

**SWReGAP Land Cover Mapping Methods Documentation**

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**Functional Unit or Mapping Zone: UT2**

**Organization: RSGIS Laboratory, Utah State University**

**Person Preparing Document: John Lowry/Jessica Kirby/Lisa Langs**

**Date of Preparation: 01 November, 2004**

**Introduction:** Unlike the other functional units mapped as part of the Utah State responsibly area, UT2 was mapped using small-mapping units rather than mega-mapping units and within two small-mapping units, SVPL and UNMT, special zone mapping strategies were commissioned. Longitudinal species diversity along the Wasatch Mountains was cause for these special circumstances. It was necessary to subdivide this Mega-Mapping unit into smaller mapping units in order to restrain distributions of geographically limited cover type (e.g. Ponderosa Pine, Lodgepole Pine, Gambel Oak, and Bigtooth Maple) to their home ranges. Each smaller unit was selected based on similarities in community type and species presence along the mountain range. (i.e. Eco-Region Unit: Wasatch Mountains, mega-mapping Unit: UT2, Associated Small Mapping Units: CWMT (Central Wasatch Mountains), NWMT (Northern Wasatch Mountains), SVPL (Sevier Plateau), UNMT (Uinta Mountains) Each small unit was mapped individually using standard CT methods described in this document, although special methods referred to as "zone mapping" applied to SVPL and UNMT mapping units. Specifics of this process are discussed below.

**1) Predictor layer preparation:**

**a) Image standardization:**

Standardization from DN values to at-sensor reflectance was performed on Landsat 7 ETM+ imagery using methods presented by Huang et. al (2001a), with the addition of a dark object subtraction step to remove atmospheric haze, as suggested by Chavez (1988, 1996). The equation used was as follows:

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

Where,

$\rho_{BandN}$  = Reflectance for Band N

$L_{bandN}$  = Digital Number for Band N

$H_{bandN}$  = Digital Number representing Dark Object for Band N

D = Normalized Earth-Sun Distance

$E_{bandN}$  = Solar Irradiance for Band N

**b) Image dates and mosaicking:**

Images were mosaicked using ERDAS Imagine 8.6 Mosaic Tool with "no outline" for type, and the "Overlay" option for overlap function.

Image dates and scenes were as follows:

ETM Scene (path/row)	Spring (yr-Julian date)	Summer (yr-Julian date)	Fall (yr-Julian date)	Spring Overlay Order	Summer Overlay Order	Fall Overlay Order
38/31	2000-117	2000-181	2000-277	3	3	4
38/32	2000-149	1999-230	1999-290	7	6	3
38/33	2000-117	2000-213	1999-306	2	5	5
38/34	2000-133	2000-165	1999-306	1	4	5
37/32	2001-128	2000-158	1999-283	5	1	1
37/33	2000-126	2000-158	1999-283	6	1	1
37/34	2000-126	2000-158	1999-283	6	1	1
36/32	2000-103	2000-247	1999-292	4	2	2

Three coverages (one for each season) showing overlap arrangement and date and scene attributed in the SOURCE field can be found:

/ut/archive/UT2/mosaic/UT2/spscn.img  
 /ut/archive/UT2/mosaic/UT2/suscscn.img  
 /ut/archive/UT2/mosaic/UT2/fascscn.img

Zonr Mosaic:

/ut/archive/UT2/mosaic/CWMT/spscn.img

/ut/archive/UT2/mosaic/CWMT/suscn.img  
/ut/archive/UT2/mosaic/CWMT/fascn.img

/ut/archive/UT2/mosaic/NWMT/spscn.img  
/ut/archive/UT2/mosaic/NWMT/suscn.img  
/ut/archive/UT2/mosaic/NWMT/fascn.img

/ut/archive/UT2/mosaic/SVPL/spscn.img  
/ut/archive/UT2/mosaic/SVPL/suscn.img  
/ut/archive/UT2/mosaic/SVPL/fascn.img

/ut/archive/UT2/mosaic/UNMT/spscn.img  
/ut/archive/UT2/mosaic/UNMT/suscn.img  
/ut/archive/UT2/mosaic/UNMT/fascn.img

Six band ETM mosaics for each season can be found at:

/ut/archive/UT2/mosaics/UT2

Zone Six Band ETM Mosaic:  
/ut/archive/UT2/mosaics/CWMT  
/ut/archive/UT2/mosaics/NWMT  
/ut/archive/UT2/mosaics/SVPL  
/ut/archive/UT2/mosaics/UNMT

**c) Image derived datasets:**

Normalized Difference Vegetation Index (NDVI): Used a modified version of the NDVI model provided by ERDAS Imagine 8.6. This model performs the band ratio (band4-band3)/(band4+band3) then scales the output by 200 to create a continuous unsigned 8-bit image ranging from 0 - 200. For an example of the \*.gmd file go to /ut/archive/UT2/img\_files/.

Tasseled cap: Brightness, Greenness & Wetness band transformations were created using coefficients derived for the Landsat 7 ETM+ sensor, by Huang, et. al (2001b). An example of the \*.gmd file can be found at /ut/archive/UT2/img\_files/.

All imagery derived predictor layers can be found at:

/ut/archive/UT2/img\_files/.

**d) DEM derived datasets:**

Thirty meter digital elevation models were obtained from the Eros Data Center, National Elevation Database (NED). The date for these data was October 1999. DEMs were converted from floating point grids to integer grids and mosaicked for the region, then clipped to the mapping area.

Aspect: A nine class aspect grid was created. Values 1=N, 2=NE, 3=E, 4=SE, 5=S, 6=SW, 7=W, 8=NW, 9=FLAT.

Landform: A 10 class landform grid was created from a topographic relative moisture (values ranging from 0-28) index grid (Manis et. al 2001).

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

/ut/archive/UT2/img\_files/

Zone Image Files:

/ut/archive/UT2/img\_files/CWMT  
 /ut/archive/UT2/img\_files/NWMT  
 /ut/archive/UT2/img\_files/SVPL  
 /ut/archive/UT2/img\_files/UNMT

**2) Samples:**

**a) Sample collection methods:**

The majority of samples were collected on the ground as polygons delineated over imagery in the field by USU field crews, but others come from other sources. Samples were assigned a label corresponding to either an Ecological System (Comer et. al 2003) or a cover type uniquely defined for the SWReGAP project.

The method and/or source for each sample can be distinguished by the SITEID field in the polygon coverage:

**UT2\_CWMT Samples \UT\ARCHIVE\UT2\TRAIN\_DATA\CWMT:**

UT Gap, Range Trend data, API work, East Manti

**UT2\_NWMT Samples \UT\ARCHIVE\UT2\TRAIN\_DATA\NWMT:**

UT Gap, Range Trend data, DOQ, USU graduate student work, and API work

**UT2\_SVPL Samples \UT\ARCHIVE\UT2\TRAIN\_DATA\SVPL:**

UT Gap, Range Trend data, DOQ, Landfire data and API work

**UT2\_UNMT Samples \UT\ARCHIVE\UT2\TRAIN\_DATA\UNMT:**

UT Gap, Range Trend data, DOQ, Land API work, Colorado Basin Wide data

Source descriptions of sample data follows:

**UT Gap:** UT070501JD01 <state collecting data><date><botanist name><site number>

Identifies a sample taken by USU RSGIS lab SWReGAP field crew.

**Range Trend:** 1999-10-14 Data provided by the Utah Department of Natural Resources, Division of Wildlife Resources, the Utah Big Game Range Trend Studies Annual Reports 1997-2001. Indicates that the most recent year of data collection at the study site was in 2000, in the Wildlife Management Unit number 10, for trend study number 14.

fish-800\_21-3: (e.g. <NF><roll#><frame#><site#>) Indicates air-photo interpreted site from 'Manti-La Sal' National Forest.

National Forest & Roll numbers	Scale	Type	Date
Dixie (199-2099)	15,840	Color	1999
Fish Lake (all except rolls 101, 201, 301)	15,840	Color	1995
Fish Lake (rolls 101, 201, 301)	15,840	Color	2001
Manti-La Sal (all rolls)	15,840	Color	2000
Uinta (all rolls)	15,840	Color	1998
Wasatch-Cache (all rolls)	15,840	Color	2001

**API:** fish-800\_21-3, was-807\_14-7, etc: (e.g. <NF><roll#><frame#><site#>) Indicates air-photo interpreted site from 'Manti-La Sal' National Forest.

National Forest & Roll numbers	Scale	Type	Date
Dixie (199-2099)	15,840	Color	1999
Fish Lake (all except rolls 101, 201, 301)	15,840	Color	1995
Fish Lake (rolls 101, 201, 301)	15,840	Color	2001
Manti-La Sal (all rolls)	15,840	Color	2000
Uinta (all rolls)	15,840	Color	1998
Wasatch-Cache (all rolls)	15,840	Color	2001

**Landfire:** Ref-<idnum> and Val-<idnum>

Indicates data collected by USDA Firelab for the Landfire project reference 2000 or validation 2001 points and plot number.

**East Manti:** DEAD-02-0018 (e.g. <quadname>-<date>-<site>)  
Indicates sample from Utah Department of Natural Resources, Division of Wildlife. East Manti Vegetation Coverage Project(2003).

**DOQ:** CWMT-dog-01, dog-cwmt-01, UT2dog040704\_1 and ut2-dog-249, NWMT120803-01, NWMT-1, unmt121203-67:  
Indicates sites obtained from interpretation of black and white Digital Orthophoto Quads available for the state of Utah from AGRC (date of DOQs is either 1993 or 1997). DOQ interpretation by RSGIS lab personnel.

**Tammy Wilson:** Tammy\_110308  
Indicates sites collected by Tammy Wilson (and others, see data base for details \UT\SITE\_DATA\DATABASE(S)\OTHER\TAMMYWILSON) a USU graduate student as a part of her thesis work. Sites where collected summer 2003-2004.

**Colorado Basin Wide data:** 080700FGR7 (e.g. <date>-<siteid>  
Indicates Colorado BLM Basin Wide Data obtained from Colorado Basin Wide database.

**b) Summary of samples:**

9,410 samples were available to model this mapping area of which 8,888 samples were used in the final model. Qualifiers for a discarded sample site was based on sample quality, Ecological System (ES) mapability and sample abundance. Sample quality can be defined as the likelihood that the sample has a correct geospatial location and that the site sample characteristics correspond with site species data. ES mapability can be defined as the sites likelihood to map accurately given the map model conditions. Landuse types, in comparison to landcover types, typically are seen as sites that were discarded for ES mapability problems (example: Recently Burned, Recently Mined or Quarried and Developed areas). Sample abundance can be defined as all Ecological System cover types with roughly less then 20 samples sites collected in the field. Polygon coverage containing all samples is located at:  
ut/archive/UT2/train\_data/.

**3) Cover types:**

**a) Classification Tree modeled cover types:**

The following cover types were modeled using the See5 Classification Tree:

**UT2 CWMT Landcover Ecological System Classes and Land Use Classes**

VALUE	CODE	Description (Ecological System Name)	Number of Samples
308	D08	Invasive Annual Grassland	13
0	S000	IGNORED	50
2	S002	Rocky Mountain Alpine Bedrock and Scree	23
6	S006	Rocky Mountain Cliff and Canyon	65
11	S011	Inter-Mountain Basins Shale Badland	13
23	S023	Rocky Mountain Aspen Forest and Woodland	189
28	S028	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	136
32	S032	Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland	60
39	S039	Colorado Plateau Pinyon-Juniper Woodland	231
42	S042	Inter-Mountain West Aspen-Mixed Conifer Forest and Woodland Complex	60

46	S046	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	153
50	S050	INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLAND AND SHRUBLAND	23
54	S054	INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND	97
56	S056	COLORADO PLATEAU MIXED LOW SAGEBRUSH SHRUBLAND	16
65	S065	INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB	23
71	S071	INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE	198
79	S079	INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB STEPPE	17
81	S081	ROCKY MOUNTAINS DRY TUNDRA	31
83	S083	ROCKY MOUNTAIN SUBALPINE MESIC MEADOW	38
85	S085	SOUTHERN ROCKY MOUNTAINS MONTANE GRASSLAND	41
93	S093	ROCKY MOUNTAINS LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND COMPLEX	49
96	S096	INTER-MOUNTAIN BASINS GREASEWOOD FLAT COMPLEX	35
102	S102	ROCKY MOUNTAINS ALPINE/MONTANE WET MEADOW	16
Total Number of Samples			1577
Total Number of Samples Mapped			1527

**UT2 NWMT Landcover Ecological System Classes and Land Use Classes**

VALUE	SCODE	Description (Ecological System Name)	Number Of Sample
306	D06	INVASIVE PERENNIAL GRASSLAND	66
0	S000	IGNORED	44
2	S002	ROCKY MOUNTAIN ALPINE BEDROCK AND SCREE	27
6	S006	ROCKY MOUNTAIN CLIFF AND CANYON COMPLEX	77
23	S023	ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND	197
24	S024	ROCKY MOUNTAIN BIGTOOTH MAPLE RAVINE WOODLAND	119
25	S025	ROCKY MOUNTAIN SUBALPINE-MONTANE LIMBER-BRISTLECONE PINE WOODLAND	16
28	S028	ROCKY MOUNTAINS SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLAND	76
31	S031	ROCKY MOUNTAINS LODGEPOLE PINE FOREST	35
32	S032	ROCKY MOUNTAINS MONTANE DRY-MESIC MIXED CONIFER FOREST AND WOODLAND	111
39	S039	COLORADO PLATEAU PINYON-JUNIPER WOODLAND	89
42	S042	INTER-MOUNTAIN BASINS ASPEN-MIXED CONIFER FOREST AND WOODLAND	51
46	S046	ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND	176
50	S050	INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLAND AND SHRUBLAND	34
54	S054	INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND	111
71	S071	INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE	602
78	S078	INTER-MOUNTAIN BASINS BIG SAGEBRUSH STEPPE	130
83	S083	ROCKY MOUNTAIN SUBALPINE MESIC MEADOW	58
91	S091	ROCKY MOUNTAINS SUBALPINE/MONTANE RIPARIAN SHRUBLAND	57
93	S093	ROCKY MOUNTAINS LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND COMPLEX	39
102	S102	ROCKY MOUNTAINS ALPINE/MONTANE WET MEADOW	68
133	S133	NORTHERN ROCKY MOUNTAIN MONTANE GRASSLAND	97
Total Number of Samples			2280
Total Number of Samples Mapped			1596

**UT2 SVPL Landcover Ecological System Classes and Land Use Classes**

VALUE	CODE	DESCRIPTION (ECOLOGICAL SYSTEM NAME)	NUMBER OF SAMPLES
0	S000	IGNORED	328
2	S002	ROCKY MOUNTAIN ALPINE BEDROCK AND SCREE	15
6	S006	ROCKY MOUNTAIN CLIFF AND CANYON COMPLEX	95
10	S010	COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND	20
23	S023	ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND	325
28	S028	ROCKY MOUNTAINS SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLAND	357
32	S032	ROCKY MOUNTAINS MONTANE DRY-MESIC MIXED CONIFER FOREST AND WOODLAND	156
36	S036	ROCKY MOUNTAINS PONDEROSA PINE WOODLAND	215
39	S039	COLORADO PLATEAU PINYON-JUNIPER WOODLAND	563
40	S040	GREAT BASIN PINYON-JUNIPER WOODLAND	106
42	S042	INTER-MOUNTAIN BASINS ASPEN-MIXED CONIFER FOREST AND WOODLAND	168
46	S046	ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND	171
50	S050	INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLAND AND SHRUBLAND	70
54	S054	INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND	305
56	S056	COLORADO PLATEAU MIXED LOW SAGEBRUSH SHRUBLAND	49
65	S065	INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB	31
71	S071	INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE	549
79	S079	INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB STEPPE	50
81	S081	ROCKY MOUNTAINS DRY TUNDRA	44
83	S083	ROCKY MOUNTAIN SUBALPINE MESIC MEADOW	50
85	S085	SOUTHERN ROCKY MOUNTAINS MONTANE GRASSLAND	55
91	S091	ROCKY MOUNTAINS SUBALPINE/MONTANE RIPARIAN SHRUBLAND	18
93	S093	ROCKY MOUNTAINS LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND COMPLEX	54
102	S102	ROCKY MOUNTAINS ALPINE/MONTANE WET MEADOW	63
Total Number of Samples			3857
			3529

**UT2 UNMT Landcover Ecological System Classes and Land Use Classes**

VALUE	CODE	ECOLOGICAL	NUMBER OF SAMPLE
0	S000	IGNORED	100
1	S001	NORTH AMERICAN ALPINE ICE FIELD	28
2	S002	ROCKY MOUNTAIN ALPINE BEDROCK AND SCREE	88
4	S004	ROCKY MOUNTAINS ALPINE FELL-FIELD	43
6	S006	ROCKY MOUNTAIN CLIFF AND CANYON COMPLEX	29
23	S023	ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND	187
30	S030	ROCKY MOUNTAINS SUBALPINE MESIC SPRUCE-FIR FOREST AND WOODLAND	200
31	S031	ROCKY MOUNTAINS LODGEPOLE PINE FOREST	214
32	S032	ROCKY MOUNTAINS MONTANE DRY-MESIC MIXED CONIFER FOREST AND WOODLAND	31

36	S036	ROCKY MOUNTAINS PONDEROSA PINE WOODLAND	48
39	S039	COLORADO PLATEAU PINYON-JUNIPER WOODLAND	49
42	S042	INTER-MOUNTAIN BASINS ASPEN-MIXED CONIFER FOREST AND WOODLAND	35
43	S043	ROCKY MOUNTAIN ALPINE DWARF SHRUBLAND	39
46	S046	ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND	26
52	S052	COLORADO PLATEAU PINYON-JUNIPER SHRUBLAND	47
54	S054	INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND	54
71	S071	INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE	145
81	S081	ROCKY MOUNTAINS DRY TUNDRA	43
83	S083	ROCKY MOUNTAIN SUBALPINE MESIC MEADOW	49
91	S091	ROCKY MOUNTAINS SUBALPINE/MONTANE RIPARIAN SHRUBLAND	66
93	S093	ROCKY MOUNTAINS LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND COMPLEX	35
102	S102	ROCKY MOUNTAINS ALPINE/MONTANE WET MEADOW	130
133	S133	NORTHERN ROCKY MOUNTAIN MONTANE GRASSLAND	10
Total Number of Samples			1696
Total Number of Samples Mapped			2236

**b) Non CT modeled cover types:**

Screen digitized over ETM imagery at a scale between 1:24,000 and 1:100,000: Updated existing **Land Use | Water Related Use** GIS coverage (screen digitizing over ETM imagery). Source of GIS coverage: Utah Department of Natural Resources, Division of Water Resources, collection period: 1985-2001. FGDC metadata for **Land Use | Water Related Use** coverage is found at: /ut/archive/UT2/non\_model/

VALUE	CODE	DESCRIPTION (ECOLOGICAL SYSTEM NAME)
13	S013	Inter-Mountain Basins Volcanic Rock and Cinder Land
93	S093	Inter-Mountain Basins Lowe Montane Riparina Woodland and Shrubland
211	N11	Open Water
221	N21	Developed, Open Space - Low Intensity
222	N22	Developed, Medium - High Intensity
281	N81	Agriculture, Pature/Hay
282	N82	Agriculture, Cultivated Crops
302	D02	Recently Burned
303	D03	Recently Mined or Quarried
10	D10	Recently Logged Areas
11	D11	Recently Chained Pinyon-Juniper Areas
14	D14	Disturbed, Oil well

Cover types modeled with a post-classification model (see section 5c for details):

**UT2 CWMT Post-Classified Landcover Ecological System Classes**

VALUE	CODE	DESCRIPTION (ECOLOGICAL SYSTEM NAME)
30	S030	Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
34	S034	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland
93	S093	Rocky Mountain Lower Montane Riparian Woodland and Shrubland

**UT2 NWMT Post-Classified Landcover Ecological System Classes**

VALUE	CODE	DESCRIPTION (ECOLOGICAL SYSTEM NAME)
30	S030	Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
34	S034	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland

**UT2 SVPL Post-Classified Landcover Ecological System Classes**

VALUE	CODE	DESCRIPTION (ECOLOGICAL SYSTEM NAME)
30	S030	Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
34	S034	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland
57	S057	Mogollon Chaparral
59	S059	Colorado Plateau Blackbrush-Mormon Tea Shrubland

**UT2 UNMT Post-Classified Landcover Ecological System Classes**

VALUE	CODE	DESCRIPTION (ECOLOGICAL SYSTEM NAME)
30	S030	Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
34	S034	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland
47	S047	Rocky Mountain Lower Montane-Foothill Shrubland

**4) Summary of predictor layers:**

Predictor layers are located UT\ARCHIVE\UT2\MOSAICS

**a) Multi band predictors:**

UT2\_fall\_2000.img (ETM bands 1-5 & 7 for fall 2000)  
 UT2\_spr\_2000.img (ETM bands 1-5 & 7 for spring 2000)  
 UT2\_sum\_2000.img (ETM bands 1-5 & 7 for summer 2000)

**Zone Image Files:**

cwmt\_fall\_2000.img (ETM bands 1-5 & 7 for fall 2000)  
 cwmt\_spr\_2000.img (ETM bands 1-5 & 7 for spring 2000)  
 cwmt\_sum\_2000.img (ETM bands 1-5 & 7 for summer 2000)

nwmt\_fall\_2000.img (ETM bands 1-5 & 7 for fall 2000)  
 nwmt\_spr\_2000.img (ETM bands 1-5 & 7 for spring 2000)  
 nwmt\_sum\_2000.img (ETM bands 1-5 & 7 for summer 2000)

svpl\_fall\_2000.img (ETM bands 1-5 & 7 for fall 2000)  
 svpl\_spr\_2000.img (ETM bands 1-5 & 7 for spring 2000)  
 svpl\_sum\_2000.img (ETM bands 1-5 & 7 for summer 2000)

unmt\_fall\_2000.img (ETM bands 1-5 & 7 for fall 2000)  
 unmt\_sum\_2000.img (ETM bands 1-5 & 7 for summer 2000)

All multi-band predictors can be found at:

/ut/archive/UT2/mosaics/

**b) Single band predictors:**

asp\_9cls.img Categorical 9 class aspect  
 elev.img Continuous (integer) elevation  
 fabrt.img Fall brightness band  
 fagrns.img Fall greenness band  
 spbrt.img Spring brightness band  
 spgrns.img Spring greenness band

subrt.img                    Summer brightness band  
 sugrn.img                   Summer greenness band  
 landf.img                    Categorical 10 class landform (from DEM)

All single-band predictors can be found at:  
 /ut/archive/UT2/img\_files/

**5) Modeling Methods:**

**Special Note:** UT2 was modeled using special methods in response to the change in longitudinal species diversity along the Wasatch Mountains. It was necessary to subdivide this Mega-Mapping unit into smaller mapping units in order to restrain distributions of geographically limited cover type (e.g. Ponderosa Pine, Lodgepole Pine, Gambel Oak, and Bigtooth Maple) to their home ranges. Each smaller unit was selected based on similarities in community type and species presence along the mountain range. (i.e. Eco-Region Unit: Wasatch Mountains, Mega Mapping Unit: UT2, Associated Small Mapping Units: CWMT (Central Wasatch Mountains), NWMT (Northern Wasatch Mountains), SVPL (Sevier Plateau), UNMT (Uinta Mountains)) Each small unit was mapped individually using standard CT methods described in this document, although special methods referred to as "zone mapping" applied to SVPL and UNMT mapping units. Final small unit maps were "burned together" to create the final UT2 map using the Overlay function in ERDAS Imagine. The small unit maps and the final UT2 map can be found at \UT\ARCHIVE\UT2\FINAL\_MAP

The special methods "Zone Mapping" mentioned above can be defined as the process of mapping landcover by segregating Ecological Systems using zones. Zones are similar to the well know Lifezone concept (e.g. Alpine, Subalpine, Montane, etc). Zone mapping was used in small mapping unit SVPL and UNMT to correct for misclassification of landcover (i.e. alpine type mapping in lowlands, etc). SVPL was segregated into three zones; Low, Middle and Alpine. UNMT was segregated into two zones; Low-Middle and Alpine. The tables that follows depicts the zone that each Ecological System label was assigned by small mapping unit respectively.

**SVPL Zone Mapping**

SCODE	Ecological System (Name)	ZONE3
S002	ROCKY MOUNTAIN ALPINE BEDROCK AND SCREE	Alpine
S081	ROCKY MOUNTAINS DRY TUNDRA	Alpine
S010	COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND	Low
S039	COLORADO PLATEAU PINYON-JUNIPER WOODLAND	Low
S040	GREAT BASIN PINYON-JUNIPER WOODLAND	Low
S046	ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND	Low
S054	INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND	Low
S056	COLORADO PLATEAU MIXED LOW SAGEBRUSH SHRUBLAND	Low
S065	INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB	Low
S079	INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB STEPPE	Low
S006	ROCKY MOUNTAIN CLIFF AND CANYON COMPLEX	Middle
S023	ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND	Middle
S028	ROCKY MOUNTAINS SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLAND	Middle
S032	ROCKY MOUNTAINS MONTANE DRY-MESIC MIXED CONIFER FOREST AND WOODLAND	Middle
S036	ROCKY MOUNTAINS PONDEROSA PINE WOODLAND	Middle
S042	INTER-MOUNTAIN BASINS ASPEN-MIXED CONIFER FOREST AND	Middle

	WOODLAND	
S071	INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE	Middle
S083	ROCKY MOUNTAIN SUBALPINE MESIC MEADOW	Middle
S085	SOUTHERN ROCKY MOUNTAINS MONTANE GRASSLAND	Middle
S091	ROCKY MOUNTAINS SUBALPINE/MONTANE RIPARIAN SHRUBLAND	Middle
S093	ROCKY MOUNTAINS LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND COMPLEX	Middle
S102	ROCKY MOUNTAINS ALPINE/MONTANE WET MEADOW	Middle
S050	INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLAND AND SHRUBLAND	Middle

#### UNMT Zone Mapping

SCODE	Ecological System (Name)	Zone
S001	NORTH AMERICAN ALPINE ICE FIELD	Alpine
S002	ROCKY MOUNTAIN ALPINE BEDROCK AND SCREE	Alpine
S004	ROCKY MOUNTAINS ALPINE FELL-FIELD	Alpine
S043	ROCKY MOUNTAIN ALPINE DWARF SHRUBLAND	Alpine
S081	ROCKY MOUNTAINS DRY TUNDRA	Alpine
S006	ROCKY MOUNTAIN CLIFF AND CANYON COMPLEX	Middle-Low
S023	ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND	Middle-Low
S030	ROCKY MOUNTAINS SUBALPINE MESIC SPRUCE-FIR FOREST AND WOODLAND	Middle-Low
S031	ROCKY MOUNTAINS LODGEPOLE PINE FOREST	Middle-Low
S032	ROCKY MOUNTAINS MONTANE DRY-MESIC MIXED CONIFER FOREST AND WOODLAND	Middle-Low
S036	ROCKY MOUNTAINS PONDEROSA PINE WOODLAND	Middle-Low
S039	COLORADO PLATEAU PINYON-JUNIPER WOODLAND	Middle-Low
S042	INTER-MOUNTAIN BASINS ASPEN-MIXED CONIFER FOREST AND WOODLAND	Middle-Low
S046	ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND	Middle-Low
S052	COLORADO PLATEAU PINYON-JUNIPER SHRUBLAND	Middle-Low
S054	INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND	Middle-Low
S071	INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE	Middle-Low
S083	ROCKY MOUNTAIN SUBALPINE MESIC MEADOW	Middle-Low
S091	ROCKY MOUNTAINS SUBALPINE/MONTANE RIPARIAN SHRUBLAND	Middle-Low
S093	ROCKY MOUNTAINS LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND COMPLEX	Middle-Low
S102	ROCKY MOUNTAINS ALPINE/MONTANE WET MEADOW	Middle-Low
S133	NORTHERN ROCKY MOUNTAIN MONTANE GRASSLAND	Middle-Low

#### Creating the Zone Mask:

A three class SVPL Zone Mask base map and a two class UNMT Zone Mask base map was created by processing the zone samples using standard CT modeling steps. These base maps were then converted into masking images, by recoding each zone to an individual binary image. These images were used as the mask file in the final

standard CT process CART Classifier step. At this step the binary mask is used to "block out" the undesired areas, allowing for the segregated covertypes to map correctly. The base maps can be found at UT\ARCHIVE\UT2\TRAIN\_DATA\SVPL\ZONE\_TRAIN\_DATA\Zone\_Mask and \UT\ARCHIVE\UT2\TRAIN\_DATA\UNMT\ZONE\_TRAIN\_DATA\Zone\_Mask. The binary mask image maps can be found at (found at UT\ARCHIVE\UT2\TRAIN\_DATA\SVPL\ZONE\_TRAIN\_DATA\Zone\_Mask and UT\ARCHIVE\UT2\TRAIN\_DATA\UNMT\ZONE\_TRAIN\_DATA\Zone\_Mask.

**Combining Zone Maps:**

Ecological System covertype zone maps were processed using standard CT methods with exception of applying the mask file images to the map in the final steps of the process. Once all Ecological System zone maps were complete, a combined map for each small unit was created by overlaying the zone maps. The completed small unit maps can be found at \UT\ARCHIVE\UT2\FINAL\_MAP\SVPL and ...UNMT

**a) Standard See5 Classification Tree modeling:**

**Sampling:** Pseudo-replication within each sample polygon was conducted in order to increase the number of samples used by the classification algorithm. While this use of non-independent data is not ideal for classification tree modeling, it has been found to improve classification accuracies, particularly when there are limited amounts of training data. 20 random points were placed within each polygon using an Arcview Avenue script. The points were converted to pixels while ensuring that the resulting pixels (the new grid) aligned with the raster predictor layers. The resulting sub-sampled pixels would often be less than 20 per sample polygon, if random points fell within the same pixel. This new grid was converted to an Imagine IMG file (e.g.m4all20ppp.img) and is available at: UT/ARCHIVE/UT2/TRAIN\_DATA/Withholding Validation Samples: 20% of the all sample polygons were withheld for validation. With the remaining 80%, 20 sub-samples were randomly selected for each sample polygon. This was done by first randomly generating points within each polygon and then converting the points to a raster \*.img file. Pixels in the \*.img (each to be considered a separate observation for the See5 classifier) were 'drilled' through predictor layers using the Sampling tool from CART Module for Imagine (EarthSatellite Corp. 2003), producing two important files for See5: the \*.names and \*.data files.

**See5 Classification Tree:** See5 (Release 1.8) data mining software (Rulequest 2004) was used for generating classification trees. Boosting was employed using 15 trials.

The See5 files are located: ut/archive/UT2/output/. The following briefly describes these files (Rulequest 2004).

**\*.names file:** Identifies the dependent variable \*.img file and the predictor \*.img files created from the CART Module Sampling tool. Required by See5 software.

**\*.data file:** Contains the training cases from which See5 extracts rules. This is also produced from the CART Module Sampling tool, by 'drilling' the dependent variable pixels through the specified predictor images. Required by See5 Software.

**\*.test file:** Produced from the CART Module Sampling tool, but not used by SWReGAP. This file, if populated, would contain a separate 'test' set of cases to evaluate the rules generated from See5. The SWReGAP mapping procedures did not populate this file, and it was not used.

**\*.names.hst file:** Produced from the CART Module Sampling tool. Details the distribution of samples available within the dependent input, and

those output to the \*.data and \*.test file. Not required by See5, but produced by CART Module Sampling tool.

\*.set file: Produced from See5 software. This file contains the settings for the classification tree run. For example the third value '15' indicates the number of boosts used for boosting.

\*.tree file: Produced from the See5 software. This file contains the classification tree in 'tree' format. This along with the \*.data and \*.names file are required by the CART Module Classifier tool to spatially apply the tree.

\*.out file: Output file generated by See5 and displayed when See5 classification tree model has run. This file provides a visual representation of the classification tree that is somewhat easier to interpret than the \*.tree file.

As a result of spatially applying the classification tree using the CART Module's Classifier tool, two files are created: an \*.img file, which is the spatial application of the tree's rules, and the \*\_error.img file which is spatial depiction of confidence in the rules generated by the tree and displayed pixel by pixel.

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

Introduction: This post-classification model was designed to be used as a tool to assist in differentiating between ecological systems that have similar characteristics. Similar characteristics can be defined as one or all of the following: Shared physiognomic structure, shared species composition and/or shared ecological process. This model has also been designed to correct for poor TM image quality. Clouds, fire smoke or dramatic scene lines are example of such quality issues.

#### **CWMT Post-Classification:**

The .gmd file used for this post-classification model is:

```
/archive/UT2 /post_model/CWMT /swgap_ut2_cwmt.gmd
```

#### **Step 1: Discriminating Mesic Conifer from Non-Mesic Conifer Forests Types**

The National Vegetation Classification Standard (NVCS) legend used for the Southwest Regional Gap Analysis Project divided Rocky Mountain conifer forest types into two distinct moisture classes; Mesic Forest types and Dry-Mesic Forest types (Comer et. al 2003). Early indications revealed that these types would be difficult to accurately discriminate using standard CT modeling methods due to site composition and spectral similarities. As a result, these types have been post modeled using their Ecological System conceptual description as a basis for modeling.

#### **Step 1A: Discriminating Between Rocky Mountain Montane Dry-Mesic and Rocky Mountain Montane Mesic Conifer Types**

Model methods: The original CT output modeled *S032 Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland* as the only montane conifer type. This post model was designed to discriminate between *S032* and, its moister ecologic counterpart, *S034 Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland*. The logic and parameters for the model were as follows:

This post-classification model was designed to extract *S034 Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland* from the standard CT modeled conifer system, *S032 Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland*.

NatureServe's NVCS concept describes S032 montane mesic system as; "occurring predominantly 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 the 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." (Comer et. al 2003)

Using the output of step 1, a conditional statement was created to extract *S034 Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland*. The conditional statement was created by using the aspect and landform characteristics described above. Affected pixels were then recoded to represent montane mesic mixed conifer system S034.

The details of the conditional statement follow:

```
EITHER 30 IF (($n2_landf == 2 OR $n2_landf== 5 OR
$n2_landf==6 OR $n2_landf== 9) AND ($n5_asp_9cls == 1 OR
$n5_asp_9cls == 2 OR $n5_asp_9cls == 0) AND ($n1_m4all1_rec
== 28)) OR $n1_m4all1_rec OTHERWISE
```

Where:

30	<i>S030 Mountain Subalpine Mesic Spruce-Fir Forest and Woodland</i>
28	<i>S028 Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland</i>
Landform	10 class landform 2= toe slopes, bottoms, and swales, 5= very moist steep slopes, 6= moderately moist steep slopes, 9= cool aspect scarps, cliffs, canyons,
Asp_9cls	Nine class aspect image 1=North facing slope 2=Northeast facing slope 0=slope less than 3 degrees
\$n1_m4all1_rec	UT2 standard CT output image. Recoded to standard integer code.

Step 1B: Discriminating Between Rocky Mountain Subalpine Dry-Mesic Spruce-Fir and Rocky Mountain Subalpine Mesic Spruce-Fir Types.

Using the output of step 2b, *S030 Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland* was extracted from its Dry-Mesic counterpart S028 following similar parameters as step 2A.

NatureServe NVCS concept (Comer et. al 2003) describes the subalpine mesic system to be;

"typically found in locations with cold air drainage or ponding, or where snowpacks linger late into the summer, such as north-facing slopes and high 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 forests are found on gentle to very steep mountain slopes, high elevation ridgetops and upper slopes, plateaulike surfaces, basins, alluvial terraces, well-drained benches, and inactive stream terraces."

Model methods: A conditional statement was created to extract *S030 Mountain Subalpine Mesic Spruce-Fir Forest and Woodland* using the above aspect and landform characteristics in order to identify this subalpine mesic conifer system. The details of the conditional statement follow:

```
EITHER 34 IF (($n2_landf == 2 OR $n2_landf == 5 OR $n2_landf ==6 OR $n2_landf== 9) AND ($n5_asp_9cls == 1 OR $n5_asp_9cls == 2 OR $n5_asp_9cls == 0) AND ($n3_memory == 32)) OR $n3_memory OTHERWISE
```

Where:

34 *S034 Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland.*

32 *S032 Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland*

landf 10 class landform  
2= toe slopes, bottoms, and swales  
5= very moist steep slopes  
6= moderately moist steep slopes  
9= cool aspect scarps, cliffs, canyons

aspect\_9cls Nine class aspect image  
1=North facing slope  
2=Northeast facing slope  
0=slope less than 3 degrees

memory CWMT standard CT output image. Recoded to standard integer code. Note that this output is a temporary memory that has been modified by previous steps in the post classification model.

**Step2:** A post-classification model was used to restrict riparian cover type *S093 Rocky Mountain Lower Montane Riparian Woodland and Shrubland* to riparian corridors.

During the visual inspection of the standard CT output image output, *S093 Rocky Mountain Lower Montane Riparian Woodland and Shrubland* was found to be mapping in undesirable (i.e. non-riparian locations). This conditional statement restricts *S093* to riparian areas using a stream corridor mask that has been buffered to 250 meters.

Model Methods: Two standard output CT model output were created; one that ignored Ecological System class *S093* and the other that mapped Ecological System class *S093*. The map that withheld *S1093* was reserved as replacement vegetation pixel values for areas that were being mapped inappropriately as *S093*. Inappropriately mapped areas were identified as any *S093* pixel that was outside of the 250 meter buffered stream corridor mask image.

The detail of the conditional statement follows:

```
EITHER $n8_m4all1_norip_rec IF ($n4_memory==93 AND
$n11_cwmt_250buf <99) OR $n4_memory OTHERWISE
```

Where:

```
93          S093 Rocky Mountain Lower Montane Riparian
            Woodland and Shrubland

M4all1_norip_rec  CWMT output image ignoring riparian
                  Ecological System class S093.
                  Recoded to standard integer code.

cwmt_250buf      250m buffered stream corridor
                  1-99= all other terrain
                  1000= suitable riparian terrain

memory          CWMT standard output image. Recoded to
                  standard integer code. Note that this
                  output is a temporary memory that has been
                  modified by previous steps in the post
                  classification model.
```

#### **NWMT Post-Classification:**

The .gmd file used for this post-classification model is:

```
/archive/UT2/post_model/NWMT/swgap_ut2nwmt_north.gmd
```

```
/archive/UT2/post_model/NWMT/swgap_ut2nwmt.gmd
```

#### **NWMT North:**

##### **Step 1:** Correcting for Clouds

A conditional statement was written for the purpose of correcting misclassified landcover Ecological System output pixels. The presence seasonal clouds that were captured on the Landsat 7 ETM+ imagery can be attributed for the errors. Errors were identified by visually inspecting Landsat imagery and CT model output images.

The details of the conditional statement follow:

```
EITHER $n31_m7all1_nosum_nooak_rec IF ($n36_cloud_mask==1) OR
$n30_m7all1_nogambeloak OTHERWISE
```

Where:

```
$n31_m7all1_nosum_nooak_rec  NWMT output image which
                              integrated NO SUMMER
                              brightness, greenness or
                              Landsat raw band imagery as
                              independent variables.
                              Recoded to standard integer
                              code.

n36_cloud_mask              cloud mask image. Indicates
                              area where error occurred.
                              1 = error
                              0 = all other area
```

n30\_m7all1\_rec NWMT standard CT output image.  
Recorded to standard integer  
code.

**Step2:** Riparian Fix to the North

The detail of the conditional statement follows:

EITHER \$n2\_m7all1\_nogambeloak\_norip\_rec IF  
(\$n18\_ripbuf\_mask==0 AND \$n43\_memory==93) OR \$n43\_memory  
OTHERWISE

Where:  
93

*S093 Rocky Mountain Lower  
Montane Riparian Woodland  
and Shrubland*

\$n2\_m7all1\_nogambeloak\_norip\_rec NWMT output image ignoring  
riparian Ecological System  
class S093.  
Recorded to standard  
integer code.

ripbuf\_mask 250m buffered stream  
corridor  
1-99= all other terrain  
1000= suitable riparian  
terrain

memory NWMT standard output image.  
Recorded to standard integer  
code. Note that this output  
is a temporary memory that  
has been modified by  
previous steps in the post  
classification model.

**Step 3:** Discriminating Mesic Conifer from Non-Mesic Conifer  
Forests Types to the North

**Step 3A:** Discriminating Between Rocky Mountain Montane Dry-Mesic  
and Rocky Mountain Montane Mesic Conifer Types

EITHER 30 IF ((\$n47\_landf == 2 OR \$n47\_landf == 5 OR  
\$n47\_landf==6 OR \$n47\_landf == 9) AND (\$n48\_aspect\_9 == 1 OR  
\$n48\_aspect\_9 == 2 OR \$n48\_aspect\_9 == 0) AND (\$n46\_memory==  
28)) OR \$n46\_memory OTHERWISE

Where:  
30

*S030 Mountain Subalpine Mesic Spruce-Fir  
Forest and Woodland*

28

*S028 Mountain Subalpine Dry-Mesic Spruce-  
Fir Forest and Woodland*

Landform

10 class landform  
2= toe slopes, bottoms, and swales,  
5= very moist steep slopes,  
6= moderately moist steep slopes,  
9= cool aspect scarps, cliffs, canyons,

Aspect\_9                    Nine class aspect image  
                               1=North facing slope  
                               2=Northeast facing slope  
                               0=slope less than 3 degrees

memory                      NWMT standard output image. Recoded to  
                               standard integer code. Note that this  
                               output is a temporary memory that has been  
                               modified by previous steps in the post  
                               classification model.

Step 3B: Discriminating Between Rocky Mountain Subalpine Dry-Mesic  
 Spruce-Fir and Rocky Mountain Subalpine Mesic Spruce-Fir Types.

EITHER 34 IF ((\$n47\_landf == 2 OR \$n47\_landf == 5 OR  
 \$n47\_landf==6 OR \$n47\_landf == 9) AND (\$n48\_aspect\_9 == 1 OR  
 \$n48\_aspect\_9== 2 OR \$n48\_aspect\_9 == 0) AND (\$n49\_memory==  
 32)) OR \$n49\_memory OTHERWISE

Where:

34                            *S034 Rocky Mountain Montane Mesic Mixed  
 Conifer Forest and Woodland.*

32                            *S032 Rocky Mountain Montane Dry-Mesic  
 Mixed Conifer Forest and Woodland*

landf                        10 class landform  
                               2= toe slopes, bottoms, and swales  
                               5= very moist steep slopes  
                               6= moderately moist steep slopes  
                               9= cool aspect scarps, cliffs, canyons

aspect\_9                    Nine class aspect image  
                               1=North facing slope  
                               2=Northeast facing slope  
                               0=slope less than 3 degrees

memory                      NWMT standard CT output image. Recoded to  
                               standard integer code. Note that this  
                               output is a temporary memory that has been  
                               modified by previous steps in the post  
                               classification model.

**NWMT:**

Step1: Riparian Fix to the South

EITHER \$n2\_m7all1\_norip\_rec IF (\$n3\_ripbuf\_mask==0 AND  
 \$n1\_m7all1\_rec==93) OR \$n1\_m7all1\_rec OTHERWISE

Where:

93                            *S093 Rocky Mountain Lower  
 Montane Riparian Woodland  
 and Shrubland*

m7all1\_norip\_rec            NWMT output image ignoring  
                               riparian Ecological System  
                               class S093. Recoded to  
                               standard integer code.

ripbuf\_mask                 250m buffered stream  
                               corridor

1-99= all other terrain  
1000= suitable riparian  
terrain

\$n1\_m7all1\_rec

NWMT standard output image.  
Recoded to standard integer  
code. Note that this output  
is a temporary memory that  
has been modified by  
previous steps in the post  
classification model.

**Step 2:** Discriminating Mesic Conifer from Non-Mesic Conifer  
Forests Types to the South

**Step 2A:** Discriminating Between Rocky Mountain Montane Dry-Mesic  
and Rocky Mountain Montane Mesic Conifer Types

```
EITHER 30 IF (($n47_landf == 2 OR $n47_landf == 5 OR
$n47_landf==6 OR $n47_landf == 9) AND ($n48_aspect_9 == 1 OR
$n48_aspect_9 == 2 OR $n48_aspect_9 == 0) AND ($n46_memory==
28)) OR $n46_memory OTHERWISE
```

Where:

30 *S030 Mountain Subalpine Mesic Spruce-Fir  
Forest and Woodland*

28 *S028 Mountain Subalpine Dry-Mesic Spruce-  
Fir Forest and Woodland*

Landform 10 class landform  
2= toe slopes, bottoms, and swales,  
5= very moist steep slopes,  
6= moderately moist steep slopes,  
9= cool aspect scarps, cliffs, canyons,

Aspect\_9 Nine class aspect image  
1=North facing slope  
2=Northeast facing slope  
0=slope less than 3 degrees

memory NWMT standard output image. Recoded to  
standard integer code. Note that this  
output is a temporary memory that has been  
modified by previous steps in the post  
classification model.

**Step 2B:** Discriminating Between Rocky Mountain Subalpine Dry-Mesic  
Spruce-Fir and Rocky Mountain Subalpine Mesic Spruce-Fir Types.

```
EITHER 34 IF (($n47_landf == 2 OR $n47_landf == 5 OR
$n47_landf==6 OR $n47_landf == 9) AND ($n48_aspect_9 == 1 OR
$n48_aspect_9== 2 OR $n48_aspect_9 == 0) AND ($n49_memory==
32)) OR $n49_memory OTHERWISE
```

Where:

34 *S034 Rocky Mountain Montane Mesic Mixed  
Conifer Forest and Woodland.*

32 *S032 Rocky Mountain Montane Dry-Mesic  
Mixed Conifer Forest and Woodland*

landf	10 class landform 2= toe slopes, bottoms, and swales 5= very moist steep slopes 6= moderately moist steep slopes 9= cool aspect scarps, cliffs, canyons
aspect_9	Nine class aspect image 1=North facing slope 2=Northeast facing slope 0=slope less than 3 degrees
memory	NWMT standard CT output image. Recoded to standard integer code. Note that this output is a temporary memory that has been modified by previous steps in the post classification model.

**Step 3:** Overlay NWMT North and NWMT South

EITHER \$n26\_m7all1\_north\_rec\_clip IF (\$n30\_maple\_mask==1) OR \$n14\_memory OTHERWISE

Where:

m7all1\_north\_rec\_clip                    output of SWGAP\_NWMT\_North.gmd

maple\_mask                                area where overlap will occur

memory                                    NWMT standard CT output image. Recoded to standard integer code. Note that this output is a temporary memory that has been modified by previous steps in the post classification model

**SVPL Post-Classification:**

The .gmd file used for this post-classification model is:

/archive/UT2/post\_model/SVPL/swgap\_ut2\_SVPL.gmd

Step1: Correcting for Clouds

EITHER \$n6\_m4svpl\_noclds\_16bit IF (\$n45\_svpl\_cloud\_mask == 1) OR \$n5\_m411mla1\_rec OTHERWISE

Where:

m4svpl\_noclds\_16bit    SVPL put image which integrated NO SUMMER brightness, greenness or Landsat raw band imagery as independent variables. Recoded to standard integer code.

svpl\_cloud\_mask        cloud mask image. Indicates area where error occurred.  
1 = error  
0 = all other area

m411mla1\_rec            SVPL standard CT output image. Recoded to standard integer code.

**Step2:** Riparian Fix

EITHER \$n21\_m4svpl\_norip\_16bit IF (\$n7\_memory == 93 AND \$n22\_svpl\_nhdb < 99) OR \$n7\_memory OTHERWISE

Where:  
 93 *S093 Rocky Mountain Lower Montane Riparian  
 Woodland and Shrubland*

m7all1\_norip\_rec SVPL output image ignoring riparian  
 Ecological System class S093. Recoded to  
 standard integer code.

ripbuf\_mask 250m buffered stream corridor  
 1-99= all other terrain  
 1000= suitable riparian terrain

memory SVPL standard output image. Recoded to  
 standard integer code. Note that this  
 output is a temporary memory that has been  
 modified by previous steps in the post  
 classification model.

**Step3:** Restrict *S040 Great Basin Pinyon Juniper Woodland*

A post-classification model was used to restrict S040. The logic and parameters for the model were as follows:

The *S040-Great Basin Pinyon-Juniper Woodland* ecological system requires the presence of *Pinus monophylla*, among other characteristic, to be considered for this ecological system nomenclature. *S040-Great Basin Pinyon-Juniper Woodland*, typically found in the Great Basin ecoregion, was discovered to inhabit a small portion of the landscape in UT2\_SVPL small unit. This system differs from its widespread Northern Colorado Plateau counterpart S039 by the presence of *Pinus monophylla* opposed to *Pinus edulis*. Differentiating between these two covertypes can be problematic using standard modeling methods and ultimately leads to misclassification by allowing a Great Basin system to occur far from its accepted natural distribution. In order to restrict S040 to its biogeographic range it was necessary to post-classify this type.

Model methods: A standard model was run using all cover types. An area of interest (AOI) was then created and used as a mask to restrict S040 to its known range. The detail of the conditional statement follows:

```
EITHER 40 IF ($n23_memory==39 AND$n25_s040_mask==1) OR
$n23_memory OTHERWISE
```

Where:  
 39 *Colorado Plateau Pinyon-Juniper Woodland*

40 *Great Basin Pinyon-Juniper Woodland*

s040\_mask Binary mask image indicating where S040  
 should be mapped on the landscape.

memory SVPL standard CT output image. Recoded to  
 standard integer code. Note: This output  
 is a temporary memory file that has been  
 modified by previous steps in the post  
 classification model.

**Step4:** Mapping S057 Mogollon Chapparral

A post-classification model was used to map S057. The logic and parameters for the model were as follows:

*S057-Mogollon Chaparral* Ecological System was post-classified to allow for the account of an otherwise anomalous land cover vegetation type within the Sevier Plateau UT2\_SVPL small mapping unit. The composition of species that define this Ecological System (i.e. *Quercus turbinella*, *Arctostaphylos pungens* and *A. pringlei*) are infrequent within this mapping zone. The extent of the chaparral has been identified by using ground true points. As a result of this systems' unique species composition and geographically restricted presence on the landscape, it was decided that post-classification would be the best method to accurately represent it on the landscape.

Model methods: A standard CT model was run which excluded the S057 training data while allowing the model to assign *S046 Rocky Mountain Gambel Oak-Mixed Montane Shrubland* pixels to the chaparral area. This post-classification model was designed to recode S046 pixel values to S057. The detail of the conditional statement follows:

```
EITHER 57 IF ($n1_s057_mask==1 and $n26_memory== 46) OR
$n26_memory OTHERWISE
```

Where:

57	<i>S057-Mogollon Chaparral</i>
46	<i>S046-Rocky Mountain Gambel Oak Mixed-Montane Shrubland</i>
s057_mask	Mask image indicating where S057 should be mapped
memory	SVPL standard CT output image. Recoded to standard integer code. Note that this output is a temporary memory that has been modified by previous steps in the post classification model

**Step5:** Mapping *S059-Colorado Plateau Blackbrush-Mormon Tea Shrubland*

The detail of the conditional statement follows:

```
EITHER 59 IF ($n29_s059_mask == 1 AND $n3_memory == 65) OR
$n3_memory OTHERWISE
```

Where:

59	<i>S059-Colorado Plateau Blackbrush-Mormon Tea</i>
65	<i>S065-Inter-Mountain Basins Mixed Salt Desert Scrub</i>
s059_mask	Mask image indicating where S059 should be mapped
memory	SVPL standard CT output image. Recoded to standard integer code. Note that this output is a temporary memory that has been modified by previous steps in the post classification model

**Step6:** Discriminating Mesic Conifer from Non-Mesic Conifer Forests Types to the South

**Step 6A:** Discriminating Between Rocky Mountain Montane Dry-Mesic and Rocky Mountain Montane Mesic Conifer Types

```
EITHER 30 IF (($n10_landf == 2 OR $n10_landf== 5 OR
$n10_landf ==6 OR $n10_landf == 9) AND ($n9_asp_9cls== 1 OR
$n9_asp_9cls == 2 OR $n9_asp_9cls == 0) AND ($n30_memory ==
28)) OR $n30_memory OTHERWISE
```

Where:

30                    *S030 Mountain Subalpine Mesic Spruce-Fir Forest and Woodland*

28                    *S028 Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland*

Landform            10 class landform  
                     2= toe slopes, bottoms, and swales,  
                     5= very moist steep slopes,  
                     6= moderately moist steep slopes,  
                     9= cool aspect scarps, cliffs, canyons,

Asp\_9cls            Nine class aspect image  
                     1=North facing slope  
                     2=Northeast facing slope  
                     0=slope less than 3 degrees

memory              SVPL standard output image. Recoded to standard integer code. Note that this output is a temporary memory that has been modified by previous steps in the post classification model.

**Step 6B:** Discriminating Between Rocky Mountain Subalpine Dry-Mesic Spruce-Fir and Rocky Mountain Subalpine Mesic Spruce-Fir Types.

```
EITHER 34 IF (($n47_landf == 2 OR $n47_landf == 5 OR
$n47_landf==6 OR $n47_landf == 9) AND ($n48_aspect_9 == 1 OR
$n48_aspect_9== 2 OR $n48_aspect_9 == 0) AND ($n49_memory==
32)) OR $n49_memory OTHERWISE
```

Where:

34                    *S034 Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland.*

32                    *S032 Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland*

landf                10 class landform  
                     2= toe slopes, bottoms, and swales  
                     5= very moist steep slopes  
                     6= moderately moist steep slopes  
                     9= cool aspect scarps, cliffs, canyons

asp\_9cls            Nine class aspect image  
                     1=North facing slope  
                     2=Northeast facing slope  
                     0=slope less than 3 degrees

memory              SVPL standard CT output image. Recoded to standard integer code. Note that this

output is a temporary memory that has been modified by previous steps in the post classification model.

**UNMT Post-Classification:**

The .gmd file used for this post-classification model is:

/archive/UT2/post\_model/UNMT/swgap\_ut2\_UNMT.gmd

**Step1:** Discriminating Mesic Conifer from Non-Mesic Conifer Forests Types to the South

**Step 1A:** Discriminating Between Rocky Mountain Montane Dry-Mesic and Rocky Mountain Montane Mesic Conifer Types

```
EITHER 30 IF (( $n3_landf == 2 OR $n3_landf == 5 OR
$n3_landf==6 OR $n3_landf == 9 ) AND ( $n4_asp_9cls== 1 OR
$n4_asp_9cls == 2 OR $n4_asp_9cls == 0 ) AND
($n2_m3a1ml1_rec == 28)) OR $n2_m3a1ml1_rec OTHERWISE
```

Where:

30 *S030 Mountain Subalpine Mesic Spruce-Fir Forest and Woodland*

28 *S028 Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland*

Landform 10 class landform  
2= toe slopes, bottoms, and swales,  
5= very moist steep slopes,  
6= moderately moist steep slopes,  
9= cool aspect scarps, cliffs, canyons,

Asp\_9cls Nine class aspect image  
1=North facing slope  
2=Northeast facing slope  
0=slope less than 3 degrees

m3a1ml1\_rec UNMT standard output image. Recoded to standard integer code.

**Step 1B:** Discriminating Between Rocky Mountain Subalpine Dry-Mesic Spruce-Fir and Rocky Mountain Subalpine Mesic Spruce-Fir Types.

```
EITHER 34 IF (( $n3_landf == 2 OR $n3_landf == 5 OR
$n3_landf==6 OR $n3_landf == 9 ) AND ( $n4_asp_9cls == 1 OR
$n4_asp_9cls == 2 OR $n4_asp_9cls == 0 ) AND ($n21_memory==
32 )) OR $n21_memory OTHERWISE
```

Where:

34 *S034 Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland.*

32 *S032 Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland*

landf 10 class landform  
2= toe slopes, bottoms, and swales  
5= very moist steep slopes  
6= moderately moist steep slopes  
9= cool aspect scarps, cliffs, canyons

asp_9cls	Nine class aspect image 1=North facing slope 2=Northeast facing slope 0=slope less than 3 degrees
memory	UNMT standard CT output image. Recoded to standard integer code. Note that this output is a temporary memory that has been modified by previous steps in the post classification model.

**Step 2:** Mapping Foothill Shrubland in Buffer

EITHER 47 IF (\$n20\_memory==46 AND \$n37\_so46tos047\_RC==1) OR \$n20\_memory OTHERWISE

Where:	
47	<i>S047 Rocky Mountain Lower Montane-Foothill Shrubland</i>
46	<i>S046 Rocky Mountain Gambel Oak-Mixed Montane Shrubland</i>
landf	10 class landform 2= toe slopes, bottoms, and swales 5= very moist steep slopes 6= moderately moist steep slopes 9= cool aspect scarps, cliffs, canyons
so46tos047_RC	Mask image indicating where S047 should be mapped. Recoded to a binary image. 1= area to be adjusted 0= all other area
memory	UT4 standard CT output image. Recoded to standard integer code. Note that this output is a temporary memory that has been modified by previous steps in the post classification model.

**c) Generalizing to MMU and map completion:**

Once the CT model and the post-classification steps were employed, the map was generalized using the Clump tool in ERDAS Imagine 8.6. The parameter of 4 connected neighbors (or "rook's move") was used in the clumping process. Isolated pixels that fell under the specified 1-acre minimum mapping unit (MMU) were removed using the Eliminate tool.

Following the Clump & Eliminate step, the non-CT modeled classes were then "burned in" to the final map using the Overlay function. The final map can be found at: /ut/archive/UT2/final\_map/.

**6) Validation:**

**a) CT model validation:** 20% of sample polygons were randomly selected and withheld from CT modeling using the featuresselect.avx as reference data. The CT model was run as described in section 5a using the remaining 80% of the samples. The 20% withheld samples were used to assess the predictive capability of the CT modeled map using the 80% training data. The CT-modeled classes were assessed using kappa.avx, which works by intersecting the validation sample polygons through the CT modeled land cover map, and considers the site correctly mapped when

the majority of pixels within the sample polygon agree with the sample label. Output from kappa.avx consists of a \*.txt, \*.dbf and \*.shp file. The \*.txt file presents the kappa statistic, the \*.dbf file is an error matrix indicating errors of commission and omission and the \*.shp file indicates for each reference sample site whether the sample location was considered correctly mapped, or incorrectly mapped and what it was mapped as. These files can be found at: /ut/archive/UT2/validation/.

**Note: UT2\_80.xls and UT2\_100.xls validation error matrices excel worksheet represents the UT2 mega mapping unit as a whole. These files are a compilation of small mapping units NWMT, CWMT, UNMT and SVPL.**

**b) Final map:** After CT model validation, a final map was generated using the methods described in section 5a this time using 100% of the sample data. Similarly to the steps involved with the 80% CT model, post-classification modeling, inclusion of the non-modeled cover types, and generalization to the MMU were completed to create the final map product, which can be found at /ut/archive/UT2/final\_map/.

**c) Discussion of mapped cover types:** The following narrative provides qualitative assessments by the mapping team for each cover type mapped in this mapping area. 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:

Not quantitatively assessed. Qualitative assessment indicates that most perennial open water has been mapped well. Ephemeral water bodies were not a focus of the effort and may be missing.

N21 DEVELOPED, OPEN SPACE-LOW INTENSITY:

Not quantitatively assessed. Qualitative assessment indicates that most low density developed areas contemporary with the date of the imagery are included. Some confusion may occur with the N22 DEVELOPED, MEDIUM-HIGH INTENSITY class.

N22 DEVELOPED, MEDIUM-HIGH INTENSITY:

Not quantitatively assessed. Qualitative assessment indicates that most low density developed areas contemporary with the date of the imagery are included. Some confusion may occur with the N21 DEVELOPED, OPEN SPACE-LOW INTENSITY class.

N81 PASTURE/HAY:

Not quantitatively assessed. Qualitative assessment indicates that most pasture/hay agricultural areas contemporary with the date of the imagery are included. This class included alfalfa and other non-irrigated agricultural types, which may be confused with N82 CULTIVATED CROPS.

N82 CULTIVATED CROPS:

Not quantitatively assessed. Qualitative assessment indicates that most cultivated agricultural areas contemporary with the date of the imagery are included. This class may be confused with N81 PASTURE/HAY, where crops were harvested prior to the date of the imagery or where crops were out of rotation for the season producing spectral signatures similar to that of N81.

D02 RECENTLY BURNED:

Not quantitatively assessed. Qualitative assessment indicates that most recently burned areas contemporary with the date of the imagery are included. This class may be confused with areas that

have had fires in the past, but where the site has become somewhat revegetated since the time of the burn.

D03 RECENTLY MINED OR QUARIED:

Not quantitatively assessed. Qualitative assessment indicates that most recently mined or quarried areas contemporary with the date of the imagery are included. Some confusion may occur with the N21 DEVELOPED, OPEN SPACE-LOW INTENSITY class.

D06 INVASIVE PERENNIAL GRASSLAND:

Quantitatively assessed, validation 50% (producers) and 64% (users) based on 14 independent validation samples. Confusion is primarily distributed between S039, S046, S071 and S078. Confusion can be partially explained by the common practice of seeding crested wheatgrass in many communities. Where training data was available D08 mapped very well.

D08 INVASIVE ANNUAL GRASSLAND:

Quantitatively assessed, validation 67% (producers) and 67% (users) based on 3 independent validation samples. Where training data was available D08 mapped very well.

D10 RECENTLY LOGGED AREAS:

Not quantitatively assessed. Qualitative assessment indicates that most recently logged areas contemporary with the date of the imagery are included. This class may be confused with areas that have been logged in the past, but where the site has become somewhat revegetated since the time of the logging.

D11 RECENTLY CHAINED PINYON-JUNIPER AREAS:

Not quantitatively assessed. Qualitative assessment indicates that most recently chained pinyon-juniper areas contemporary with the date of the imagery are included. This class may be confused with areas that have been chained in the past, but where the site has become somewhat revegetated since the time of the chaining.

D14 DISTURBED - OIL WELL:

Not quantitatively assessed. Qualitative assessment indicates that most disturbed areas due to oil well development contemporary with the date of the imagery are included. There are areas known to have oil well development but were not mapped due to minimum mapping unit constraints. Some confusion may occur with the N21 DEVELOPED, OPEN SPACE-LOW INTENSITY class.

S001 NORTH AMERICAN ALPINE ICE FIELD:

Quantitatively assessed, validation 100% (producers) and 100% (users) based on 6 independent validation samples. This system represents perennial snow fields within the Uinta Mountains. It may be slightly over mapped. Talus slopes with late season snow captured on the summer Landsat TM may be better mapped as S002. S001 is mapping extremely well as expected.

S002 ROCKY MOUNTAIN ALPINE BEDROCK AND SCREE:

Quantitatively assessed, validation 91% (producers) and 76% (users) based on 32 independent validation samples. S006 mapped very well.

S004 ROCKY MOUNTAIN ALPINE FELL-FIELD:

Quantitatively assessed, validation 44% (producers) and 57% (users) based on 9 independent validation samples. Confusion is primarily with S043 ROCKY MOUNTAIN ALPINE DWARF-SHRUBLAND (2 of 9 samples) and S081 Rocky Mountain Dry Tundra (2 of 9 samples). All three systems are found in an alpine environment and are made up

of dwarfed fauna which can account for this confusion. Where training data was available S004 mapped very well.

S006 ROCKY MOUNTAIN CLIFF AND CANYON COMPLEX:

Quantitatively assessed, validation 54% (producers) and 71% (users) based on 54 independent validation samples. S006 mapped very well. Confusion is primarily with S071 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (9 of 54 samples) and S039 COLORADO PLATEAU PINYON-JUNIPER WOODLAND (6 of 54 samples). It is unclear why this confusion is occurring. Where training data was available S006 mapped very well.

S010 COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND:

Quantitatively assessed, validation 75% (producers) and 75% (users) based on 4 independent validation samples. S010 is mapping well.

S011 INTER-MOUNTAIN BASINS SHALE BADLANDS: Quantitatively assessed, validation 100% (producers) and 100% (users) based on 3 independent validation samples. S011 is mapping very well in spite of low sample numbers.

S013 INTER-MOUNTAIN BASINS ROCK AND CINDERLAND:

Not quantitatively assessed. Qualitative assessment indicates that areas where volcanic rock and cinderland were relatively void of vegetation are included. This class may be confused with areas known to have underlying volcanic rock substrata, but are covered by a greater proportion of vegetation than this relatively unvegetated land cover type.

S023 ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND: Quantitatively assessed, validation 85% (producers) and 73% (users) based on 181 independent validation samples. Confusion is primarily with S042 INTER-MOUNTAIN WEST ASPEN-MIXED CONIFER FOREST AND WOODLAND COMPLEX (6 of 181 samples) and S046 ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND (5 of 27 samples). Confusion can be partially explained by spectral similarities among these cover types. S023 mapped very well.

S024 ROCKY MOUNTAIN BIGTOOTH MAPLE RAVINE WOODLAND:

Quantitatively assessed, validation 71% (producers) and 74% (users) based on 24 independent validation samples. Confusion is primarily with S046 ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND (4 of 24 samples). Confusion can be explained by morphological and spectral signature similarities among these two cover types.

S025 ROCKY MOUNTAIN SUBALPINE-MONTANE LIMBER-BRISTLECONE PINE WOODLAND: Quantitatively assessed, validation 50% (producers) and 100% (users) based on 4 independent validation samples. Where training data was available S025 mapped very well. Confusion is with S028 and S071.

S028 ROCKY MOUNTAIN SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLAND: Quantitatively assessed, validation 73% (producers) and 60% (users) based on 156 independent validation samples. Confusion is primarily with S031 ROCKY MOUNTAINS LODGEPOLE FOREST (11 of 156 samples) and S042 INTER-MOUNTAIN WEST ASPEN-MIXED CONIFER FOREST AND WOODLAND COMPLEX (12 of 156 samples). Confusion can be explained by spectral similarities and shared species among these two cover types.

S030 ROCKY MOUNTAIN SUBALPINE MESIC SPRUCE-FIR FOREST AND WOODLAND: Not quantitatively assessed. This cover type was

attained using a post processing modeler. Please reference methods section entitled *Post-classification and recoding*, detailed explanation. Post-classification mapped S030 well.

S031 ROCKY MOUNTAIN LODGEPOLE PINE FOREST:

Quantitatively assessed, validation 54% (producers) and 61% (users) based on 50 independent validation samples. Significant confusion is with S028 ROCKY MOUNTAINS SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLAND (17 of 50 samples). Confusion can be attributed to spectral signature similarity among these two cover types.

S032 ROCKY MOUNTAIN MONTANE DRY-MESIC MIXED CONIFER FOREST AND

WOODLAND: Quantitatively assessed, validation 47% (producers) and 59% (users) based on 74 independent validation samples. Significant confusion is with S028 ROCKY MOUNTAINS SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLAND (21 of 74 samples). Confusion can be attributed to spectral signature similarity among these two cover types.

S034 ROCKY MOUNTAIN MONTANE MESIC MIXED CONIFER FOREST AND

WOODLAND: Not quantitatively assessed. This cover type was attained using a post processing modeler. Please reference methods section entitled *Post-classification and recoding, Step 2b*, for a detailed explanation. Post-classification mapped S034 well.

S036 ROCKY MOUNTAIN PONDEROSA PINE WOODLAND:

Quantitatively assessed, validation 53% (producers) and 58% (users) based on 53 independent validation samples. Confusion primarily occurring with S039 COLORADO PLATEAU PINYON-JUNIPER WOODLAND (12 of 53 samples). Spectral can be to blame for this confusion.

S039 COLORADO PLATEAU PINYON-JUNIPER WOODLAND: Quantitatively assessed, validation 83% (producers) and 68% (users) based on 191 independent validation samples. Confusion is distributed among S071 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (7 of 191 samples), S054 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND (4 of 191 samples), and S046 ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND (4 of 191 samples). Sagebrush and Gambel Oak/ Mixed Montane Shrubs are common in the understory of S039 and can be at time codominating the stand. Overall, this upper pinyon-juniper belt woodland mapped very well.

S040 GREAT BASIN PINYON-JUNIPER WOODLAND:

Quantitatively assessed, validation 64% (producers) and 82% (users) based on 22 independent validation samples. Significant confusion is with S039 COLORADO PLATEAU PINYON-JUNIPER WOODLAND (5 of 22 samples). Both cover types are comprised of pinyon-juniper differing only by the type of dominating pinyon present in the stand. Where training data was available S040 mapped very well.

S042 INTER-MOUNTAIN WEST ASPEN-MIXED CONIFER FOREST AND WOODLAND

COMPLEX: Quantitatively assessed, validation 16% (producers) and 38% (users) based on 64 independent validation samples. Confusion is distributed among S023 ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND (19 of 64 samples) and S028 ROCKY MOUNTAINS SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLAND (23 of 64 samples). Confusion can be explained by similarities in species composition among these three cover types. Overall this is a difficult and variable cover type to map.

S043 ROCKY MOUNTAIN ALPINE DWARF-SHRUBLAND:

Quantitatively assessed, validation 38% (producers) and 33% (users) based on 8 independent validation samples. Confusion is

primary with S102 ROCKY MOUNTAINS ALPINE/MONTANE WET MEADOW. Both types are spectrally and hydrological similar, which can be attributed to some of this confusion.

S046 ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND:

Quantitatively assessed, validation 61% (producers) and 61% (users) based on 109 independent validation samples. Confusion is distributed among several systems. Confusion can be partially explained by the presence of *Quercus gambelii* in the understory of a variety of systems and the patchwork growing habits which allows for S046 to intermingle with other systems. Spectral similarities can also drive confusion with S023.

S047 ROCKY MOUNTAINS LOWER MONTANE-FOOTHILL SHRUBLAND

Not quantitatively assessed. This cover type was attained using a post processing modeler. Please reference methods section entitled *Post-classification and recoding*, for a detailed explanation. Post-classification mapped S047 very well.

S050 INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLAND AND

SHRUBLAND: Quantitatively assessed, validation 30% (producers) and 80% (users) based on 27 independent validation samples. Confusion is primarily with S039 COLORADO PLATEAU PINYON-JUNIPER WOODLAND (4 of 27 samples). These systems tend to occur in close relation to one another. Confusion can be explained by similarity in stand structure and signature.

S052 COLORADO PLATEAU PINYON-JUNIPER SHRUBLAND: Quantitatively assessed, validation 70% (producers) and 58% (users) based on 10 independent validation samples. Confusion is primarily with S039 COLORADO PLATEAU PINYON-JUNIPER WOODLAND (2 of 10 samples). Both systems are pinyon-juniper, differing only by the stand height and growing patterns, which can explain the confusion. Overall, this lower pinyon-juniper belt shrubland is mapping well.

S054 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND: Quantitatively assessed, validation 77% (producers) and 64% (users) based on 115 independent validation samples. Confusion is primarily with S071 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (8 of 115 samples) and S078 INTER-MOUNTAIN BASINS BIG SAGEBRUSH STEPPE (8 of 115 samples). All three systems are dominated by Big Sagebrush. S071 differs only by subspecies and S078 by the significant presence of perennial grass. Otherwise, S054 is mapping well.

S056 COLORADO PLATEAU MIXED LOW SAGEBRUSH SHRUBLAND:

Quantitatively assessed, validation 33% (producers) and 75% (users) based on 18 independent validation samples. Confusion is primarily with S054 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND (7 of 18 samples). These two systems are commonly found adjacent to one another, and share codominating species. Where training data was available S056 mapped very well.

S057 MOGOLLON CHAPARRAL:

Not quantitatively assessed. This cover type was attained using a post processing modeler. Please reference methods section entitled *Post-classification and recoding* for a detailed explanation. Post-classification mapped S047 very well.

S059 COLORADO PLATEAU BLACKBRUSH-MORMON-TEA SHRUBLAND:

Not quantitatively assessed. This cover type was attained using a post processing modeler. Please reference methods section entitled *Post-classification and recoding* for a detailed explanation. Post-classification mapped S047 very well.

S065 INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB:

Quantitatively assessed, validation 58% (producers) and 54% (users) based on 12 independent validation samples. Confusion is distributed among several different communities. Confusion can be partially attributed to the diversity of habitats in which *Atriplex confertifolia* can reside. Where training data was available S065 mapped well.

S071 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE:

Quantitatively assessed, validation 78% (producers) and 69% (users) based on 300 independent validation samples. Confusion is predominantly with S054 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND (12 of 300 samples). Confusion can be partially explained by similarities in species and/or could likely be attributed to sub-specie misidentification.

S078 INTER-MOUNTAIN BASINS BIG SAGEBRUSH STEPPE:

Quantitatively assessed, validation 38% (producers) and 32% (users) based on 26 independent validation samples. Confusion is predominantly with S054 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND (5 of 26 samples) and S071 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (7 of 26 samples). All three systems are dominated by Big Sagebrush. S071 differs only by subspecies and S054 by the absence of significant perennial grass.

S079 INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB STEPPE:

Quantitatively assessed, validation 50% (producers) and 58% (users) based on 14 independent validation samples. Confusion is primarily with S054 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND (5 of 14 samples). Confusion can be partially explained by the variability of species composition within S079. These two systems are commonly found adjacent to one another, and share codominating species. Where training data was available S079 mapped very well.

S081 ROCKY MOUNTAIN DRY TUNDRA

Quantitatively assessed, validation 60% (producers) and 71% (users) based on 25 independent validation samples. Confusion is distributed among several different alpine communities. Where training data was available S081 mapped very well.

S083 ROCKY MOUNTAIN SUBALPINE MESIC MEADOW:

Quantitatively assessed, validation 40% (producers) and 40% (users) based on 62 independent validation samples. Confusion is significant with S071 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (14 of 40 samples). These two systems are commonly found adjacent to one another, and share codominating species. Where training data was available S083 mapped very well.

S085 SOUTHERN ROCKY MOUNTAINS MONTANE GRASSLAND: Quantitatively assessed, validation 12% (producers) and 45% (users) based on 42 independent validation samples. Confusion is primarily with S071 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (17 of 42 samples) and S054 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND (5 of 42 samples). These systems are commonly found adjacent to one another and can share codominating species. Where training data was available S085 mapped very well.

S091 ROCKY MOUNTAIN SUBALPINE-MONTANE RIPARIAN SHRUBLAND:

Quantitatively assessed, validation 47% (producers) and 64% (users) based on 30 independent validation samples. Confusion is primarily with S102 ROCKY MOUNTAINS ALPINE/MONTANE WET MEADOW (5 of 30 samples). Confusion can be partially explained by morphologic/hydrologic/spectral similarities between the two cover types. Where training data was available S091 mapped well.

S093 ROCKY MOUNTAINS LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND COMPLEX: Quantitatively assessed, validation 50% (producers) and 72% (users) based on 36 independent validation samples. Confusion is primarily with S046 ROCKY MOUNTAINS GAMBEL OAK - MIXED MONTANE SHRUBLAND (6 of 36 samples). Confusion can be partially explained by morphologic and spectral similarities between the two cover types. Where training data was available S093 mapped very well.

S096 INTER-MOUNTAIN BASINS GREASEWOOD FLAT COMPLEX: Quantitatively assessed, validation 57% (producers) and 100% (users) based on 7 independent validation samples. Confusion is with a variety of cover types. Where training data was available S096 mapped very well.

S102 ROCKY MOUNTAINS ALPINE/MONTANE WET MEADOW: Quantitatively assessed, validation 45% (producers) and 50% (users) based on 40 independent validation samples. Confusion is primarily with S071 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE (7 of 40 samples). These systems are commonly found adjacent to one another and can share codominating species. Where training data was available S102 mapped very well.

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