SWReGAP Land Cover Mapping Methods Documentation

Functional Unit or Mapping Zone: NV4 (East Great Basin Mapping Unit)

Organization: Lockheed Martin Environmental Services Office in association with the U.S. Environmental Protection Agency – Landscape Ecology Branch

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1) Predictor layer preparation:

a) Image standardization:

Because of the insufficient number and quality of "dark objects" in the Nevada Landsat ETM+ imagery, a simple conversion of digital numbers to at-sensor reflectance was performed via the following equation:

$$\rho_{BandN} = \frac{\pi(L_{BandN} * Gain_{BandN} + Bias_{BandN}) * D^2}{E_{BandN} * (COS((90 - \theta) * \pi / 180))}$$

Where,

ρ_{BandN} = Reflectance for Band N

L_{bandN} = Digital Number for Band N

D = Normalized Earth-Sun Distance

E_{bandN} = Solar Irradiance for Band N

b) Image dates and mosaicking:

Images were mosiacked using ERDAS Imagine 8.6 Mosiac Tool with "no cutline" for *type*, and the "overlay" option for *overlap function*.

Image dates and scenes were as follows:

ETM+ Scene (path/row)	Summer (yr – Julian date)	Fall (yr – Julian date)
38/34	2000 – 165	1999 - 306
39/31	2000 - 172	1999 – 297
39/32	2000 - 156	1999 – 281
39/33	2000 - 172	1999 - 281
39/34	2000 - 188	NO SCENE AVAILABLE
40/31	1999 - 192	1999 – 288
40/32	2000 - 195	1999 - 272
40/33	2000 - 227	1999 - 288
40/34	2000 - 163	1999 - 288
41/31	2000 - 202	1999 - 247
41/32	2000 - 202	1999 - 247
41/33	2000 - 202	1999 - 282
42/31	2000 - 209	1999 - 270
42/32	2000 - 209	1999 - 254
42/33	2000 - 209	1999 - 270

Spring scenes were not used due to the abundance of snow across a significant portion of the scenes. This snow rendered the spring imagery unsuitable for land cover modeling purposes.

Two coverages (summer and fall mosaics) showing overlap arrangement, date, and path/row can be found at:

/nv/archive/nv24/mosaic/mosaics.zip – nv4_summer_mosaic.shp
/nv/archive/nv24/mosaic/mosaics.zip – nv4_fall_mosaic.shp

The six-band ETM+ mosaics can be found in:

/nv/archive/nv24/mosaic/nv24_summer.zip – nv24_summer.img
/nv/archive/nv24/mosaic/nv24_fall.zip – nv24_fall.img

c) Image derived datasets:

Landsat 7 ETM+ (Reflectance values): Once the digital numbers of the Landsat mosaic were converted to reflectance values, these "raw" bands were incorporated into land cover models. These images are labeled as *nv4_summer* and *nv4_fall*.

Tasseled Cap: Bright-ness, green-ness, and wet-ness band transformations were created for the summer and fall mosaics using coefficients derived from the Landsat 7 ETM+ sensor, by Huang et al. (2001b). An example of the *.gmd file can be found at: /nv/archive/nv24/img_files/. These images are labeled as *nv4_sum_tcap* and *nv4_fall_tcap*.

Multi-temporal Kauth-Thomas Transformation: "Stable" and "change" components of bright-ness, green-ness, and wet-ness were created from the Tasseled Cap transformations of the summer and fall mosaics by using the transformation coefficients of Collins and Woodcock (1996). The first three bands of this image represent stable elements of bright-

ness, green-ness, and wet-ness, while the second three bands represent "change" elements of bright-ness, green-ness, and wet-ness. An example of the *.gmd file can be found at: /nv/archive/nv24/img_files/. This image is labeled as *nv4_mtk*.

Fractional Vegetation: The percent of ground covered by photosynthetic vegetation was estimated by the equation of Carlson and Ripley (1997). Reference values used in the equation were identified by examination of NDVI histograms and locating known sites of bare soil and irrigated agricultural fields. An example of the *.gmd file can be found at: /nv/archive/nv24/img_files/. These images are labeled as *nv4_sum_fr* and *nv4_fall_fr*.

All image-derived datasets and corresponding *.gmd models can be found in:

/nv/archive/nv24/img_files/images1.zip
/nv/archive/nv24/img_files/images2.zip
/nv/archive/nv24/img_files/images3.zip

d) DEM derived datasets:

Aspect: The aspect image was derived from the original elevation grid via the *aspect* algorithm in the *topographic analysis* menu of ERDAS Imagine. Aspect values range from 0 to 361, where 361 indicates flat terrain. This image is labeled as *nv4_asp*.

Southwest-ness: Since tree models are sometimes confounded by circular variables (i.e. aspect), the aspect image was converted to a linear "southwest-ness" image. Values range from -1 (indicating northeast-facing slopes) to +1 (indicating southwest-facing slopes). An example of the *.gmd file can be found at: /nv/archive/nv24/img_files/. This image is labeled as *nv4_swness*.

Elevation: The elevation image was created by importing the original elevation grid to an ERDAS Imagine file format. This image is labeled as *nv4_elev*.

Slope: The slope image was produced from the original elevation grid via the *slope* algorithm in the *topographic analysis* menu of ERDAS Imagine. The units of the slope image are degrees and range from 0 to 90. This image is labeled as *nv4_slope*.

Landform: A 10-class landform was created from a topographic relative moisture (values ranging from 0-28) index grid (Manis et al. 2001). This image is labeled as *nv4_landf*.

For modeling purposes, all ARCINFO grids were converted to ERDAS Imagine .img files, and can be found at:

/nv/archive/nv24/img_files/images1.zip
/nv/archive/nv24/img_files/images2.zip
/nv/archive/nv24/img_files/images3.zip

2) Samples:

a) Sample collection methods:

All training site data was collected by Eastern Nevada Landscape Coalition (ENLC) field crews during the summer and fall of 2003 by the protocols described in the "Field Methodologies and Training Manual for Nevada Field Crews" (see http://www.epa.gov/nerlesd1/land-

sci/pdf/training-manual.pdf for further details). Based on the floristic composition and ecological setting, each training site was assigned an *Alliance* and *Ecological System* label (Comer et. al. 2003).

NV090403BB02: Identifies a training site collected by an ENLC field crew. The site identification indicates it was sampled on September 4, 2003 by Brian Brost.

No other training data sources were available for the NV4 mapping unit.

b) Summary of samples:

A total of 5,985 training sites were collected in the NV4 mapping unit. A polygon coverage containing all training site locations and their ecological system labels are found at:

/nv/archive/nv4/train_data/shapefiles.zip – nv4_sites.shp

S Code	# Samples	Ecological System Label
D02	3	Recently Burned
D04	4	Invasive Southwest Riparian Woodlands and Shrublands
D06	64	Invasive Perennial Grasslands
D08	81	Invasive Annual Grassland
D09	104	Invasive Annual and Biennial Forblands
N11	20	Open Water
N31	26	Barren
N81	36	Pasture/Hay Irrigated Agriculture
N82	1	Cultivated Crops – Irrigated Agriculture
S002	10	Rocky Mountains Alpine Bedrock and Scree
S004	3	Rocky Mountains Alpine Fell Fields
S009	86	Inter-Mountain Basins Cliff and Canyon
S011	1	Inter-Mountain Basins Shale Badlands
S013	1	Inter-Mountain Basins Volcanic Rock and Cinder Lands
S014	25	Inter-Mountain Basins Greasewood Wash
S015	22	Inter-Mountain Basins Playa
S020	18	North American Warm Desert Wash
S023	41	Rocky Mountain Aspen Forest and Woodlands
S026	35	Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodlands
S028	7	Rocky Mountains Subalpine Dry-Mesic Spruce-Fir Forest and Woodlands
S030	12	Rocky Mountains Subalpine Mesic Spruce-Fir Forest and Woodlands
S032	7	Rocky Mountains Montane Dry-Mesic Mixed Conifer Forest and Woodlands
S034	26	Rocky Mountains Montane Mesic Mixed Conifer Forest and Woodlands
S036	5	Rocky Mountains Ponderosa Pine Woodlands
S039	1	Colorado Plateau Pinyon-Juniper Woodlands
S040	860	Great Basin Pinyon-Juniper Woodlands
S042	17	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodlands
S045	5	Inter-Mountain Basins Mat Saltbush Shrublands
S046	27	Rocky Mountains Gambel Oak- Mixed Montane Shrublands
S050	132	Inter-Mountain Basins Mountain Mahogany Woodland and Shrublands
S053	41	Great Basin Semi-Desert Chaparral
S054	1230	Inter-Mountain Basins Big Sagebrush Shrublands

S055	1002	Great Basin Xeric Mixed Sagebrush Shrublands
S065	488	Inter-Mountain Basins Mixed Salt Desert Scrub
S069	17	Sonora-Mojave Creosote-White Bursage Desert Scrub
S071	399	Inter-Mountain Basins Montane Sagebrush Steppe
S078	84	Inter-Mountain Basins Big Sagebrush Steppe
S079	210	Inter-Mountain Basins Semi-Desert Shrub Steppe
S081	7	Rocky Mountains Dry Tundra
S083	1	Rocky Mountains Subalpine Mesic Meadow
S090	107	Inter-Mountain Basins Semi-Desert Grasslands
S090L	50	Inter-Mountain Basins Semi-Desert Grasslands – Ephemeral Wetlands
S091	8	Rocky Mountains Subalpine-Montane Riparian Shrublands
S092	25	Rocky Mountains Subalpine-Montane Riparian Woodlands
S096	208	Inter-Mountain Basins Greasewood Flats
S096L	61	Inter-Mountain Basins Greasewood Flats – *Distichilis spicata* Herbaceous
S100	53	North American Arid West Emergent Marsh
S102	6	Rock Mountain Alpine-Montane Wet Meadow
S118	181	Great Basin Foothill Lower Montane Riparian Woodland and Shrublands
TOTAL	**5985**	

3) Cover types:

a) Classification Tree modeled cover types:

The following cover type were modeled via the EROS Data Center's CART Module for ERDAS Imagine:

S Code	Ecological System Name
D04	Invasive Southwest Riparian Woodlands and Shrublands
D06	Invasive Perennial Grasslands
D08	Invasive Annual Grasslands
D09	Invasive Annual and Biennial Forblands
N31	Barren
S002	Rocky Mountains Alpine Bedrock and Scree
S004	Rocky Mountains Alpine Fell Fields
S009	Inter-Mountain Basins Cliff and Canyons
S014	Inter-Mountain Basins Greasewood Wash
S015	Inter-Mountain Basins Playa
S016	North American Warm Desert Bedrock, Cliff, and Outcrop
S019	North American Warm Desert Volcanic Rocklands
S020	North American Warm Desert Wash
S022	North American Warm Desert Playa
S023	Rocky Mountain Aspen Forest and Woodlands
S026	Inter-Mountain Basins Subalpine Limber-Bristlecone Forest and Woodlands
S028	Rocky Mountains Dry-Mesic Spruce-Fir Forests and Woodlands
S030	Rocky Mountains Mesic Spruce-Fir Forests and Woodlands
S032	Rocky Mountains Dry-Mesic Mixed Conifer Forests and Woodlands
S034	Rocky Mountains Mesic Mixed Conifer Forests and Woodlands
S036	Rocky Mountains Ponderosa Pine Woodlands
S040	Great Basin Pinyon-Juniper Woodlands
S042	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodlands
S046	Rocky Mountains Gambel Oak-Mixed Montane Shrublands
S050	Inter-Mountain Basins Mountain Mahogany Woodland and Shrublands
S053	Great Basin Semi-Desert Chaparral

S054	Inter-Mountain Basins Big Sagebrush Shrublands
S055	Great Basin Xeric Mixed Sagebrush Shrublands
S060	Mojave Mid-Elevation Mixed Desert Scrub
S065	Inter-Mountain Basins Mixed Salt Desert Scrub
S069	Sonora-Mojave Creosote-White Bursage Desert Scrub
S070	Sonora-Mojave Desert Mixed Salt Desert Scrub
S071	Inter-Mountain Basins Montane Sagebrush Steppe
S078	Inter-Mountain Basins Big Sagebrush Steppe
S079	Inter-Mountain Basins Semi-Desert Shrub Steppe
S081	Rocky Mountains Dry Tundra
S090	Inter-Mountain Basins Semi-Desert Grasslands
S092	Rocky Mountains Subalpine-Montane Riparian Woodlands and Shrublands
S094	North American Warm Desert Lower Montane Riparian Woodlands and Shrublands
S096	Inter-Mountain Basins Greasewood Flats
S097	North American Warm Desert Riparian Woodlands and Shrublands
S100	North American Arid West Emergent Marsh
S102	Rock Mountain Alpine-Montane Wet Meadow
S118	Great Basin Foothill Lower Montane Riparian Woodland and Shrublands

The following ecological systems were withheld from the modeling process due to insufficient sample size: INTER-MOUNTAIN BASINS SHALE BADLANDS (S011), INTER-MOUNTAIN BASINS VOLCANIC ROCK AND CINDERLANDS (S013), COLORADO PLATEAU PINYON-JUNIPER WOODLANDS (S039), INTER-MOUNTAIN BASINS MAT SALTBUSH SHRUBLANDS (S045), and ROCKY MOUNTAINS SUBALPINE MESIC MEADOW (S083).

b) Non CT modeled cover types:

The PASTURE/HAY IRRIGATED AGRICULTURE (S Code – N81) was screen digitized using Landsat ETM+ imagery at a scale of 1:24,000 and 1:100,000. PASTURE/HAY IRRIGATED AGRICULTURE is given the value “2” in this image.

The OPEN WATER (S Code - N11) cover type was mapped by a presence/absence model in which Open Water training sites were labeled as “1” while all other training sites were labeled as “0.” A model was executed with the Image CART Module using the reflectance and topographic variables. The output was compared against the summer Landsat imagery to remove minor errors. OPEN WATER is given the value “2” in this image.

The DEVELOPED, LOW INTENSITY (S code – N21) and DEVELOPED, MED-HIGH INTENSITY (S code – N22) was developed by sub-setting the urbanized regions from a fractional vegetation layer, and performing a density slice of the fractional vegetation values to differentiate the two urban classes from natural vegetation. Within the nv24_urban.img file, DEVELOPED, LOW INTENSITY was labeled as “2” and DEVELOPED, MED-HIGH INTENSITY was labeled as ”3.”

The RECENTLY MINED OR QUARRIED (S Code – D03) was screen digitized using Landsat ETM+ imagery at a scale of 1:24,000 and 1:100,000. RECENTLY MINED OR QUARRIED is given the value “2” in this image.

The RECENTLY BURNED (S Code - D02) cover type was mapped by performing an unsupervised classification of Landsat imagery that was subsequently subjected to a density slice to identify those areas scarred by fire. RECENTLY BURNED is given the value “2” in this image.

The image files depicting these non-modeled classes are found in: /nv/archive/nv241/non_model/nv4_non_model.zip – nv24_agriculture.img

/nv/archive/nv24/non_model/nv4_non_model.zip - nv24_burns.img
/nv/archive/nv24/non_model/nv4_non_model.zip - nv24_water.img
/nv/archive/nv24/non_model/nv4_non_model.zip - nv24_urban.img
/nv/archive/nv24/non_model/nv4_non_model.zip - nv24_mines.img

4) Summary of predictor layers used:

a) Multi band predictors:

nv4_summer.img	(ETM+ bands 1-5 & 7 - mixed 1999 & 2000 images)
nv4_fall.img	(ETM+ bands 1-5 & 7 - mixed 1999 & 2000 images)
nv4_mtk.img	(bands 1-3 = stable brightness, greenness, wetness; bands 4-6 = change brightness, greenness, wetness)
nv3_sum_tcap.img	(summer brightness, greenness, wetness)
nv3_fall_tcap.img	(fall brightness, greenness, wetness)
nv1_sum_tcap.img	(summer brightness, greenness, wetness)
nv4_sum_tcap.img	(summer brightness, greenness, wetness)
nv4_fall_tcap.img	(fall brightness, greenness, wetness)

All single- and multi-band predictors can be found at:
/nv/archive/nv24/img_files/images1.zip
/nv/archive/nv24/img_files/images2.zip
/nv/archive/nv24/img_files/images2.zip

b) Single band predictors:

nv4_slope.img	Continuous slope (units = degrees)
nv4_swness.img	Linear, continuous transformation of aspect
nv4_elev.img	Continuous elevation (units = meters)
nv4_sum_fr.img	Continuous fractional vegetation
nv4_fall_fr.img	Continuous fractional vegetation
nv4_landf.img	Categorical 10 class landform (from DEM)

5) Modeling Methods:

a) See5 Classification Tree modeling:

Training Data Sets: Once training site polygons were attributed with an ecological system label, 20% of the training sites for each land cover class were withheld for an accuracy assessment. Thus, two training data sets were produced:

1) An *80% training data set* used to produce a "preliminary" land cover maps (and subjected to an accuracy assessment)
2) A *total data set* used to create a "final" land cover map.

Data Set Generation: Twenty points were randomly located within each of the training site polygons of the *80%* and *total data sets* using the Random Points extension for ArcView. The two sets of random points were converted to ARCINFO grids and then to Imagine *.img files. Each Imagine pixel was attributed with the appropriate ecological system code. The *80% data set* contained 4,793 training site polygons that were converted by the process described above into 56,735 pixels for use in creating the "preliminary" land cover map via the CART modeling process. The *total data set* contained 5,985 training site polygons that were converted into 71,292 pixels for production of the "final" land cover map via the CART modeling process.

Sample pixels were "drilled" through each of the predictor data layers to produce a data set containing both predictor (imagery and DEM-derived) variables and the response variable (ecological system label code) using the *CART Sampling Tool* of the CART Module (EarthSatellite Corporation 2003). For both the *80%* and *total* data sets, 16 CART training data sets were prepared by the methodology described above

where each CART training data set was composed of different numbers and sets of predictor variables. The training data sets developed the NV4 mapping unit are described below:

Model #	Model Name	# of Variables	Variable Labels
1	Sum	6	Summer
2	Fall	6	Fall
3	Mtk	6	Multi-temporal Kauth-Thomas
4	Topo	4	Slope, Southwest-ness, Elevation, Landform
5	Sftcap	6	Summer and Fall Tasseled Cap
6	Sum_ses	9	Summer, Slope, Southwest-ness, Elevation
7	Fall_ses	9	Fall, Slope, Southwest-ness, Elevation
8	Mtk_ses	9	Multi-temporal Kauth-Thomas, Fall, Slope, Southwest-ness, Elevation
9	Sffr_ses	5	Summer and Fall Fractional Vegetation, Southwest-ness, Elevation
10	Sum_ftcap_l	10	Summer, Fall Tasseled Cap, Landform
11	Fall_stcap_l	10	Fall, Summer Tasseled Cap, Landform
12	Sum_mtk_ffr_s	14	Summer, Multi-temporal Kauth-Thomas, Fall Fractional Vegetation, Slope
13	Fall_mtk_sfr_e	14	Fall, Multi-temporal Kauth-Thomas, Summer Fractional Vegetation, Elevation
14	Sum_fall_ses	14	Summer, Fall, Slope, Southwest-ness, Elevation
15	Sum_fall_mtk	18	Summer, Fall, Multi-temporal Kauth-Thomas
16	Full	29	Summer, Fall, Multi-temporal Kauth-Thomas, Summer and Fall Tasseled Cap, Summer and Fall Fractional Vegetation, Slope, Southwest-ness, Elevation

The output files from the CART Sampling Tool (*.names, *.data, *.test) are located in:

/nv/archive/nv24/output/80percent/see5_files.zip

Classification Tree Construction: See5 data mining software (Release 1.8, http://www.rulequest.com) was used to construct 16 tree classifiers for both the *80%* and *total* data sets. Boosting was employed using 15 trials for the construction of each tree classifier. The output files (*.out, *.names.hst, *.set) from tree classifier construction are found at:

/nv/archive/nv24/output/80percent/see5_files.zip

CART Classifier and Land Cover Map Creation: The *CART Classifier* of Imagine CART module was used to implement the tree classifier produced by the See5 software package and thus create a land cover map. A total of 16 land cover images were produced for the *80% data set*:

1) sum.img
2) fall.img
3) mtk.img
4) topo.img
5) tcap.img

6) sum_ses.img
7) fall_ses.img
8) mtk_ses.img
9) fall_stcap_1.img
10) sum_ftcap_1.img
11) sffr_ses.img
12) sum_fall_ses.img
13) sum_mtk_ffr_s.img
14) fall_mtk_sfr_e.img
15) sum_fall_mtk.img
16) full.img

The 16 output land cover maps are found at:

/nv/archive/nv24/output/80percent/nv4_input_maps.zip

These 16 images were stacked in a single .img file with 16 bands, each corresponding to one of the 16 land cover maps. The STACK MAJORITY function was then used to allow each land cover map to "vote" for the best ecological system label for every pixel. In other words, the 16 ecological system labels (one from each land cover map) for each pixel location are tallied, and the ecological system with the highest number of "votes" is entered into the output "preliminary" land cover map. The "pseudo-random forest" model (nv4_prf.gmd) and "preliminary" map resulting from this process (nv4_prf16.img) can be found at:

/nv/archive/nv1/output/80percent/nv4_input_maps.zip

This land cover classification, following the addition of non-modeled classes, was subjected to an accuracy assessment using the withheld data (1,192 reference sites).

b) Post-classification, recoding and other modeling steps:

Introduction: The post-classification models described below were used to differentiate ecological systems that possessed similar ecological and spectral characteristics. In these cases, species composition, and eco-regional location was not enough to distinguish between certain ecological systems especially when the systems share phenological and hydrological characteristics.

The models used are located at:

/nv/archive/nv24/post_model/s028_to_S030.gmd
/nv/archive/nv24/post_model/s030_to_S028.gmd
/nv/archive/nv24/post_model/s034_to_S032.gmd

Step 1: Discriminating S028-Rocky Mountains Subalpine Dry-Mesic Spruce-Fir Forests and Woodlands and S030-Rocky Mountains Subalpine Mesic Spruce-Fir Forests and Woodlands. The logic and parameters are as follows:

This model was used to differentiate S028-Rocky Mountains Subalpine Dry-Mesic Spruce-Fir Forests and Woodlands and S030-Rocky Mountains Subalpine Mesic Spruce-Fir Forests and Woodlands. NatureServe describes S030 to be "*typically found in location with cold air drainage or ponding, or where snow pack lingers late into the summer, such as north-facing slopes and higher elevation ravines. They can extend down in elevation below the subalpine zone in places where cold air ponding occurs; northerly and easterly aspects predominate. These forest are found on gentle to very steep mountain slopes, high elevation ridge tops and upper-slopes, plateau-like surfaces, basins, alluvial terraces, well-drained benches, and inactive stream terraces.*"

Model Methods: The preliminary models were run to include both ecological systems. A conditional statement was then applied to re-classify S030 pixels on drier, southerly facing slopes to S028, and a second conditional statement was used to re-classify S028 pixels on wetter, northerly-facing slopes to S030.

Model 1a: Either S028 (IF *Modeled Vegetation* = S030 AND ((ASPECT GT 45) AND (ASPECT LT 275)) OR *Modeled Vegetation* OTHERWISE

Model 1b: Either S030 (IF *Modeled Vegetation* = S028 AND ((ASPECT LE 45) OR (ASPECT GE 275)) OR *Modeled Vegetation* OTHERWISE

Step 2: Discriminating S034-Rocky Mountains Montane Dry-Mesic Mixed Conifer Forests and Woodlands and S032-Rocky Mountains Montane Mesic Mixed Conifer Forests and Woodlands. The logic and parameters are as follows:

This model was used to differentiate S034-Rocky Mountains Montane Dry-Mesic Mixed Conifer Forests and Woodlands and S032-Rocky Mountains Montane Mesic Mixed Conifer Forests and Woodlands. NatureServe describes S032 to occur "*in cool ravines and on north-facing slopes. Elevations range from 1200 to 3300 m. Occurrences of this system are found on cooler and more mesic sites than Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland. Such sites include lower and middle slopes of ravines, along stream terraces, moist, concave topographic positions and north- and east-facing slopes which burn somewhat infrequently.*"

Model Methods: The preliminary models were run to include only the S034-Rocky Mountains Montane Dry-Mesic Mixed Conifer Forests and Woodlands ecological systems. A conditional statement was applied to re-classify S034 pixels on moister, northerly facing slopes to S032.

Model 1a: Either S032 (IF *Modeled Vegetation* = S034 AND ((ASPECT LE 45) OR (ASPECT GE 275)) OR *Modeled Vegetation* OTHERWISE

Step 3: Recoding S096L-Inter-Mountain Basins Greasewood Flats - *Distichilis spicata* herbaceous pixels to S015-Inter-Mountain Basins Playa.

This was a simple operation that used the Raster-Recode function of ERDAS Imagine to recode those S096L-Inter-Mountain Basins Greasewood Flats - *Distichilis spicata* Herbaceous pixels to S015-Inter-Mountain Basins Playa.

Step 4: Upon inspection of the eco-regional transition between mapping units NV4 East Great Basin region) and NV5 (Mojave Desert region), it was decided that transition overly abrupt and did not reflect the gradual transition of vegetation types between these eco-regions. It was decided to smooth this abrupt transition through the use of a Great Basin-Mojave transition model.

While the training data set for the NV3 mapping unit included a small number of training sites from the north limit of the Mojave eco-region, it was insufficient to produce a gradual transition between the eco-regions. Therefore, a broad overlap region was delineated to include adequate sample numbers of both Great Basin and Mojave vegetation types. The overlap region polygon can be found at:

/nv/archive/gb_mjav_transition/trans_region.aoi

The overlap region included approximately 3600 training sites. The abbreviated database containing the training site attributes can be found at:

/nv/archive/gb_mjav_transition/transition_sites.mdb

The shapefile containing the training sites used to classify the Great Basin-Mojave transition is located at:

/nv/archive/gb_mjav_transition/transition_sites.shp

The overlap region polygon was also used to subset a number of predictor variables including summer and fall reflectance data, summer and fall Tasseled Cap variables, slope and elevation.

The predictor variables are located at:

/nv/archive/gb_mjav_transition/images/images1.zip

The 3600 transition training sites were then used to classify the vegetation of the transition via the EDC CART module. A single model was constructed using the predictor variables listed above. The See5 output files generated during the modeling process are found at:

/nv/archive/gb_mjav_transition/images/output.zip

The resulting preliminary land cover map for the Great Basin-Mojave Transition (gb_mjav_transition.img) is located at:

/nv/archive/gb_mjav_transition/images/images1.zip

The resulting land cover map for the transition region was used in conjunction with the preliminary land cover map for the NV3 mapping unit (prf15_v2.img) to generate an "agreement" map. This map depicts only those pixels that share the same ecological systems label in both the original NV3 preliminary map and transition maps. As expected, most of the pixels that were not retained ("disagreement" pixels that had conflicting ecological systems labels) were distributed along the southern border of the NV3 mapping unit.

To complete the process, a second model was created to retain the "agreement" pixel labels, and to then assign labels to "disagreement" pixels. A polygon was delineated that captured the highest density of "disagreement" pixels in the transition region between the Great Basin and the Mojave Desert eco-regions. This polygon is located at:

/nv/archive/gb_mjav_transition/transition_fill.aoi

It was decided the "disagreement" pixels to the north of the transition_fill.aoi polygon would be filled with labels from the original NV3 preliminary land cover map, "disagreement" pixels south of the transition_fill.aoi polygon would be filled with labels from the original NV5 (Mojave) land cover map, and "disagreement" pixels in the transition_fill.aoi polygon would receive labels from the Great Basin-Mojave Transition land cover map. The rationale was that pixels outside the area of disagreement would have a higher probability of being correctly modeled by the NV3 or NV5 land cover models since they are further away from the transition region. The region with the high density of "disagreement" pixels was filled with labels from the transition map since the transition land cover map was created with data from both eco-region's vegetation types, it should have a higher probability of being "correct" than the NV3 land cover map (whose training data contained very little Mojave vegetation types).

The resulting preliminary map (nv4_prelimnary_pixel.img) for the NV4 mapping unit is the result of this process.

c) Generalizing to MMU and map completion:

This final land cover map had non-modeled classes incorporated into it. This image was then subjected to the CLUMP function with 4 *connected neighbors*. This image then had the ELIMINATE algorithm run upon it to yield a land cover map generalized to the 2 hectare minimum mapping unit.

6) Validation:

a) CT model validation:

Twenty percent of the sample polygons were randomly selected and withheld from CT modeling. The preliminary CT models were run as described in section 5a using the remaining 80% of the training site data. The 20% withheld samples were used to ass the predictive capability of the CT modeled map via the kappa.avx extension for ArcView by intersecting the reference polygons through the CT modeled land cover map. This extension considers the site correctly mapped when the majority of pixels within the reference polygon agree with the reference label. Output from kappa.avx includes a *.txt, *.dbf, and *.shp file. The *.txt file contains the kappa statistic. The *.dbf file contains an error matrix indicating errors of omission and commission. The *.shp file contains the locations of the reference polygons whether the reference polygon was correct or incorrect, and the actual ecological systems label for the site. These files can be found at:

/nv/archive/nv24/validation

b) Final map:

A second set of 15 land cover images were produced for the *total data set*:

1) sum.img
2) fall.img
3) fall_mtk_topo.img
4) fall_stcap_topo.img
5) fall_topo.img
6) mtk.img
7) mtk_topo.img
8) sffr_topo.img
9) sftcap.img
10) sftcap_topo.img
11) sum_fall.img
12) sum_fall_sftcap.img
13) sum_ftcap_topo.img
14) sum_mtk_topo.img
15) sum_topo.img
16) topo.img

The 16 output land cover maps are found at:

/nv/archive/nv24/output/alldata/input_maps.zip

These 15 images were processed by the methods described above. The "pseudo-random forest" model (nv4_prf16.gmd) and "final" map resulting from this process (prf16_v1.img) can be found at:

/nv/archive/nv24/output/alldata/input_maps.zip

c) Discussion of mapped cover types: The following narrative provides qualitative assessments for each cover type mapped in the NV3 mapping unit. It is intended to elaborate on the quantitative results of the CT model validation from the perspective of those most familiar with the map and the mapping process and is hoped to be of value to potential map users.

N11 OPEN WATER: Quantitatively assessed, validation 75% (producers) and 100% (users) based on 4 independent samples. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. A qualitative assessment suggests that water has been mapped well, however the error matrix indicates some confusion between OPEN WATER and ephemeral water bodies and emergent wetlands.

N21 DEVELOPED, OPEN SPACE-LOW INTENSITY: Not quantitatively assessed. Qualitative assessment indicates that most low intensity developed areas contemporary with the date of the imagery are included. Some confusion is expected to occur with the N22 DEVELOPED, MEDIUM-HIGH INTENSITY class.

N22 DEVELOPED, MEDIUM-HIGH INTENSITY: Not quantitatively assessed. Qualitative assessment indicates that most low intensity developed areas contemporary with the date of the imagery are included. Some confusion is expected to occur with the N21 DEVELOPED, OPEN SPACE-LOW INTENSITY class.

N31 BARREN: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 5 independent samples. This system was most often confused with INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (3 of 5 reference sites) and INTER-MOUNTAIN BASINS GREASEWOOD FLATS (1 of 5 reference sites).

N81 PASTURE HAY–IRRIGATED AGRICULTURE: Quantitatively assessed, validation 86% (producers) and 75% (users) based on 7 independent samples. In general, this system was mapped well though it might have been over-represented at the expense of INVASIVE PERENNIAL GRASSLANDS in some instances. There is also the possibility that some riparian grasslands have been mistaken for irrigated agriculture.

D02 RECENTLY BURNED: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 1 independent sample. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was modeled separately. The confusion of the land cover class is likely due to differences between the dates of imagery and training data collection.

D03 RECENTLY MINED OR QUARRIED: Not quantitatively assessed. A qualitative assessment suggests this land cover class is well mapped, though there may be some confusion between this class and BARREN (N31).

D04 INVASIVE SOUTHWEST RIPARIAN WOODLANDS AND SHRUBLANDS: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 1 independent sample. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. Though this system was sparsely mapped, a qualitative assessment suggests this system is likely confused with GREAT BASIN FOOTHILLS LOWER MONTANE RIPARIAN WOODLANDS AND SHRUBLANDS.

D06 INVASIVE PERENNIAL GRASSLANDS: This system was not quantitatively assessed. Even qualitatively, this accuracy of this system is difficult to establish. Because this system is largely composed of seeded grasses (e.g. *Agropyron cristatum* Semi-Natural Herbaceous alliance) in areas formerly occupied by sagebrush-grass mosaics, this type of confusion is to be expected.

D08 INVASIVE ANNUAL GRASSLANDS: Quantitatively assessed, validation 31% (producers) and 67% (users) based on 13 independent samples. This system was confused with INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB (2 of 13 reference sites), INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (3 of 13 reference sites), and GREAT BASIN XERIC MIXED SAGEBRUSH SHRUBLANDS (2 of 13 reference sites) that might be attributed to differences between the dates of imagery and sample data collection.

D09 INVASIVE ANNUAL AND BIENNIAL FORBLANDS: Quantitatively assessed, validation 5% (producers) and 100% (users) based on 21 independent samples. This disturbance system is with INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB (7 of 21 reference sites) and INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (4 of 21 reference sites). This is another ecological system that is associated with disturbance, and is thus difficult to map.

S002 ROCKY MOUNTAINS ALPINE BEDROCK AND SCREE: Quantitatively assessed, validation 33% (producers) and 100% (users) based on 3 independent samples. The number of reference sites was very small, and not enough for a robust assessment of thematic accuracy. This system was most commonly confused with INTER-MOUNTAIN BASINS CLIFF AND CANYONS (1 of 3 reference sites).

S009 INTER-MOUNTAIN BASINS CLIFF AND CANYONS: Quantitatively assessed, validation 18% (producers) and 43% (users) based on 17 independent samples. This system was confused with GREAT BASIN XERIC MIXED SAGEBRUSH SHRUBLANDS (6 of 17 reference sites) and GREAT BASIN PINYON-JUNIPER WOODLANDS (4 of 17 reference sites) that occurred on steep slopes and with relatively sparse vegetative cover.

S014 INTER-MOUNTAIN BASINS GREASEWOOD WASH: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 5 independent samples. This system was confused with INTER-MOUNTAIN BASINS GREASEWOOD FLATS (2 of 5 reference sites) and INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (2 of 5 reference sites). This linear system is readily confused with the ecological systems above due to its similarity of ecological settings.

S015 INTER-MOUNTAIN BASINS PLAYAS: Quantitatively assessed, validation 25% (producers) and 25% (users) based on 4 independent samples. The number of reference sites was very small, and not enough for a robust assessment of thematic accuracy. This system was confused with INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB (3 of 4 reference sites) due to similarities of soil brightness and sparse vegetative cover.

S016 NORTH AMERICAN WARM DESERT BEDROCK, CLIFF, AND OUTCROP: This system was not quantitatively assessed. Qualitatively, this system appears to be adequately mapped, and is distributed only in the southern-most region of the NV4 mapping unit where it forms a transition to the Mojave eco-region. This system was mapped using the Great Basin – Mojave Transition methodology.

S019 NORTH AMERICAN WARM DESERT VOLCANIC ROCKLAND: This system was not quantitatively assessed. Qualitatively, this system appears to be adequately mapped, and is distributed only in the southern-most region of the NV4 mapping unit where it forms a transition to the Mojave eco-region. This system was mapped using the Great Basin – Mojave Transition methodology.

S020 NORTH AMERICAN WARM DESERT WASH: Quantitatively assessed, validation 75% (producers) and 75% (users) based on 4 independent samples. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. Despite the success indicated by the accuracies listed above, this system was not mapped as linear patches exclusively, but rather as small to medium sized patches, suggesting it has been mapped into adjacent uplands.

S022 NORTH AMERICAN WARM DESERT PLAYA: This system was not quantitatively assessed. Qualitatively, this system appears to be adequately mapped, and is distributed only in the southern-most region of the NV4 mapping unit where it forms a transition to the Mojave eco-region. This system was mapped using the Great Basin – Mojave Transition methodology.

S023 ROCKY MOUNTAINS ASPEN FOREST AND WOODLANDS: Quantitatively assessed, validation 38% (producers) and 43% (users) based on 8 independent samples. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was most commonly confused with INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLANDS AND SHRUBLANDS (2 of 8 reference sites), INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH SHRUBLANDS (1 of 8 reference sites), ROCKY MOUNTAINS SUBALPINE-MONTANE RIPARIAN WOODLANDS AND SHRUBLANDS (1 of 8 reference sites), and GREAT BASIN FOOTHILLS LOWER MONTANE RIPARIAN WOODLANDS AND SHRUBLANDS (1 of 8 reference sites). Confusion with the riparian systems was a regular occurrence due to the floristic similarity between these systems.

S026 INTER-MOUNTAIN BASINS SUBALPINE-MONTANE LIMBER-BRISTLECONE PINE WOODLANDS: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 7 independent samples. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was most commonly confused with INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLANDS AND SHRUBLANDS (3 of 7 reference sites) and INTER-MOUNTAIN BASINS ASPEN-MIXED FOREST AND WOODLANDS (2 of 7 reference sites). Qualitatively, this system appears to be under-mapped due the abundance of GREAT BASIN PINYON-JUNIPER WOODLANDS and INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLANDS AND SHRUBLANDS sites in the training data set.

S028 ROCKY MOUNTAINS SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLANDS: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 1 independent samples The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was confused with GREAT BASIN PINYON-JUNIPER WOODLANDS (1 of 1 reference sites). Though this system appears to be mapping adequately, there is likely confusion between it and ROCKY MOUNTAINS SUBALPINE MESIC SPRUCE-FIR FOREST AND WOODLANDS, INTER-MOUNTAIN BASINS SUBALPINE-MONTANE LIMBER-BRISTLECONE PINE WOODLANDS, and ROCKY MOUNTAINS MONTANE DRY-MESIC MIXED CONIFER FORESET AND WOODLANDS systems.

S030 ROCKY MOUNTAINS SUBALPINE MESIC SPRUCE-FIR FOREST AND WOODLANDS: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 2 independent samples. The number of reference

sites was small, and not enough for a robust assessment of thematic accuracy. This system was confused with INTER-MOUNTAIN BASINS SUBALPINE-MONTANE LIMBER-BRISTLECONE PINE WOODLANDS (1 of 2 reference sites) and INTER-MOUNTAIN BASINS ASPEN-MIXED FOREST AND WOODLANDS (1 of 2 reference sites). Though this system appears to be mapping adequately, there is likely confusion between it and ROCKY MOUNTAINS SUBALPINE MESIC SPRUCE-FIR FOREST AND WOODLANDS, INTER-MOUNTAIN BASINS SUBALPINE-MONTANE LIMBER-BRISTLECONE PINE WOODLANDS, and ROCKY MOUNTAINS MONTANE DRY-MESIC MIXED CONIFER FORESET AND WOODLANDS systems.

S032 ROCKY MOUNTAINS MONTANE DRY-MESIC MIXED CONIFER FORESET AND WOODLANDS: Not quantitatively assessed. This system was mapped via a post-classification model. This system is sparsely distributed as might be expected since most of the montane conifer systems tended to occur in moister ecological settings. Therefore, this system seems to be well mapped.

S034 ROCKY MOUNTAINS MONTANE MESIC MIXED CONIFER FOREST AND WOODLANDS: Quantitatively assessed, validation 17% (producers) and 100% (users) based on 7 independent samples. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was confused with ROCKY MOUNTAINS SUBALPINE MESIC SPRUCE-FIR FOREST AND WOODLANDS (2 of 7 reference sites) and INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (2 of 7 reference sites). Confusion with other conifer forest systems is understandable, however confusion with montane sagebrush is less defensible, unless there were sparse woodlands being confused with sagebrush steppe with dense herbaceous vegetation.

S036 ROCKY MOUNTAINS PONDEROSA PINE WOODLANDS: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 1 independent sample. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was confused with INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (1 of 1 reference sites). This is a rare ecological system in the eastern Great Basin known from a very small number of training sites. It is therefore expected that is has been confused with other coniferous ecological systems in Montane ecological settings.

S040 GREAT BASIN PINYON-JUNIPER WOODLANDS: Quantitatively assessed, validation 92% (producers) and 62% (users) based on 170 independent samples. This system was mapped very well in this mapping unit and not confused consistently with other ecological systems. It does appear to be over-mapped at the expense of INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE at higher elevations and GREAT BASIN XERIC MIXED SAGEBRUSH SHRUBLANDS at lower elevations. For a dominant matrix system of the Great Basin, this is a very satisfactory result.

S042 INTER-MOUNTAIN BASINS ASPEN-MIXED FOREST AND WOODLANDS: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 3 independent samples. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was confused with ROCKY MOUNTAINS ASPEN FOREST AND WOODLANDS (2 of 3 reference sites) and with ROCKY MOUTNAINS SUBALPINE-MONTANE RIPARIAN WOODLANDS AND SHRUBLANDS (1 of 3 reference sites). Both of these sources of confusion are understandable since they are all composed of significant amounts of *Populus tremuloides*.

S046 ROCKY MOUNTAINS GAMBEL OAK – MIXED MONTANE SHRUBLANDS: Quantitatively assessed, validation 20% (producers) and 100% (users) based on 5 independent samples. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was most commonly confused with GREAT BASIN PINYON-JUNIPER WOODLANDS (3 of 5 reference sites). This system was mapped from training data that came predominantly from the southern region of the NV4 mapping unit. Qualitatively, this system is adequately mapped, but appears to be somewhat over-mapped in the northern fringes of the Mojave eco-region.

S050 INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLANDS AND SHRUBLANDS: Quantitatively assessed, validation 35% (producers) and 50% (users) based on 26 independent samples. This system was confused with INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (11 of 26 reference sites) and GREAT BASIN PINYON-JUNIPER WOODLANDS (6 of 26 reference sites). These sources of confusion are reasonable since *Cercocarpus ledifolius* is often found in a gradient with *Artemisia tridentata spp. vaseyana*, *Juniperus osteosperma*, and *Pinus monophylla*.

S053 GREAT BASIN SEMI-DESERT CHAPARRAL: Quantitatively assessed, validation 100% (producers) and 89% (users) based on 8 independent samples. This system is included in the NV3 mapping unit due to the procedures used to model the Great Basin-Mojave transition. This system was mapped from training data collected in the southern region of the NV4 mapping unit, and therefore its mapped distribution was fitting since it only occurs in the southern extent of this mapping unit.

S054 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS: Quantitatively assessed, validation 79% (producers) and 51% (users) based on 243 independent samples. This system was confused at higher elevations with GREAT BASIN XERIC MIXED SAGEBRUSH SHRUBLANDS (29 of 243 reference sites), GREAT BASIN PINYON-JUNIPER WOODLANDS (9 of 243 reference sites), and INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (4 of 243 reference sites), and at lower elevations with INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB (9 of 243 reference sites. This matrix system was over-mapped largely at the expense of INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB STEPPE (13 reference sites) and INTER-MOUNTAIN BASINS GREASEWOOD FLATS (19 reference sites).

S055 GREAT BASIN XERIC MIXED SAGEBRUSH SHRUBLANDS: Quantitatively assessed, validation 44% (producers) and 51% (users) based on 200 independent samples. This system was confused with INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (74 of 200 reference sites) along lake terraces, alluvial fans, and bajadas, and with GREAT BASIN PINYON-JUNIPER SHRUBLANDS (18 of 200 reference sites). These sources of confusion are common in other mapping units of the Great Basin. This system was over-mapped at the expense of INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB (17 reference sites), which can share similar ecological settings, especially *Sarcobatus baileyii* Shrublands alliance sites.

S060 MOJAVE MID-ELEVATION MIXED DESERT SCRUB: Quantitatively assessed, validation 100% (producers) and 100% (users) based on 10 independent samples. The mapped extent of this ecological system is based on the procedures used to model the Great Basin-Mojave transition in the southern region of the NV4 mapping unit. Though it appears to be well mapped from a qualitative perspective, but confusion may exist between this system and its Great Basin counter-parts, INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS and GREAT BASIN XERIC MIXED SAGEBRUSH SHRUBLANDS.

S065 INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB: Quantitatively assessed, validation 46% (producers) and 40% (users) based on 96 independent samples. This system was confused with INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (28 of 96 reference sites) and GREAT BASIN XERIC MIXED SAGEBRUSH SHRUBLANDS (17 of 96 reference sites). This ecological system was over mapped at the expense of INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB STEPPE (11 reference sites) and INTER-MOUNTAIN BASINS GREASEWOOD FLATS (11 reference sites).

S069 SONORA-MOJAVE CREOSOTE-WHITE BURSAGE DESERT SCRUB: Quantitatively assessed, validation 100% (producers) and 100% (users) based on 3 independent samples. The number of reference sites was very small, and not enough for a robust assessment of thematic accuracy. Qualitatively, this system was mapped well and was restricted to the lower basins of the NV4 mapping unit's southern region.

S070 SONORA-MOJAVE DESERT MIXED SALT DESERT SCRUB: This system was not quantitatively assessed. This system was confused with INTER-MOUNTAIN BASINS GREASEWOOD FLATS (3 of 3 reference sites). The mapped extent of this ecological system is based on the procedures used to model the Great Basin-Mojave transition in the southern region of the NV4 mapping unit. Qualitatively, this system was mapped well and was restricted to the lower basins of the NV4 mapping unit's southern region.

S071 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE: Quantitatively assessed, validation 59% (producers) and 53% (users) based on 80 independent samples. This system was confused with GREAT BASIN PINYON-JUNIPER WOODLANDS (21 of 80 reference sites) and INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (8 of 80 reference sites). Qualitatively, this system was adequately mapped, though it was somewhat over-mapped at the expense of INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLANDS AND SHRUBLANDS.

S078 INTER-MOUNTAIN BASINS BIG SAGEBRUSH STEPPE: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 17 independent samples. This ecological system was confused with INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (9 of 17 reference sites) due to the floristic and ecological setting similarities between these systems. It was also confused with GREAT BASIN PINYON-JUNIPER WOODLANDS (4 of 17 reference sites).

S079 INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB STEPPE: Quantitatively assessed, validation 2% (producers) and 50% (users) based on __ independent samples. This system was confused with INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB (47 of 113 reference sites), and also with INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (13 of 113 reference sites). This is likely due to the overlap of ecological setting these systems occur in, and the association of this system with disturbance of the INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS system.

S081 ROCKY MOUNTAINS DRY TUNDRA: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 1 independent sample. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was confused with INTER-MOUNTAIN BASINS SUBALPINE-MONTANE LIMBER-BRISTLECONE PINE WOODLANDS (1 of 1 reference sites).

S090 INTER-MOUNTAIN BASINS SEMI-DESERT GRASSLANDS: Quantitatively assessed, validation 13% (producers) and 29% (users) based on 30

independent samples. This system has not mapped well, and was confused with the matrix communities of INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (8 of 30 reference sites), GREAT BASIN PINYON-JUNIPER WOODLANDS (4 of 30 reference sites), and INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (3 of 30 reference sites). This community tends to occur in patches among the matrix sagebrush and pinyon-juniper systems.

S092 ROCKY MOUNTAINS SUBALPINE-MONTANE RIPARIAN FORESTS AND WOODLANDS: Quantitatively assessed, validation 14% (producers) and 33% (users) based on 7 independent samples. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was most commonly confused with GREAT BASIN PINYON-JUNIPER WOODLANDS (4 of 7 reference sites). This confusion might be attributed to the over-mapping of GREAT BASIN PINYON-JUNIPER WOODLANDS, and the linear patch shape exhibited by this system.

S094 NORTH AMERICAN WARM DESERT LOWER MONTANE RIPARIAN WOODLANDS AND SHRUBLANDS: This system was not quantitatively assessed. Qualitatively, it appears in appropriate locations adjacent to OPEN WATER and in drainage bottoms in the southern region of the NV4 mapping unit.

S096 INTER-MOUNTAIN BASINS GREASEWOOD FLATS: Quantitatively assessed, validation 21% (producers) and 45% (users) based on 42 independent samples. This ecological system is confused with INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB (11 of 42 reference sites) along the fringes of lake terraces and with INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (19 of 42 reference sites).

S100 NORTH AMERICAN ARID WEST EMERGENT MARSH: Quantitatively assessed, validation 18% (producers) and 25% (users) based on 11 independent samples. The number of reference sites was very small, and not enough for a robust assessment of thematic accuracy. This system appears to be mapped well despite confusion with INTER-MOUNTAIN BASIN FOOTHILL LOWER MONTANE RIPARIAN WOODLANDS AND SHRUBLANDS (4 of 11 reference sites) and with INTER-MOUNTAIN BASIN SEMI-DESERT GRASSLANDS (4 of 11 reference sites). Confusion with both of these communities is likely due to the heavy abundance of herbaceous vegetation in all of these systems. The confusion might also be related to differences in the dates of imagery and data acquisition.

S102 ROCKY MOUNTAINS ALPINE-MONTANE WET MEADOW: Quantitatively assessed, validation 0% (producers) and 0% (users) based on 1 independent sample. The number of reference sites was small, and not enough for a robust assessment of thematic accuracy. This system was confused with ROCKY MOUNTAIN ASPEN FOREST AND WOODLANDS (1 of 1 reference sites)

S118 GREAT BASIN FOOTHILL LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLANDS: Quantitatively assessed, validation 44% (producers) and 64% (users) based on 36 independent sample. Qualitatively, this system appears to be mapped well, but was confused INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLANDS (2 of 36 reference sites), NORTH AMERICAN WARM DESERT LOWER MONTANE RIPARIAN WOODLANDS AND SHRUBLANDS (2 of 36 reference sites), and INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH SHRUBLANDS (3 of 36 reference sites). Its geographic distribution is consistent with expectations, except at higher elevations where it may be confused with upland, non-riparian ecological systems.

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