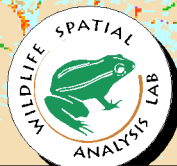
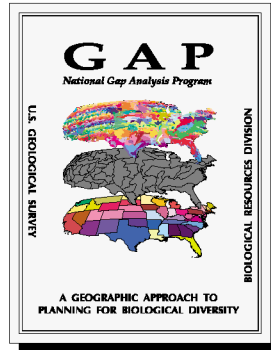


# MONTANA Gap Analysis

## Montana Land Cover Atlas



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COVER ILLUSTRATION :  
Enlargement of statewide land cover  
map for the Dillon, Montana area

# MONTANA LAND COVER ATLAS

## THE MONTANA GAP ANALYSIS PROJECT

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## **Introduction**

This atlas is a product of the Montana Gap Analysis project (MT-GAP). It is intended to serve as a reference to accompany and supplement the project's digital data in a geographic information system (GIS). We begin with a description of the land cover classification system that we used, followed by a brief overview of the mapping process. Then, for each cover type, we provide a statewide map of its distribution, a photograph, a descriptive summary of its size and spatial characteristics, and plant composition.

Much of the information contained in the atlas was obtained from a digital GIS database which is also available (see "How to obtain GAP data" below). Users are reminded that the digital source data were derived and assembled for the purpose of mapping land cover at relatively broad scales. Although the smallest mapping unit was 90 m<sup>2</sup> pixels, such small units are not visible on the atlas maps, nor should one assume that the digital data warrant use at such fine scale. Thematic map accuracy was calculated using fuzzy sets and a bootstrap procedure which allowed misclassification probabilities to be estimated at the location of each training data point. Absolute thematic accuracy for 45 cover types averaged 61.4%, ranging from 4.4% for Western Hemlock to 93.2% for Missouri Breaks; at the "acceptable" level, mean accuracy increased to nearly 89%.

## **Classification system**

In 1991, at the outset of MT-GAP, there was no classification system for existing vegetation available for Montana, and by the time our land cover map was completed in 1997, we were aware of no complete list of alliance types for the state. Consequently, we followed the lead of neighbors in Wyoming (Merrill et al. 1996) and developed a classification based on the hierarchical design of Anderson et al. (1976). Land cover types were targeted and defined according to known occurrences in the state and from classifications used for GAP projects in both Idaho (Caicco et al. 1995) and Wyoming (Merrill et al. 1996). The final list of 50 land cover types is shown in Table 1.

## **Mapping methods**

The 50 land cover types were mapped as follows. We developed a two-stage, digital process (Figure 1) to independently classify and label 33 Landsat TM scenes covering Montana. Using more than 23,000 ground reference data, nearly 4.4 million raster polygons were labeled to one of 94 land cover types. Upland cover types were mapped to a 2 ha minimum map unit (MMU) statewide. In eastern Montana, riparian and woody draw vegetation types were mapped to a 0.4 ha MMU, whereas in western Montana, a separate pixel classification was performed for riparian types. These independent classifications were edge-matched to create a virtually seamless raster database. From this, we created a statewide layer with a single attribute, land cover type. Recognizing that this dataset would be too large for predicting the statewide distributions of 425 terrestrial vertebrates, several additional steps were carried out to reduce the output file size, including 1) regrouping the 94 cover types to 50 types that were mapped more consistently across the state, and 2) resampling the 30 m grid to 90 m. The final land cover database has a variable MMU, ranging from 0.8 ha (one 90 m<sup>2</sup> pixel) for water, riparian, and woody draw cover types, to 100 ha (125 90 m<sup>2</sup> pixels) for clouds and cloud shadows. The intended MMU for all other cover types was 2 ha, the target of our final merge, but due to the resampling step, some upland types remain in the database as single 90 m<sup>2</sup> pixels. Most upland types, however, should occur in patches of 2.4 ha (three 90 m<sup>2</sup> pixels) or larger. More details about these methods can be found in the project final report (Redmond et al. 1998).

Table 1. The classification system used to map Montana's existing vegetation and land cover.

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**I. Urban and Agricultural Lands**

- 1100 Urban or Developed Lands
- 2010 Agricultural Lands - Dry
- 2020 Agricultural Lands - Irrigated

**II. Grasslands**

*herbaceous cover > 15%, shrub cover < 15%, and forest cover < 10%*

- 3110 Altered Herbaceous
- 3130 Very Low Cover Grasslands
- 3150 Low / Moderate Cover Grasslands
- 3170 Moderate / High Cover Grasslands
- 3180 Montane Parklands & Subalpine Meadows

**III. Shrublands**

*shrub cover (SC) > 15% and forest cover < 10%; except 3500 classes where SC = HC*

- 3200 Mixed Mesic Shrubs
- 3300 Mixed Xeric Shrubs
- 3309 Silver Sage
- 3310 Salt-Desert Shrub / Dry Salt Flats
- 3350 Sagebrush
- 3510 Mesic Shrub - Grassland Associations
- 3520 Xeric Shrub - Grassland Associations

**IV. Forest Lands**

*forest cover > 10%*

- 4000 Low Density Xeric Forest
- 4140 Mixed Broadleaf Forest
- 4203 Lodgepole Pine
- 4205 Limber Pine
- 4206 Ponderosa Pine
- 4207 Grand Fir
- 4210 Western Red Cedar
- 4211 Western Hemlock
- 4212 Douglas-fir
- 4214 Rocky Mountain Juniper
- 4215 Western Larch
- 4216 Utah Juniper
- 4223 Douglas-fir / Lodgepole Pine
- 4260 Mixed Whitebark Pine Forest
- 4270 Mixed Subalpine Forest
- 4280 Mixed Mesic Forest
- 4290 Mixed Xeric Forest
- 4300 Mixed Broadleaf & Conifer Forest
- 4400 Standing Burnt Forest

**V. Water**

- 5000 Water

**VI. Riparian Types**

*sites clearly associated with riparian areas or woody draws*

- 6110 Conifer Riparian
- 6120 Broadleaf Riparian
- 6130 Mixed Broadleaf & Conifer Riparian
- 6200 Graminoid & Forb Riparian
- 6300 Shrub Riparian
- 6400 Mixed Riparian

**VII. Barren Lands**

*sites with forest cover < 10%, shrub cover < 10%, and herbaceous cover < 10%*

- 7300 Rock
- 7500 Mines, Quarries, Gravel Pits
- 7600 Badlands
- 7604 Missouri Breaks
- 7800 Mixed Barren Sites

**VIII. Alpine**

*vegetated sites above treeline*

- 8100 Alpine Meadows

**IX. Perennial Snow and Ice**

- 9100 Snowfields or Ice

**X. Other**

- 9800 Clouds
  - 9900 Cloud Shadows
-

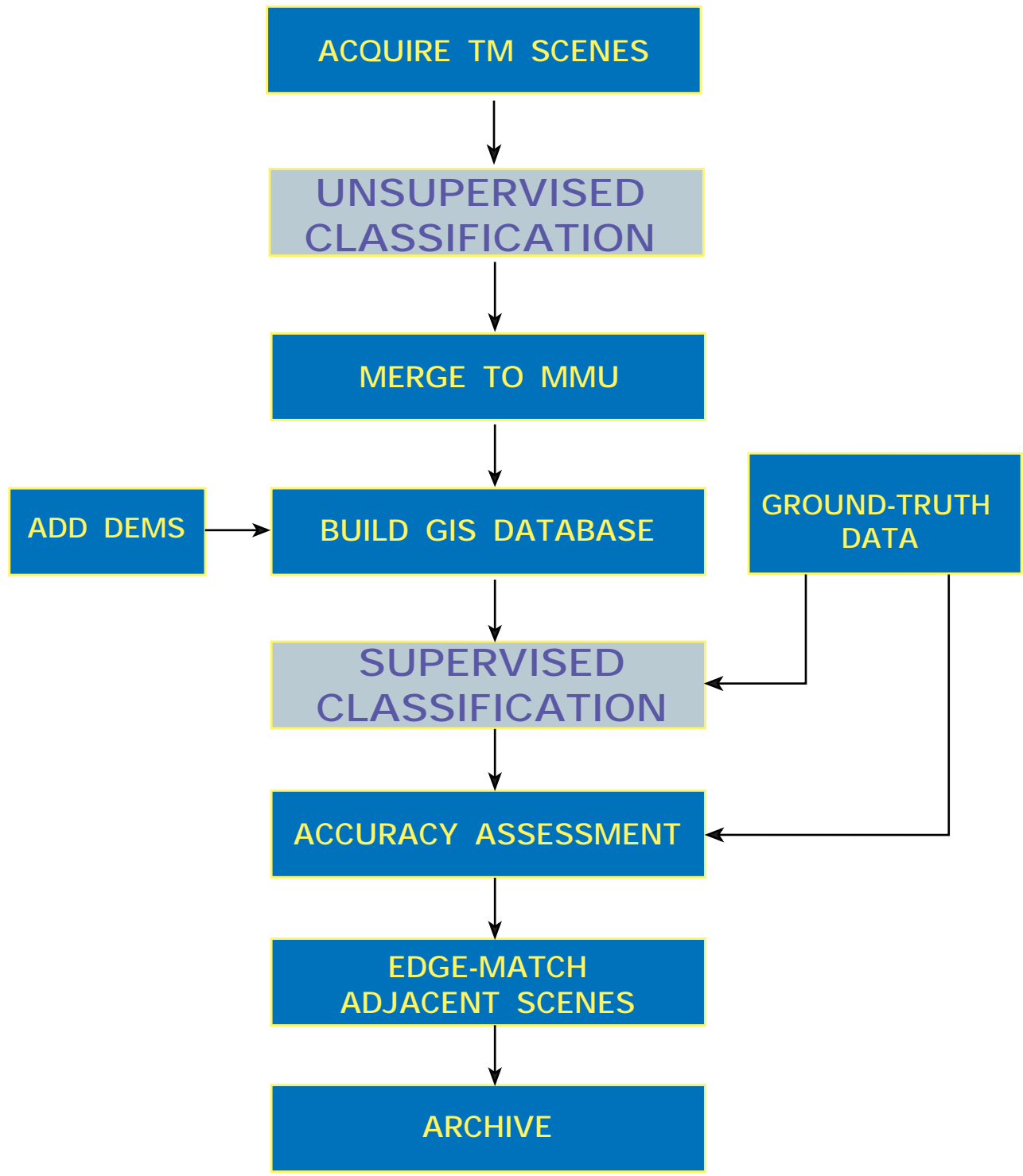


Figure 1. Overview of the two-stage digital process applied to 33 Landsat TM scenes for Montana.

## **How to obtain GAP data**

It is the goal of the Gap Analysis Program and the USGS Biological Resources Division (BRD) to make the data and associated information as widely available as possible. Use of the data requires specialized geographic information system (GIS) software and substantial computing power. Additional information on how to obtain and use the data is provided below and on the GAP homepage:

*<http://www.gap.uidaho.edu/gap>*

Follow the links to “project information” and then to Montana or any other state of interest.

## **Official disclaimer for GAP data**

Although these data have been processed successfully on a computer system at the BRD, no warranty expressed or implied is made regarding the accuracy or utility of the data on any other system or for general or scientific purposes. Also, the act of distribution does not constitute any such warranty. This disclaimer applies both to individual use of the data and aggregate use with other data. It is strongly recommended that these data are directly acquired from a BRD server [see above for approved data providers] and not indirectly through other sources which may have changed the data in some way. It is also strongly recommended that careful attention be paid to the content of the metadata file associated with these data. The Biological Resources Division is not liable for improper or incorrect use of the data described and/or contained herein.

These data were compiled with regard to the following standards. Please be aware of the limitations of the data. These data are meant to be used at a scale of 1:100,000 or smaller (such as 1:250,000 or 1:500,000) for the purpose of assessing the conservation status of vertebrate species and vegetation types over large geographic regions. The data may or may not have been assessed for statistical accuracy. Data evaluation and improvement may be ongoing. The Biological Resources Division makes no claim as to the data's suitability for other purposes. This is writable data which may have been altered from the original product if not obtained from a designated data distributor identified above.

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An effort of this magnitude is completed only with the input, support, and contributions of many people. We attempt to thank all contributors as best we can, and apologize for any omissions along the way. Despite the careful review of cover type distributions by knowledgeable scientists and managers in the state, the ultimate responsibility for the accuracy and utility of this atlas rests with the authors. We welcome any and all constructive feedback.

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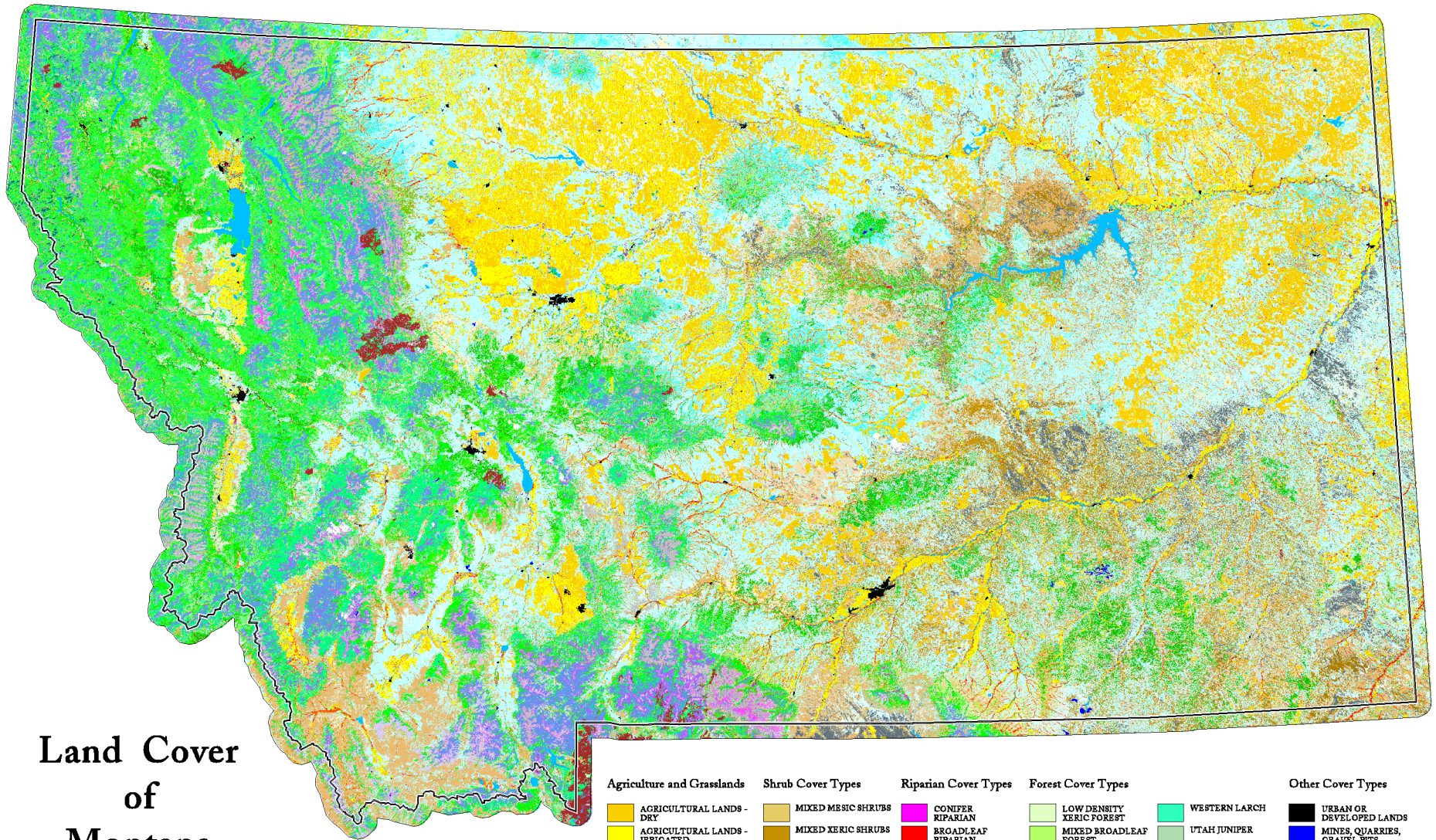
Classification and labeling of the 11 TM images in western Montana were funded by the Forest Service, Northern Region. Martin Prather provided the leadership and guidance to see it through to completion; he was assisted by three different Contracting Officers: Jim Hamilton, Roger Thomas, and Dallas Summerfield. Dave Atkins devoted nearly two years to managing the day-to-day interactions between our respective organizations. Further coordination between Forest Service field crews and this lab was provided by Kristen Loken, Marcy Mahr, and one of us (Fisher). The sometimes thankless job of data entry was carried out with care by Gerri Deleo and Pat Mikota. Field data then were processed, formatted, and transferred to us by Dave Browder, John Caratti, Mike Jensen, and Rosa Nygaard. Biophysical data related to landform boundaries in Montana were provided by John Nesser. Dick Roullier and Bill Tanke helped us acquire all 7.5 minute digital elevation models (DEMs) and Cartographic Feature Files for the state from the Forest Service Geometronics Service Center. A number of other Forest Service personnel also deserve special mention: Art Zack (Idaho Panhandle), Pat Green (Nez Perce), Sonny Castille (Clearwater), Dan Leavell (Kootenai), Maria Mantas (Flathead), Nora Leetch (Lolo), Janet Johnson and Linda Pietarinen (Bitterroot), John Joy (Deer Lodge), Lee Harry and Dan Svoboda (Beaverhead), Lois Olsen (Helena), Tim Horn (Lewis and Clark), Julie Neff-Shea (Gallatin), and Jeff DiBenedetto (Custer).

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# Land Cover of Montana



| Agriculture and Grasslands     | Shrub Cover Types                 | Riparian Cover Types              | Forest Cover Types       | Other Cover Types                    |
|--------------------------------|-----------------------------------|-----------------------------------|--------------------------|--------------------------------------|
| AGRICULTURAL LANDS - DRY       | MIXED MESIC SHRUBS                | CONIFER RIPARIAN                  | LOW DENSITY XERIC FOREST | URBAN OR DEVELOPED LANDS             |
| AGRICULTURAL LANDS - IRRIGATED | MIXED XERIC SHRUBS                | BROADLEAF RIPARIAN                | MIXED BROADLEAF FOREST   | MINES, QUARRIES, GRAVEL PITS         |
| ALTERED HERBACEOUS             | SILVER SAGE                       | MIXED BROADLEAF/ CONIFER RIPARIAN | LODGEPOLE PINE           | ROCK                                 |
| VERY LOW COVER GRASSLANDS      | SALT-DESERT SHRUB/ DRY SALT FLATS | SHRUB RIPARIAN                    | LIMBER PINE              | BADLANDS                             |
| LOW/MODERATE COVER GRASSLANDS  | SAGEBRUSH                         | MIXED RIPARIAN                    | PONDEROSA PINE           | MISSOURI BREAKS                      |
| MODERATE/HIGH COVER GRASSLANDS | MESIC SHRUB-GRASS ASSOCIATIONS    | GRAMINOID & FORB RIPARIAN         | GRAND FIR                | MIXED BARREN SITES                   |
|                                | XERIC SHRUB-GRASS ASSOCIATIONS    |                                   | WESTERN RED CEDAR        | MONTANE PARKLANDS/ SUBALPINE MEADOWS |
|                                |                                   |                                   | WESTERN HEMLOCK          | ALPINE MEADOWS                       |
|                                |                                   |                                   | DOUGLAS-FIR              | SNOWFIELDS OR ICE                    |
|                                |                                   |                                   | ROCKY MTN. JUNIPER       | WATER                                |
|                                |                                   |                                   |                          | WESTERN LARCH                        |
|                                |                                   |                                   |                          | UTAH JUNIPER                         |
|                                |                                   |                                   |                          | DOUGLAS-FIR/ LODGEPOLE PINE          |
|                                |                                   |                                   |                          | MIXED WHITEBARK PINE FOREST          |
|                                |                                   |                                   |                          | MIXED SUBALPINE FOREST               |
|                                |                                   |                                   |                          | MIXED MESIC FOREST                   |
|                                |                                   |                                   |                          | MIXED XERIC FOREST                   |
|                                |                                   |                                   |                          | MIXED BROADLEAF/ CONIFER FOREST      |
|                                |                                   |                                   |                          | STANDING BURNT FOREST                |