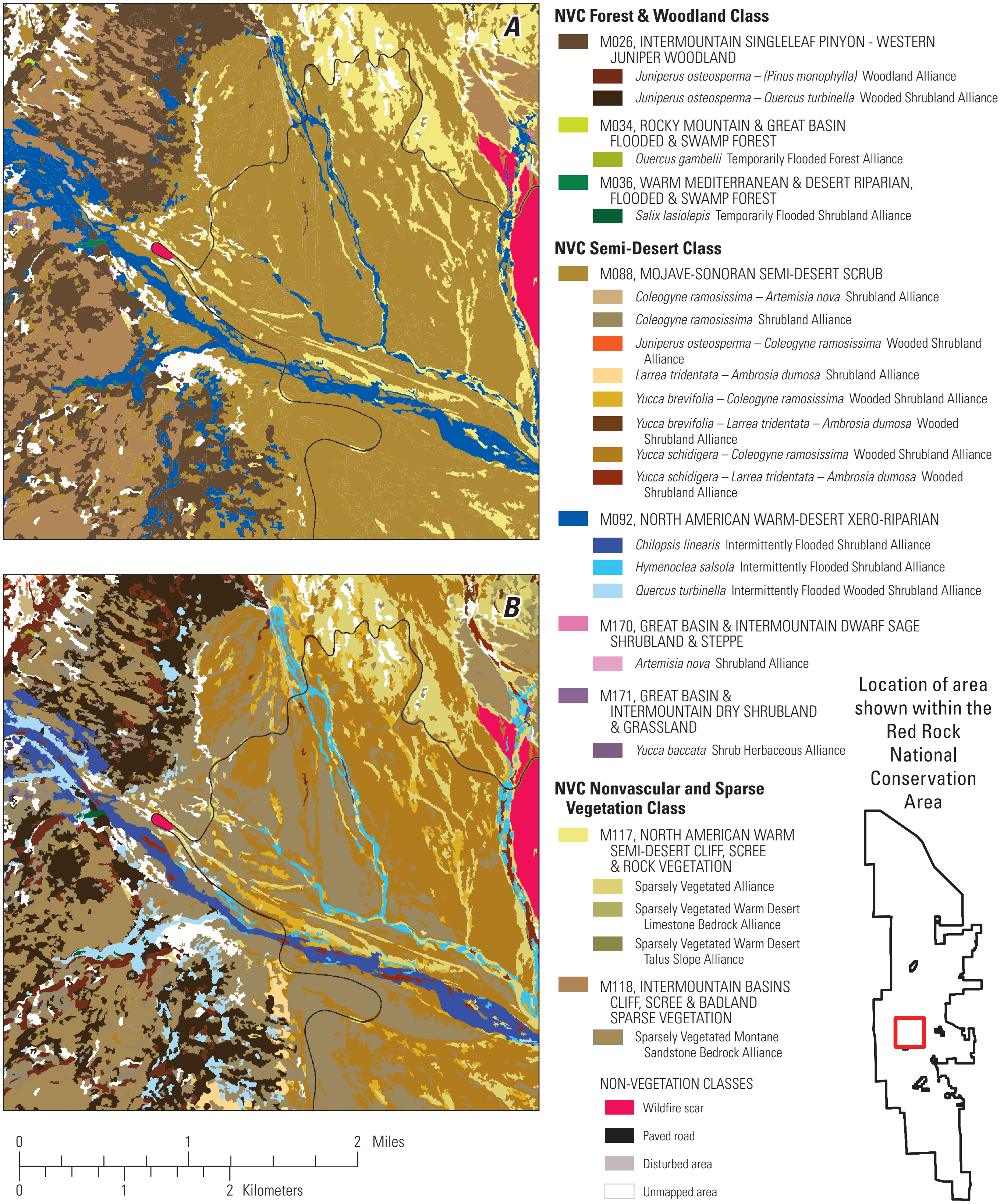

Figure 13. Selected area of Red Rock Canyon National Conservation Area mapped by *A*, National Vegetation Classification Standard (NVC) macrogroup and *B*, NVC alliance.

Table 4. Number of unique classes and associated National Vegetation Classification Standard (NVC) hierarchy categories by study area.

[Map class counts include 6 non-vegetated classes. **Abbreviations**: ACEC, Area of Critical Environmental Concern; NCA, National Conservation Area]

Study area	Map classes	NVC alliances	NVC macrogroups	NVC classes
Red Rock Canyon NCA	55	37	12	4
Mormon Mesa ACEC	69	27	5	3
Coyote Springs ACEC	26	13	5	3
Piute-Eldorado Valley ACEC	49	16	4	2
Total unique for all areas	155	67	13	4

Table 5. Map class code, map class, area, and alliance in the Red Rock Canyon National Conservation Area.

Map class code	Map class	Area (hectares)	Alliance name
213	YUBR-YUSC/CORA	11,251.7	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
127	CORA	9,676.1	*Coleogyne ramosissima* Shrubland Alliance
214	YUBR-YUSC/LATR-AMDU	8,485.2	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
999	Unclassified	5,392.5	(Unclassified)
500	SV	5,007.2	Sparsely Vegetated Alliance
152	LATR/AMDU	4,046.9	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
216	YUSC/CORA	3,623.7	*Yucca schidigera – Coleogyne ramosissima* Wooded Shrubland Alliance
501	SV_LB	3,607.8	Sparsely Vegetated Warm Desert Limestone Bedrock Alliance
146	JUOS-PIMO-PUST/EPVI	2,917.2	*Juniperus osteosperma* – (*Pinus monophylla*) Woodland Alliance
194	YUBR/CORA	2,764.0	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
147	JUOS-PIMO/QUGA	2,270.7	*Juniperus osteosperma* – (*Pinus monophylla*) Woodland Alliance
502	SV_SB	2,196.2	Sparsely Vegetated Montane Sandstone Bedrock Alliance
144	JUOS-PIMO/CORA	1,905.7	*Juniperus osteosperma* – (*Pinus monophylla*) Woodland Alliance
140	GUMI	1,633.2	*Gutierrezia microcephala* Shrubland Alliance
149	JUOS-PIMO/QUTU-GAFL/ARPU5	1,457.7	*Juniperus osteosperma – Quercus turbinella* Wooded Shrubland Alliance
211	YUBR-YUSC-AMDU-EPVI	1,367.3	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
143	JUOS/CORA	1,224.4	*Juniperus osteosperma – Coleogyne ramosissima* Wooded Shrubland Alliance
130	CORA-ARNO	1,159.8	*Coleogyne ramosissima – Artemisia nova* Shrubland Alliance
221	YUSC/LATR/AMDU	1,050.6	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
171	LATR/EPVI	755.6	*Larrea tridentata – Ephedra viridis* Shrubland Alliance
167	LATR/AMDU-EPNE-KRER	614.5	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
189	QUTU_IF	587.5	*Quercus turbinella* Intermittently Flooded Wooded Shrubland Alliance
899	Wildfire scar	510.2	(Non-vegetated class)
186	PUST/FAPA/ARBI_LB	497.2	*Purshia stansburiana – Artemisia bigelovii* Limestone Bedrock Shrubland Alliance
503	SV_TS	470.1	Sparsely Vegetated Warm Desert Talus Slope Alliance
168	LATR/AMDU-HYSA_IF	454.1	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
148	JUOS-PIMO/QUGA/ARPU5	413.0	*Juniperus osteosperma* – (*Pinus monophylla*) Woodland Alliance
133	EPTO-AMDU	320.7	*Ephedra torreyana – Ambrosia dumosa* Shrubland Alliance
220	YUSC/LATR	279.0	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance

Table 5. Map class code, map class, area, and alliance in the Red Rock Canyon National Conservation Area.—Continued

Map class code	Map class	Area (hectares)	Alliance name
892	Ruderal area of road	265.1	Sparsely Vegetated Ruderal Herbaceous Alliance
139	GAFL-QUGA-ARPU5-CEGR	237.2	*Quercus gambelii* Mixed Shrubland Alliance
128	CORA Dense	214.3	*Coleogyne ramosissima* Shrubland Alliance
212	YUBR/YUSC/ARBI	210.2	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
116	ATCA/ARNO	198.2	*Atriplex canescens – Artemisia nova* Shrubland Alliance
998	Disturbed	182.9	(Non-vegetated class)
150	JUOS/PRFA-PUST-FAPA	162.5	*Juniperus osteosperma* Woodland Alliance
188	QUGA_TF	144.7	*Quercus gambelii* Temporarily Flooded Forest Alliance
126	CHLI/PRFA-HYSA_IF	128.3	*Chilopsis linearis* Intermittently Flooded Shrubland Alliance
117	ATCA/SCAR	96.8	*Atriplex canescens* Shrubland Alliance
135	FAPA-PRFA_IF	73.3	*Fallugia paradoxa* Intermittently Flooded Shrubland Alliance
193	YUBA-CORA/ACSP12-ACHY	70.9	*Yucca baccata* Shrub Herbaceous Alliance
113	ARNO	65.2	*Artemisia nova* Shrubland Alliance
141	HYSA_IF	64.1	*Hymenoclea salsola* Intermittently Flooded Shrubland Alliance
992	Paved road with ruderal	59.7	(Non-vegetated class)
129	CORA/PLRI	58.3	*Coleogyne ramosissima – Pleuraphis rigida* Shrub Herbaceous Alliance
118	ATCO	56.7	*Atriplex confertifolia* Shrubland Alliance
145	JUOS-PIMO/ARNO	55.7	*Juniperus osteosperma* – (*Pinus monophylla*) Woodland Alliance
180	PLRI-ACSP12	55.3	*Pleuraphis rigidia* Herbaceous Alliance
187	PUST/FAPA/PRFA_LB	47.9	*Purshia stansburiana* Limestone Bedrock Shrubland Alliance
994	Unpaved road	42.6	(Non-vegetated class)
993	Paved road	24.7	(Non-vegetated class)
190	SALA_TF	9.0	*Salix lasiolepis* Temporarily Flooded Shrubland Alliance
131	ELRO_S	5.5	*Eleocharis* (*quinqueflora, rostellata*) Saturated Herbaceous Alliance
121	CHLI_IF	3.8	*Chilopsis linearis* Intermittently Flooded Shrubland Alliance
119	ATPO	1.3	*Atriplex polycarpa* Shrubland Alliance
114	ATCA	1.1	*Atriplex canescens* Shrubland Alliance

Table 6. Map class code, map class, area, and alliance in the Mormon Mesa Area of Critical Environmental Concern.

Map class code	Map class	Area (hectares)	Alliance name
152	LATR/AMDU	14,887.1	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
999	Unclassified	9,830.9	(Unclassified)
196	YUBR/LATR/AMDU	6,271.5	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
500	SV	3,010.4	Sparsely Vegetated Alliance
221	YUSC/LATR/AMDU	2,692.7	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
501	SV_LB	2,490.7	Sparsely Vegetated Warm Desert Limestone Bedrock Alliance
228	YUSC/LATR/AMDU-KRGR_DP	1,853.8	*Yucca schidigera* Desert Pavement Wooded Shrubland Alliance
229	YUSC/LATR/AMDU-KRGR-ENVI	1,629.3	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
163	LATR/PLRI	1,428.0	*Larrea tridentata – Pleuraphis rigida* Shrub Herbaceous Alliance
990	Cloud	1,268.2	(Non-vegetated class)
197	YUBR/LATR/AMDU_DP	1,263.3	*Yucca brevifolia* Desert Pavement Wooded Shrubland Alliance
151	LATR	1,109.3	*Larrea tridentata* Shrubland Alliance
156	LATR/AMDU-EPTO	1,053.7	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
198	YUBR/LATR/AMDU-LYAN	1,018.0	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
169	LATR-CYAC/AMDU	987.9	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
235	YUSC/LATR-ENVI/AMDU_IF	861.4	*Yucca schidigera* Intermittently Flooded Wooded Shrubland Alliance
223	YUSC/LATR/AMDU_DP	772.3	*Yucca schidigera* Desert Pavement Wooded Shrubland Alliance
207	YUBR/YUSC/LATR/AMDU-LYAN	749.4	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
154	LATR/AMDU/PLRI	670.6	*Larrea tridentata – Pleuraphis rigida* Shrub Herbaceous Alliance
226	YUSC/LATR/AMDU-KRER	576.1	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
160	LATR/KRGR/AMDU	568.8	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
224	YUSC/LATR/AMDU-AMFR	558.8	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
173	LATR-FECY_LB	527.1	*Larrea tridentata – Ferocactus cylindraceus* Limestone Bedrock Shrubland Alliance
110	ACGR-YUSC/HYSA-AMDU_IF	471.9	*Acacia greggii* Intermittently Flooded Shrubland Alliance
215	YUSC/AMDU-KRGR/TICA_LB	455.3	*Yucca schidigera – Ambrosia dumosa* Limestone Bedrock Wooded Shrubland Alliance
236	YUSC/LATR-KRGR/AMDU_DP	351.0	*Yucca schidigera* Desert Pavement Wooded Shrubland Alliance
195	YUBR/LATR	321.5	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
175	LATR-YUSC/AMDU_DP	281.9	*Yucca schidigera* Desert Pavement Wooded Shrubland Alliance
227	YUSC/LATR/AMDU-KRER/ERIN	255.7	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
504	SV_LS	254.4	Sparsely Vegetated Landslide Mass–Wasting Slope Herbaceous Alliance
109	ACGR-YUSC/AMDU-KRGR_IF	253.3	*Acacia greggii* Intermittently Flooded Shrubland Alliance
157	LATR/AMDU-KRER	217.2	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
898	Ruderal	194.5	Sparsely Vegetated Ruderal Herbaceous Alliance
123	CHLI/ACGR/LATR-LYCO/AMDU_IF	148.5	*Acacia greggii* Intermittently Flooded Shrubland Alliance
106	ACGR/LATR-KRGR-LYCO/AMDU_IF	138.5	*Acacia greggii* Intermittently Flooded Shrubland Alliance

Table 6. Map class code, map class, area, and alliance in the Mormon Mesa Area of Critical Environmental Concern.—Continued

Map class code	Map class	Area (hectares)	Alliance name
998	Disturbed	125.3	(Non-vegetated class)
181	PRFA/ENVI-SADO_IF	104.7	*Prunus fasciculata* Intermittently Flooded Shrubland Alliance
138	FECY/SCRI-PLPL_LB	104.4	*Ferocactus cylindraceous* Limestone Bedrock Shrubland Alliance
994	Unpaved road	103.4	(Non-vegetated class)
112	AMDU-LATR	95.3	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
184	PRFA-PSFR/ENVI/GUMI_IF	70.7	*Prunus fasciculata* Intermittently Flooded Shrubland Alliance
158	LATR/AMDU-LEFR/PLRI_TS	64.8	*Larrea tridentata – Ambrosia dumosa* Limestone Talus Slope Shrubland Alliance
219	YUSC/FECY/KRGR-AMDU_LB	63.4	*Yucca schidigera – Ferocactus cylindraceus* Limestone Bedrock Shrubland Alliance
237	YUSC/LATR-PSFR/AMDU	57.7	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
992	Paved road with ruderal	54.5	(Non-vegetated class)
134	ERPA_IF	50.3	*Ericameria paniculata* Intermittently Flooded Shrubland Alliance
182	PRFA/ERFA-SADO_IF	37.7	*Prunus fasciculata* Intermittently Flooded Shrubland Alliance
111	AMDU	37.5	*Ambrosia dumosa* Shrubland Alliance
155	LATR/AMDU-CYRA	35.3	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
136	FECY/ENFA_LB	31.8	*Ferocactus cylindraceous* Limestone Bedrock Shrubland Alliance
103	ACGR/BEJU-KRGR/HYSA_IF	30.2	*Acacia greggii* Intermittently Flooded Shrubland Alliance
137	FECY/OPPOE-AMDU_LB	28.7	*Ferocactus cylindraceous* Limestone Bedrock Shrubland Alliance
240	YUSC/LATR-PSFR/KRER-AMDU	19.8	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
102	ACGR/BEJU/HYSA_IF	17.4	*Acacia greggii* Intermittently Flooded Shrubland Alliance
172	LATR-ERPA-PSFR/HYSA-AMDU_IF	16.2	*Ericameria paniculata* Intermittently Flooded Shrubland Alliance
174	LATR-MOUT/LYAN-ERFA_LB	15.6	*Larrea tridentata – Mortonia utahensis* Limestone Bedrock Shrubland Alliance
191	TARA_TF	15.5	*Tamarix spp.* Semi-natural Temporarily Flooded Shrubland Alliance
115	ATCA/SPAN	14.9	*Atriplex canescens* Ruderal Shrub Herbaceous Alliance
222	YUSC/LATR/AMDU/PLRI	13.2	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
238	YUSC/LATR-PSFR/AMDU-ACSH	10.4	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
993	Paved road	7.5	(Non-vegetated class)
192	TARA/LATR-PRGL/ATPO_TF	5.6	*Tamarix spp.* Semi-natural Temporarily Flooded Shrubland Alliance
234	YUSC/LATR-AMDU	5.2	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
125	CHLI/CHVI_IF	3.7	*Chilopsis linearis* Intermittently Flooded Shrubland Alliance
239	YUSC/LATR-PSFR/AMDU-KRER	3.4	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
153	LATR/AMDU/ERTR	1.1	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
203	YUBR/LATR-YUSC/AMDU/PLRI	0.7	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
233	YUSC/LATR/KRER-OPPOE	0.6	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
120	BRLO_IF	0.5	*Brickellia longifolia* Intermittently Flooded Shrubland Alliance
162	LATR/LYCO/ACHY_D	0.3	*Larrea tridentata – Achnatherum hymenoides* Shrub Herbaceous Dune Alliance

Coyote Springs ACEC

From the 108 RACE samples in and around the Coyote Springs ACEC, 27 AFE models were developed. Table 7 lists the map classes and the area they occupy in the final land-cover data set for the Coyote Springs ACEC. The LATR/AMDU class is the most common in the ACEC, occupying 4,900 hectares. At the alliance level, *Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance and *Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance occupy the most cover with 30 and 26 percent, respectively. There are 1,960 hectares unclassified, or about 9 percent.

Piute-Eldorado Valley ACEC

From the 530 RACE samples in and around the Piute-Eldorado ACEC, 59 AFE models were developed. Table 8 lists the map classes and the area they occupy in the final land-cover data set for the Piute-Eldorado Valley ACEC. The LATR/AMDU class is the most common in the ACEC, occupying 59,600 hectares. At the NVC alliance level, *Larrea tridentata – Ambrosia dumosa* Shrubland Alliance is dominant with 46 percent land cover. There are 6,920 hectares unclassified, or about 5 percent cover.

Map Accuracy

A statistical, quantitative accuracy assessment was not within the scope of this study. A stratified random or equalized random accuracy assessment at the map class level would require about a thousand field samples randomly distributed throughout the study areas. SWReGAP used a less statistically robust method of withholding a portion of field samples to be used for accuracy assessment (Kepner and others, 2005). The SWReGAP method was not feasible for this study because field sampling and land-cover analyses were ongoing simultaneously, and all field samples available were used for evaluating and validating the AFE model outputs.

The SWReGAP field sample database for Nevada (Kepner, 2005) is the only known source of freely available, independent field samples for the study areas. Of the 35 SWReGAP samples that fall within the study areas, 28 samples, or 80 percent, agree with the final land-cover datasets at the NVC macrogroup level. All of the matching samples are in the Mojave-Sonoran Semi-Desert Scrub Macrogroup, the most mapped unit in Clark County by SWReGAP. The samples are not evenly distributed geographically or by map class. This measure qualitatively supports, but in no way confirms, the hypothesis that the final land-cover data sets are at least as accurate as previously available products.

Accuracy can be evaluated by use. The map class boundaries were only slightly modified from the original feature extraction outputs by the filtering process. Therefore, it is believed the boundaries correspond well to features on the ground. With additional field data, the map classes to which features belong can be confirmed or updated, and map accuracy improved.

Summary

Existing land-cover data sets for most areas in Clark County, Nevada, are based on 30-meter Landsat imagery and generalized vegetation classes. These data sets are insufficient for land managers to make decisions in areas meant to protect natural resources and wildlife, in particular the desert tortoise (*Gopherus agassizii*) and its habitat.

DigitalGlobe's QuickBird satellite imagery was used as the high-resolution base imagery for classification. Feature Analyst feature extraction software was used as the classification tool. More than 1,000 vegetation samples were collected in accordance with NVC naming hierarchy and sampling protocol, and from them, more than 200 AFE models were created to produce the vegetation map classes in the final land-cover data sets. These data sets also include hand-edited map units of paved roads, disturbed areas, and areas damaged by wild fires. These maps are much more detailed than previously available land-cover maps, both in resolution and in vegetation map classes.

Table 7. Map class code, map class, area, and alliance in the Coyote Springs Area of Critical Environmental Concern.

Map class code	Map class	Area (hectares)	Alliance name
152	LATR/AMDU	4,917.5	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
234	YUSC/LATR-AMDU	2,420.6	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
999	Unclassified	1,963.3	(Unclassified)
111	AMDU	1,542.8	*Ambrosia dumosa* Shrubland Alliance
899	Wildfire scar	1,527.7	(Non-vegetated class)
183	PRFA-MOUT/BUUT-SADO_LB	1,428.3	*Prunus fasciculata* Limestone Bedrock Shrubland Alliance
151	LATR	1,411.9	*Larrea tridentata* Shrubland Alliance
237	YUSC/LATR-PSFR/AMDU	1,354.5	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
222	YUSC/LATR/AMDU/PLRI	835.4	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
239	YUSC/LATR-PSFR/AMDU-KRER	764.8	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
500	SV	631.9	Sparsely Vegetated Alliance
153	LATR/AMDU/ERTR	428.2	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
238	YUSC/LATR-PSFR/AMDU-ACSH	409.9	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
240	YUSC/LATR-PSFR/KRER-AMDU	394.2	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
892	Ruderal area of road	209.7	Sparsely Vegetated Ruderal Herbaceous Alliance
203	YUBR/LATR-YUSC/AMDU/PLRI	153.5	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
241	YUSC/PRFA-MOUT/BUUT-SADO_LB	131.6	*Yucca schidigera – Prunus fasciculata* Limestone Bedrock Wooded Shrubland Alliance
178	MOUT/LEFR-SADO-EPTO_LB	83.6	*Mortonia utahensis* Limestone Bedrock Shrub Alliance
233	YUSC/LATR/KRER-OPPOE	70.6	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
992	Paved road with ruderal	59.7	(Non-vegetated class)
898	Ruderal	48.3	Sparsely Vegetated Ruderal Herbaceous Alliance
163	LATR/PLRI	25.1	*Larrea tridentata – Pleuraphis rigida* Shrub Herbaceous Alliance
161	LATR/LYAN-ATCA	23.7	*Larrea tridentata* Shrubland Alliance
998	Disturbed	16.3	(Non-vegetated class)
125	CHLI/CHVI_IF	5.7	*Chilopsis linearis* Intermittently Flooded Shrubland Alliance
994	Unpaved road	1.5	(Non-vegetated class)
185	PRGL/ATCA_SF	0.9	*Prosopis glandulosa* Seasonally Flooded Shrubland Alliance

Table 8. Map class code, map class, area, and alliance in the Piute-Eldorado Valley Area of Critical Environmental Concern.

Map class code	Map class	Area (hectares)	Alliance name
152	LATR/AMDU	59,559.5	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
159	LATR/CORA	10,633.2	*Larrea tridentata – Coleogyne ramosissima* Shrubland Alliance
999	Unclassified	6,917.8	(Unclassified)
195	YUBR/LATR	6,307.6	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
201	YUBR/LATR/PLRI-LYAN-CORA	5,988.6	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
163	LATR/PLRI	5,949.7	*Larrea tridentata – Pleuraphis rigida* Shrub Herbaceous Alliance
221	YUSC/LATR/AMDU	5,688.0	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
990	Cloud	3,199.8	(Non-vegetated class)
200	YUBR/LATR/PLRI-LYAN	2,936.6	*Yucca brevifolia – Pleuraphis rigida* Wooded Herbaceous Alliance
220	YUSC/LATR	2,727.6	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
205	YUBR/LATR-YUSC/KRLA	2,482.1	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
242	YUSC/ERFA	2,180.5	*Yucca schidigera – Eriogonum fasciculatum* Wooded Shrubland Alliance
107	ACGR/PHCA/ERPA-BRIN_IF	2,168.2	*Acacia greggii* Intermittently Flooded Shrubland Alliance
165	LATR/SEAR/AMDU	2,097.8	*Larrea tridentata – Ambrosia dumosa* Shrubland Alliance
101	ACGR wash LATR/AMDU complexes	1,513.4	*Acacia greggii* Intermittently Flooded Shrubland Alliance
225	YUSC/LATR/AMDU-ERFA	1,384.2	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
204	YUBR/LATR-YUSC/CORA/CYAC/YUBA-EPNE	1,298.1	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
108	ACGR/PHCA_IF	1,279.1	*Acacia greggii* Intermittently Flooded Shrubland Alliance
230	YUSC/LATR/EPTO/AMDU	1,060.0	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
199	YUBR/LATR/CORA	911.6	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
176	LATR-YUSC/KRLA	867.0	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
243	YUSC-NOBI/ERFA	665.3	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
202	YUBR/LATR/PLRI	639.1	*Yucca brevifolia – Pleuraphis rigida* Wooded Herbaceous Alliance
151	LATR	622.0	*Larrea tridentata* Shrubland Alliance
892	Ruderal area of road	518.2	Sparsely Vegetated Ruderal Herbaceous Alliance

Table 8. Map class code, map class, area, and alliance in the Piute-Eldorado Valley Area of Critical Environmental Concern.—Continued

Map class code	Map class	Area (hectares)	Alliance name
206	YUBR/YUSC/LATR	432.6	*Yucca brevifolia – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
231	YUSC/LATR/ERFA-AMDU	346.7	*Yucca schidigera – Eriogonum fasciculatum* Wooded Shrubland Alliance
208	YUBR/YUSC/LATR/CORA	345.6	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
217	YUSC/EPTO/ERFA-ERCO23	289.2	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
154	LATR/AMDU/PLRI	209.3	*Larrea tridentata – Pleuraphis rigida* Shrub Herbaceous Alliance
124	CHLI/ACGR/PHCA/HYSA-SEAR_IF	207.9	*Chilopsis linearis* Intermittently Flooded Shrubland Alliance
210	YUBR/YUSC-YUBA/ACSPS2/PLRI	200.7	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
134	ERPA_IF	163.8	*Ericameria paniculata* Intermittently Flooded Shrubland Alliance
194	YUBR/CORA	130.8	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
992	Paved road with ruderal	128.7	(Non-vegetated class)
218	YUSC/EPTO-LATR/PLRI	126.5	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
166	LATR-ACGR-YUSC	123.3	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
105	ACGR/HYSA-EPTO/ERFA-SADO_IF	99.2	*Acacia greggii* Intermittently Flooded Shrubland Alliance
998	Disturbed	96.3	(Non-vegetated class)
104	ACGR/HYSA/ERFA_IF	94.6	*Acacia greggii* Intermittently Flooded Shrubland Alliance
142	JUCA_GB	91.7	*Juniperus californica* Granite Bedrock Woodland Alliance
209	YUBR/YUSC/PLRI-GUMI	87.0	*Yucca brevifolia – Coleogyne ramosissima* Wooded Shrubland Alliance
164	LATR/LYAN/PLRI	50.9	*Larrea tridentata – Pleuraphis rigida* Shrub Herbaceous Alliance
994	Unpaved road	37.2	(Non-vegetated class)
179	PICA/YUBR/PUGL/CORA	33.7	*Pinus californiarum* Woodland Alliance
232	YUSC/LATR/HYSA-AMDU	11.3	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance
899	Wildfire scar	11.2	(Non-vegetated class)
122	CHLI/ACGR/ERPA-AMER_IF	4.2	*Chilopsis linearis* Intermittently Flooded Shrubland Alliance
170	LATR-EPTO/AMDU	3.5	*Larrea tridentata – Ephedra torreyana* Shrubland Alliance
177	LATR-YUSC-CYAC/YUBA-EPNE	0.7	*Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Wooded Shrubland Alliance

References Cited

Brussard, P.F., Charlet, D.A., and Dobkin, D., 1999, The Great Basin-Mojave Desert region, in Mac, M.J., Opler, P.A., Puckett-Haecker, C.E.and Doran, P.D. (eds), The status and trends of the Nation's biological resources: U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia, p. 505–542.

Bureau of Land Management, 1980, Final environmental assessment NV-050-9-30: Oil and gas leasing in the Red Rock Canyon recreation lands, 249 p.

Bureau of Land Management, 2006, NV_Fire_history layers: Nevada State Office ACEC Geospatial Data web page, accessed April 18, 2013, at *http://www.blm.gov/nv/st/en/prog/more_programs/geographic_sciences/gis/geospatial_data.html*.

Bureau of Land Management, 2013, Crosswalk from ecological systems to NVCS macrogroups, attachment 4 in memo: The National Vegetation Classification and Associated Mapping Standards for Bureau of Land Management planning documents and assignment of State-level Vegetation Classification Data Stewards, accessed September 16, 2013, at *http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_instruction/2013/im_2013-111_the_national.html*.

Charlet, D.A., Damar, N.A., and Leary, P.J., 2014, Vegetation database for land-cover mapping, Clark and Lincoln Counties, Nevada: U.S. Geological Survey, Data Series 827, 17 p., *http://pubs.usgs.gov/ds/827*.

Comer, P., Faber-Langendoen, D., Evans, R., Gawler, S., Josse, C., Kittel, G., Menard, S., Pyne, M., Reid, M., Schulz,K., Snow, K., and Teague, J., 2003. Ecological systems of the United States: A working classification of U.S. terrestrial systems: NatureServe, Arlington, Virginia, accessed April 18, 2013, at *http://www.natureserve.org/library/usEcologicalsystems.pdf*.

Daly, C., Gibson, W., Doggett, M., Smith, J., and Taylor, G., 2004, Up-to-date monthly climate maps for the conterminous United States, 14th AMS Conference on Applied Climatology: American Meteorological Society, Seattle, Washington, January 13–16, 2004, 8 p.

ERDAS, Inc., 2010, ERDAS Field Guide, accessed April 18, 2013, at *http://geospatial.intergraph.com/fieldguide/wwhelp/wwhimpl/js/html/wwhelp.htm*.

ESRI, 2011, ArcGIS Desktop 9.3 Help, accessed May 21, 2013, at *http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm*.

Fenneman, N.M and Johnson, D.W., 1946, Physiographic divisions of the conterminous United States: U.S. Geological Survey, USGS special map, accessed December 6, 2012 at *http://water.usgs.gov/lookup/getspatial?physio*.

Federal Geographic Data Committee, 2008, National vegetation classification standard, version 2, FGDC-STD-005-2008, accessed December 6, 2012, at *http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/NVCS_V2_FINAL_2008-02.pdf*.

Geosystems, 2013, ATCOR for ERDAS IMAGINE produce website, accessed August 21, 2013, at *http://www.geosystems.de/atcor/index.html*.

Heaton, J.S., Miao, X., Von Seckendorff, K., Charlet, D. Grimmer, A., Patil, R., 2011, Final vegetation GIS data delivery: final report. Report to Clark County MSHCP 2005-UNR-578:D21.

Homer, C.H., Fry, J.A., and Barnes C.A., 2012, The National Land Cover Database, U.S. Geological Survey Fact Sheet 2012-3020, 4 p., accessed December 6, 2012, at *http://pubs.usgs.gov/fs/2012/3020/fs2012-3020.pdf*.

Kepner, W.G., 2005, Landcover Training Site Database for Nevada (2002–2004), accessed September 13, 2013, at *http://earth.gis.usu.edu/swgap/data/field_databases/nv/NVGap_Database/documents/NV_Gap_Database_metadata.html*.

Kepner, W.G., Sajwaj, T.D., Bradford, D.F., and Evanson, E.J.. 2005, Nevada geospatial data browser: Las Vegas, Nev., U.S. Environmental Protection Agency, Office of Research and Development, EPA/600/C-05/005, accessed May 4, 2007, at *http://www.epa.gov/nerlesd1/land-sci/gap.htm*.

Longwell, C.R., Pampeyan, E.H., Bowyer, B., and Roberts, R.J., 1965, Geology and Mineral Deposits of Clark County, Nevada. Nevada Bureau of Mines and Geology, Bulletin 62, 218 p., with 1:250,000 scale geologic map.

Maxwell, J., Gergely, K., and Aycrigg, J., 2010, Gap analysis bulletin, vol. 18: U.S. Geological Survey, 47 p., accessed December 6, 2012, at *http://www.gap.uidaho.edu/Bulletins/18/GAPBulletin18.pdf*.

Prior-Magee, J.S., Boykin, K.G., Bradford, D.F., Kepner, W.G., Lowry, J.H., Schrupp, D.L., Thomas, K.A., and Thompson, B.C., eds., 2007, Southwest Regional Gap Analysis Project Final Report: U.S. Geological Survey, Gap Analysis Program, Moscow, Id., at *ftp://ftp.gap.uidaho.edu/products/regional/southwest/Report/SWReGAP%20Final%20Report.pdf*.

RECON Environmental, Inc., 2000, Final Clark County multiple species habitat conservation plan and environmental impact statement for issuance of a permit to allow incidental take of 79 species in Clark County, Nevada: Report to Clark County Department of Comprehensive Planning and U.S. Fish and Wildlife Service.

Shreve, F., 1942, The desert vegetation of North America: The Botanical Review, v. 8, no. 4, p. 195–246.

Smith, D.S. and Nowak, R.S., 1990, Ecophysiology of plants in the intermountain lowlands, chap. 6 in Osmond, C.B., and others, eds., Plant biology of the Basin and Range: New York, NY, Springer Verlag, p. 179–241.

U.S. Department of Agriculture, 2013, The PLANTS database: National Resources Conservation Service, National Plant Data Team, Greensboro, NC, 27401-4901 USA, accessed April 18 2013, *http://plants.usda.gov.*

Visual Learning Systems, Inc., 2008, Feature Analyst 4.2 for ArcGIS Reference Manual, 354 p., accessed April 18, 2013, at *http://www.featureanalyst.com/feature_analyst/publications/manuals/FA_4.2_RELEASE/FA_4.2_Reference_arc_040908_RELEASE.pdf*.

Appendix

Appendix 1. Complete List of Species Symbols and Abbreviations Used in the Data Sets

Table 1-1. Complete list of species symbols and abbreviations used in the data sets.

[**Abbreviations**: NRCS, Natural Resources Conservation Service; USDA, U.S. Department of Agriculture]

Stand name code for azonal feature	Azonal feature
DP	(Desert pavement)
D	(Dune)
GB	(Granite bedrock)
G_B	(Gravel barrens)
IF	(Intermittently flooded)
LS	(Landslide mass-wasting slope)
LB	(Limestone bedrock)
PN	(Petrocaclic nodules)
Playa	(Playa)
QB	(Quartzite bedrock)
SB	(Sandstone bedrock)
S	(Saturated)
SF	(Seasonally flooded)
PF	(Semi-permanently flooded)
SV	(Sparsely vegetated)
SM	(Spring mound)
TS	(Talus slope)
TF	(Temporarily flooded)
TB	(Tuff bedrock)
VB	(Volcanic bedrock)

Stand name symbol for vegetation species	USDA/NRCS species name ([1]U.S. Department of Agriculture, 2013)
ABCO	*Abies concolor concolor*
ACGR	*Acacia greggii*
ACSH	*Acamptopappus shockleyi*
ACSPS2	*Acamptopappus sphaerocephalus*
ACGL	*Acer glabrum diffusum*
ACHY	*Achnatherum hymenoides*
ACLE	*Achnatherum lettermannii*
ACPA	*Achnatherum parishii parishii*
ACSP12	*Achnatherum speciosum*
ADCO	*Adenophyllum cooperi*
AGUT	*Agave utahensis eborispina*
AMDU	*Ambrosia dumosa*
AMER	*Ambrosia eriocentra*
AMUT	*Amelanchier utahensis* (*sensu lato*)
AMFR	*Amphipappus fremontii fremontii*
AMTO	*Amsonia tomentosa*
ANCA	*Anemopsis californica*
ANSC	*Angelica scabrida*
ANRO	*Antennaria rosea*
ANSO	*Antennaria soliceps*
AQFO	*Aquilegia formosa*
ARPU5	*Arctostaphylos pungens*
ARMU	*Argemone munita*
ARPUP6	*Aristida purpurea purpurea*
ARBI	*Artemisia bigelovii*
ARDR	*Artemisia dracunculus*
ARMI	*Artemisia michauxiana*
ARNO	*Artemisia nova*
ARTR	*Artemisia tridentata*
ARTRT	*Artemisia tridentata tridentata*
ARTRW	*Artemisia tridentata wyomingensis*
ARDO	*Arundo donax*
ATCA	*Atriplex canescens*
ATCO	*Atriplex confertifolia*
ATHY	*Atriplex hymenelytra*
ATLE	*Atriplex lentiformis*
ATPO	*Atriplex polycarpa*
BASA	*Baccharis salicifolia*
BASE	*Baccharis sergiloides*
BAMU	*Baileya multiradiata*
BEJU	*Bebbia juncea aspera*
BOGR	*Bouteloua gracilis*
BOTR	*Bouteloua trifida*
BRTO	*Brassica tournefortii*
BRAT	*Brickellia atractyloides*
BRCA	*Brickellia californica*
BRGR	*Brickellia grandiflora*
BRIN	*Brickellia incana*
BRLO	*Brickellia longifolia*
BRMI	*Brickellia microphylla watsonii*
BROB	*Brickellia oblongifolia*
BRCI	*Bromus ciliatus*
BRMA	*Bromus rubens*
BRTE	*Bromus tectorum*
BUUT	*Buddleja utahensis*
CALA	*Calylophus lavandulifolius*
CANE	*Carex nebrascensis*
CAPR	*Carex praegracilis*
CARO	*Carex rossii*
CEGR	*Ceanothus greggii* (*sensu lato*)
CEMA	*Ceanothus martinii*
CERE	*Celtis laevigata reticulata*
CEOC	*Cercis orbiculata*
CEIN	*Cercocarpus intricatus*
CELE	*Cercocarpus ledifolius intercedens*
CHLI	*Chilopsis linearis arcuata*
CHGR	*Chrysothamnus gramineus*
CHVI	*Chrysothamnus viscidiflorus viscidiflorus* (*sensu lato*)
CIAR	*Cirsium arizonicum*
CIEAC	*Cirsium clokeyi*
CLLI	*Clematis ligusticifolia*
CORA	*Coleogyne ramosissima*
COUM	*Comandra umbellata pallida*
CUSA	*Cuscuta salina*
CYAC	*Cylindropuntia acanthocarpa*
CYBI	*Cylindropuntia bigelovii*

Table1-1. Complete list of species symbols and abbreviations used in the data sets.—Continued

[**Abbreviations**: NRCS, Natural Resources Conservation Service; USDA, U.S. Department of Agriculture]

Stand name symbol for vegetation species	USDA/NRCS species name ([1]U.S. Department of Agriculture, 2013)	Stand name symbol for vegetation species	USDA/NRCS species name ([1]U.S. Department of Agriculture, 2013)
CYEC	*Cylindropuntia echinocarpa*	FRVE	*Fraxinus velutina*
CYRA	*Cylindropuntia ramosissima*	GAST	*Galium stellatum eremicum*
CYWH	*Cylindropuntia whipplei*	GAFL	*Garrya flavescens*
DASE	*Dalea searlsiae*	GACO	*Gaura coccinea*
DAPU	*Dasyochloa pulchella*	GLSP	*Glossopetalon spinescens aridum*
DISP	*Distichlis spicata*	GRSP	*Grayia spinosa*
DORE	*Dodecatheon redolens*	GUMI	*Gutierrezia microcephala*
DRCU	*Draba cuneifolia*	GUSA	*Gutierrezia sarothrae*
ECPO	*Echinocactus polycephalus*	HESH	*Hecastocleis shockleyi*
ECEN	*Echinocereus engelmannii* (*sensu lato*)	HEMU	*Heliomeris multiflora*
ELAN	*Elaeagnus angustifolia*	HECO	*Hesperostipa comata*
ELRO	*Eleocharis rostellata*	HERU	*Heuchera rubescens alpicola*
ELEL	*Elymus elymoides* (*sensu lato*)	HODU	*Holodiscus dumosus*
ELTR	*Elymus trachycaulus*	HYSA	*Hymenoclea salsola*
ENFA	*Encelia farinosa*	HYCO	*Hymenoxys cooperi*
ENVI	*Encelia virginensis*	ISAC	*Isocoma acradenia eremophila*
EPFA	*Ephedra fasciculata*	IVJA	*Ivesia jaegeri*
EPNE	*Ephedra nevadensis*	JAAM	*Jamesia americana rosea*
EPTO	*Ephedra torreyana*	JUBA	*Juncus balticus*
EPVI	*Ephedra viridis*	JUCA	*Juniperus californica*
ERCO40	*Ericameria compacta*	JUCO	*Juniperus communis depressa*
ERCO23	*Ericameria cooperi*	JUOS	*Juniperus osteosperma*
ERDI	*Ericameria discoidea discoidea*	JUSC	*Juniperus scopulorum*
ERLI	*Ericameria linearifolia*	KRER	*Krameria erecta*
ERNA7	*Ericameria nana*	KRGR	*Krameria grayi*
ERNAH	*Ericameria nauseosa hololeuca*	KRLA	*Krascheninnikovia lanata*
ERNAL	*Ericameria nauseosa leiosperma*	LATR	*Larrea tridentata*
ERNAM	*Ericameria nauseosa mojavensis*	LEFR	*Lepidium fremontii*
ERNAS	*Ericameria nauseosa speciosa*	LELA	*Lepidium lasiocarpum*
ERPA	*Ericameria paniculata*	LINU	*Leptosiphon nuttallii pubescens*
ERPAN	*Ericameria parryi nevadensis*	LILE	*Linum lewisii*
ERCL	*Erigeron clokeyi clokeyi*	LUAR	*Lupinus argenteus*
ERAN	*Eriodictyon angustifolium*	LYAN	*Lycium andersonii*
ERFA	*Eriogonum fasciculatum polifolium*	LYCO	*Lycium cooperi*
ERHEA	*Eriogonum heermannii argense*	LYSH	*Lycium shockleyi*
ERHEC	*Eriogonum heermannii clokeyi*	MAFR	*Mahonia fremontii*
ERHES	*Eriogonum heermannii sulcatum*	MAHA	*Mahonia haematocarpa*
ERIN	*Eriogonum inflatum*	MARE	*Mahonia repens*
ERPU	*Eriogonum pusillum*	MAST	*Maianthemum stellatum*
ERTR	*Eriogonum trichopes*	MEOF	*Melilotus officinalis*
ERUMJ	*Eriogonum umbellatum juniporinum*	MESP	*Menodora spinescens*
ERWR	*Eriogonum wrightii membranaceum*	MELA	*Mentzelia laevicaulis*
ERCI	*Erodium cicutarium*	MOUT	*Mortonia utahensis*
EUUR	*Eucnide urens*	MUAS	*Muhlenbergia asperifolia*
FAPA	*Fallugia paradoxa*	MUPO	*Muhlenbergia porterii*
FEUT	*Fendlerella utahensis*	MUTH	*Muhlenbergia thurberi*
FECY	*Ferocactus cylindraceus* (*sensu lato*)	NIAT	*Nicotiana attenuata*
RHBE	*Frangula betulifolia obovata*	NOBI	*Nolina bigelovii*
RHTO	*Frangula californica ursina*	OECAC	*Oenothera caespitosa crinita*
FRAN	*Fraxinus anomala*	OPBA	*Opuntia basilaris*

Table 1-1. Complete list of species symbols and abbreviations used in the data sets.—Continued

[**Abbreviations**: NRCS, Natural Resources Conservation Service; USDA, U.S. Department of Agriculture]

Stand name symbol for vegetation species	USDA/NRCS species name ([1]U.S. Department of Agriculture, 2013)	Stand name symbol for vegetation species	USDA/NRCS species name ([1]U.S. Department of Agriculture, 2013)
OPPH	*Opuntia phaeacantha*	QUTU	*Quercus turbinella*
OPPOE	*Opuntia polyacantha erinacea*	RHTR	*Rhus trilobata anisophylla*
OPPOH	*Opuntia polyacantha hystricina*	RICE	*Ribes cereum*
PESEC	*Pedicularis semibarbata charlestonensis*	RIMO	*Ribes montigenum*
PEPA8	*Penstemon palmeri*	ROWO	*Rosa woodsii ultramontana*
PERA	*Peraphyllum ramosissimum*	RULE	*Rubus leucodermis*
PEGR	*Perityle gracilis*	SAME	*Salazaria mexicana*
PEIN	*Perityle intricata*	SAEX	*Salix exigua*
PENI	*Petalonyx nitidus*	SAGO	*Salix gooddingii*
PEPA13	*Petalonyx parryi*	SALA	*Salix lasiolepis*
PEPU	*Petradoria pumila*	SAPA	*Salsola paulsenii*
PECA	*Petrophytum caespitosum*	SADOC	*Salvia dorrii clokeyi*
PESC	*Peucephyllum schottii*	SADO	*Salvia dorrii dorrii*
PHMI	*Philadelphus microphyllus*	SANIC5	*Sambucus nigra cerulea*
PHCA	*Phoradendron californicum*	SAVE	*Sarcobatus vermiculatus*
PHAU	*Phragmites australis*	SCAR	*Schismus arabicus*
PHAL	*Physocarpus alternans*	SCRI	*Scopulophila rixfordii*
PIDE	*Picrothamnus desertorum*	SESP	*Senecio spartioides*
PICA	*Pinus californianum*	SEAR	*Senna armata*
PIFL	*Pinus flexilis*	SIRA	*Sisyrinchium radicatum*
PILO	*Pinus longaeva*	SOSP	*Solidago spectabilis*
PIMO	*Pinus monophylla*	SPAM	*Sphaeralcea ambigua* (*sensu lato*)
PIPO	*Pinus ponderosa scopulorum*	SPAN	*Sphaeralcea angustifolia*
PIMI	*Piptatheropsis micranthum*	SPGR	*Sphaeralcea grossulariifolia pedata*
PLJA	*Pleuraphis jamesii*	SPAI	*Sporobolus airoides*
PLRI	*Pleuraphis rigida*	SPCR	*Sporobolus cryptandrus*
PLPL	*Pleurocoronis pluriseta*	STEL	*Stanleya elata*
PLSE	*Pluchea sericea*	STPI	*Stanleya pinnata*
POCO	*Poa compressa*	STPA	*Stephanomeria parryi*
POFE	*Poa fendleriana*	SUMO	*Suaeda moquinii*
POPR	*Poa pratensis*	SYLO	*Symphoriocarpos longiflorus*
POSE	*Poa secunda*	SYOR	*Symphoriocarpos oreophilus parishii*
POMA	*Polygala macradenia*	TARA	*Tamarix ramosissima*
POAN	*Populus angustifolia*	TEAX	*Tetradymia axillaris* (*sensu lato*)
POFR	*Populus fremontii*	TECA	*Tetradymia canescens*
POTR	*Populus tremuloides*	THMO	*Thamnosma montana*
POGR	*Porophyllum gracile*	TICA	*Tiquilia canescens*
POCR	*Potentilla crinita*	TRMU	*Tridens muticus*
PRGL	*Prosopis glandulosa torreyana*	TYDO	*Typha domingensis*
PRPU	*Prosopis pubescens*	ULPU	*Ulmus pumila*
PRFA	*Prunus fasciculata*	VAAC	*Valeriana acutiloba pubicarpa*
PSSP	*Pseudoroegneria spicata*	VIAR	*Vitis arizonica*
PSCO	*Psilostrophe cooperi*	YUBA	*Yucca baccata*
PSFR	*Psorothamnus fremontii*	YUBR	*Yucca brevifolia*
PSPO	*Psorothamnus polydenius*	YUEL	*Yucca elata*
PUGL	*Purshia glandulosa*	YUSC	*Yucca schidigera*
PUST	*Purshia stansburiana*	ZIOB	*Ziziphus obtusifolia*
QUGA	*Quercus gambelii*		

[1]U.S. Department of Agriculture, 2013, USDA/NRCS PLANTS Database: National Plant Data Team, Greensboro, NC 27401-4901 USA, accessed April 18, 2013, at *http://plants.usda.gov*.

Appendix 2. Field Samples Used for Feature Analyst Training in Each Study Area

Table 2-1. Field samples from Red Rock National Conservation Area used as training input for Feature Analyst automated feature extraction models.

[Source: Charlet, D.A., Leary, P.J., and Damar, N.A., 2014, Vegetation database for land-cover mapping, Clark and Lincoln Counties, Nevada: U.S. Geological Survey, Data Series 827, 17 p., *http://dx.doi.org/10.3133/ds827*: Sample ID, Unique number used to identify sample in field sample database; Stand name, Descriptor for sample based on dominant species in each canopy layer.]

Sample ID	Stand name
5003	LATR/ATCO
5008	ATPO_IF
5024	LATR/AMDU-ATCO_DP
5025	ATCA_D
5026	ATCO-LEFR
5029	ATPO_IF
5030	ATCA-ATPO_IF
5048	YUBR/YUSC/LATR-KRER-AMDU
5053	SUMO/ATCO_IF
5074	YUSC/MESP-CORA
5076	LATR/CORA/BRMA
5077	YUSC/CORA
5078	SV_IF
5084	ATCA
5091	PLRI
5097	YUSC/LATR/AMDU
5101	ATCO/AMDU_DP
5102	SV_PN_DP
5109	SPAI_IF
5111	EPTO/CORA
5117	LATR/AMDU/PLRI
5125	LATR/AMDU-KRER
5136	LATR/HYSA/PSFR_IF
5141	YUSC/LATR/CORA
5147	LATR/AMDU
5160	PLRI
5164	ATCA/EPVI
5188	PIMO/JUOS/QUTU/GAFL
5190	LATR/AMDU-EPTO
5202	PIMO/FAPA/ARTR
5203	YUBR/YUSC/CORA
5206	PIMO/CHLI/QUTU_IF
5207	SALA/CEOC/RHBE_TF
5208	PIPO/CERE/QUTU_TF
5212	QUTU/PRFA/ARTRT_IF
5221	CORA
5222	YUBA/ACSP12-ACHY
5224	SV_G_B
5225	ELRO_S
5236	QUGA_TF
5237	CORA
5245	JUOS-PIMO/PUST/ARNO
5253	ARNO
5256	YUSC/LATR/AMDU
5258	ATCA/CORA
5265	ELRO-SOSP_S
5268	JUOS/PIMO
5273	JUOS
5279	JUOS-PIMO/GLSP-CORA
5280	JUOS-PIMO/CORA
5292	BASE_IF
5295	PUST/ARTR
5296	QUGA_TF

Table 2-2. Field samples from Mormon Mesa Area of Critical Environmental Concern used as training input for Feature Analyst automated feature extraction models.

[Source: Charlet, D.A., Leary, P.J., and Damar, N.A., 2014, Vegetation database for land-cover mapping, Clark and Lincoln Counties, Nevada: U.S. Geological Survey, Data Series 827, 17 p., *http://dx.doi.org/10.3133/ds827*: Sample ID, Unique number used to identify sample in field sample database; Stand name, Descriptor for sample based on dominant species in each canopy layer.]

Sample ID	Stand name
1358	LATR/AMDU
1360	YUSC/LATR/AMDU-KRER
1490	LATR/AMDU
1498	LATR/PLRI
1842	LATR/AMDU
1842	LATR/AMDU
1843	LATR/AMDU
1851	LATR/AMDU
1852	LATR/AMDU
1853	LATR/AMDU
1853	LATR/AMDU
1857	LATR/AMDU
1859	LATR/AMDU
1864	LATR
1865	LATR
1871	FECY/OPPOE-AMDU_LB
1874	YUBR/LATR/AMDU
1875	YUBR/LATR/AMDU
1877	YUBR/LATR/AMDU
1883	PRFA/ERFA-SADO_IF
1890	LATR/AMDU
1893	YUBR/LATR/AMDU
1894	LATR-CYAC/AMDU
1896	YUBR/LATR
1900	YUBR/LATR/AMDU
1903	LATR
1905	YUBR/LATR/AMDU
1911	CHLI/ERPA/HYSA_IF
1923	YUBR/LATR/AMDU
1926	LATR-ERPA-PSFR/HYSA-AMDU_IF
1928	AMDU-LATR
1930	LATR/AMDU
1931	LATR/AMDU-EPTO
1935	ERPA_IF
1936	LATR/AMDU/ACHY-PLRI
1937	LATR/AMDU-EPTO
1938	LATR/AMDU
1940	LATR/AMDU
1941	LATR/AMDU
1942	LATR/AMDU
1944	YUSC/LATR/AMDU
1945	YUSC/LATR/AMDU
2113	YUBR/LATR/AMDU
2114	LATR-MOUT/LYAN_ERFA_LB
2115	FECY/ENFA_LB
2122	YUSC/LATR/AMDU
2125	ACGR-YUSC/HYSA-AMDU_IF
2126	LATR/AMDU-KRER
2126	LATR/AMDU/KRER
2127	LATR/AMDU
2128	PRFA-PSFR/ENVI/GUMI_IF
2130	PRFA/ENVI-SADO_IF
2132	YUBR/YUSC/LATR/AMDU-LYAN
2133	LATR/AMDU
2135	LATR-FECY_LB
2136	YUSC/LATR_KRGR/AMDU_DP
2137	LATR-YUSC/AMDU_DP
2443	YUSC/LATR/AMDU
2559	LATR/AMDU
2560	LATR/AMDU
2563	ACGR/LATR-KRGR-LYCO/AMDU_IF
2564	ATCA/SPAN
2566	TARA_TF
2567	TARA-LATR-PRGL/ATPO_TF
2568	LATR/AMDU/PLRI
2569	LATR/AMDU_SV_DP
2570	LATR/KRGR/AMDU
2570	LATR/KRGR/AMDU
2571	LATR_VB
2572	YUSC/LATR/AMDU-KRGR_DP
2573	YUSC/LATR-BEJU/AMDU_IF
2574	ACGR/BEJU-KRGR/HYSA_IF
2575	LATR
2576	LATR/AMDU-CYRA
2580	LATR
2581	LATR/AMDU
2582	CHLI/ACGR/LATR-LYCO/AMDU_IF
2583	YUSC/LATR/AMDU-KRGR_DP
2584	YUSC/AMDU-KRGR/TICA_LB
2585	ACGR-YUSC/AMDU-KRGR_IF
2586	YUSC/FECY/KRGR-AMDU_LB
2587	YUSC/LATR/AMDU-AMFR
2589	YUSC/LATR/AMDU_DP
2589	YUSC/LATR/AMDU_DP
2653	ACGR/BEJU/HYSA_IF
2654	BRLO_IF
2655	YUSC/LATR/AMDU_DP
2659	LATR/AMDU-LEFR/PLRI_TS
2661	FECY/SCRI-PLPL_LB
2663	LATR/AMDU
2908	YUBR/YUSC/LATR/AMDU-AMFR
2908	YUBR/YUSC/LATR/AMDU-AMFR
2910	YUSC/LATR-ENVI/AMDU_IF
2912	YUSC/LATR/AMDU-KRGR-ENVI_IF
2913	YUSC/LATR/AMDU_DP
2915	YUSC/LATR/KRGR/ERIN
2916	YUSC/LATR/AMDU-KRER/ERIN

Table 2-3. Field samples from Coyote Springs Area of Critical Environmental Concern used as training input for Feature Analyst automated feature extraction models.

[Source: Charlet, D.A., Leary, P.J., and Damar, N.A., 2014, Vegetation database for land-cover mapping, Clark and Lincoln Counties, Nevada: U.S. Geological Survey, Data Series 827, 17 p., *http://dx.doi.org/10.3133/ds827*: Sample ID, Unique number used to identify sample in field sample database; Stand name, Descriptor for sample based on dominant species in each canopy layer.]

Sample ID	Stand name
338	LATR/AMDU
341	LATR/AMDU/ERTR
343	YUSC/LATR/AMDU/PLRI
345	YUSC/LATR-PSFR/AMDU-KRER
346	YUSC/LATR-PSFR/AMDU-ACSH
347	YUSC/LATR-PSFR/AMDU
347	YUSC/LATR-PSFR/AMDU
1361	YUSC/LATR-PSFR/KRER-AMDU
1363	YUSC/LATR/KRER-OPPOE
1364	AMDU
1365	CHLI/CHVI_IF
1365	CHLI/CHVI_IF
1394	LATR/AMDU
1395	YUSC/LATR-AMDU
1396	AMDU/BAMU-SPAM
1398	LATR/LYAN-ATCA
1407	PRGL/ATCA_SF
1527	LATR/AMDU
1529	LATR/AMDU
1532	YUBR/LATR-YUSC/AMDU/PLRI
2140	LATR
2151	YUSC/PRFA-MOUT/BUUT-SADO_LB
2490	LATR/AMDU

Table 2-4. Field samples from Piute-Eldorado Valley Area of Critical Environmental Concern used as training input for Feature Analyst automated feature extraction models.

[Source: Charlet, D.A., Leary, P.J., and Damar, N.A., 2014, Vegetation database for land-cover mapping, Clark and Lincoln Counties, Nevada: U.S. Geological Survey, Data Series 827, 17 p., *http://dx.doi.org/10.3133/ds827*: Sample ID, Unique number used to identify sample in field sample database; Stand name, Descriptor for sample based on dominant species in each canopy layer.]

Sample ID	Stand name
168	LATR/AMDU
178	YUBR/LATR/CORA
179	YUBR/YUSC/LATR/CORA
185	YUSC/LATR/ACSPS2
187	YUSC/LATR/EPTO/ACSPS2-AMDU
188	YUSC/LATR/AMDU
194	LATR/AMDU
197	LATR/AMDU-SEAR
240	CHLI/ACGR/PHCA/HYSA-SEAR_IF
249	LATR/AMDU
250	LATR/AMDU
250	LATR/AMDU
253	ACGR/PHCA/HYSA-SEAR_IF
258	ACGR/PHCA_IF
276	YUSC/LATR
292	ACGR/PHCA/ERPA-BRIN_IF
297	YUBR/LATR/AMDU
309	ACGR/HYSA-ERPA-AMER
310	YUBR/YUSC-YUBA/ACSPS2/PLRI
311	YUBR/YUSC/PLRI-GUMI
328	CHLI/ACGR/ERPA-AMER_IF
330	YUSC/LATR/ERFA
332	YUSC/EPTO-LATR/PLRI
333	YUSC/LATR/ERFA-AMDU
1220	LATR/PLRI
1221	ERPA_IF
1222	LATR/PLRI
1225	LATR/AMDU
1226	YUSC/LATR/AMDU
1228	LATR/AMDU
1229	LATR/AMDU
1240	LATR/AMDU
1241	LATR/AMDU
1241	LATR/AMDU
1258	LATR/AMDU
1258	LATR/AMDU
1259	YUSC/LATR/HYSA-AMDU
1265	YUSC-NOBI/ERFA
1266	YUSC/LATR/AMDU
1271	LATR/CORA
1274	LATR/AMDU
1287	YUSC/LATR/ERFA
1791	LATR/AMDU
1828	YUSC/LATR-AMDU-ERFA
1964	LATR/SEAR/AMDU
1970	YUBR/LATR-YUSC/KRLA-KRER
1996	YUSC/LATR/AMDU
1998	YUSC/EPTO/ERFA-ERCO23
1999	ACGR/HYSA/ERFA_IF
2072	LATR-EPTO/AMDU
2073	ACGR/HYSA-EPTO/ERFA-SADO_IF
2088	EPNE/SPAM/DAPU-ARPUP6
2089	YUBR/LATR-YUSC-CYAC/CORA-YUBA-EPNE
2454	LATR-ACGR-YUSC/AMDU-ERFA
2631	PICA/YUBR/PUGL/CORA

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