DISTRIBUTION OF ASPEN WOODLANDS IN THE BUREAU OF LAND MANAGEMENT'S ROCK SPRINGS (WYOMING) FIELD OFFICE, AND A PROPOSAL FOR FIELD STUDY OF THEIR NATURE AND CONDITION

Final Report for
Assistance Agreement KAA041040

between the BLM Rock Springs Field Office and the University of Wyoming,
Wyoming Natural Diversity Database

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ABSTRACT

Quaking aspen (*Populus tremuloides* Michx.) provides the only deciduous tree habitat on uplands in southwestern Wyoming. Stands of aspen are most common on the foothills of the mountains, but also grow at lower elevations in the basins. Aspen woodland in some form has been mapped on three digital data layers that cover the Bureau of Land Management's Rock Springs Field Office. Those three layers were combined in a geographic information system, and from the combined layer, a set of points was generated where aspen likely occurs on public lands. A subset of those points was selected as possible sampling locations for the collection of information on the species composition, vegetation structure, and condition of the aspen woodlands. A sampling methodology is suggested that would use systematic descriptions of entire stands and plot-based sampling of saplings and trees in homogeneous areas of the stands. This information would help biologists and managers understand what sort of management practices might be useful in aspen woodlands throughout the field office.

ACKNOWLEDGEMENTS

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INTRODUCTION

Aspen woodlands provide the only upland deciduous forest habitat, and most of the entire deciduous forest habitat, in the basins and foothills of southwestern Wyoming (Merrill *et al.* 1996). The possible decline in aspen woodlands throughout the western United States is a subject of considerable concern to biologists and resource managers (Shepperd *et al.* 2000). Discussion of this topic seems to have focused on aspen woodland in the mountains, with little attention given to the lower elevation stands that provide a large proportion of the habitat structure in areas such as the basins of southwestern Wyoming.

In 2004, the Bureau of Land Management and the Wyoming Natural Diversity Database entered into a cooperative project to devise an approach for determining the distribution, nature, and condition of aspen woodlands in the Bureau's Rock Springs Field Office of southwestern Wyoming (Figure 1). Aspen woodlands occur there on the foothills of the surrounding mountains, and at lower elevations in the basins. This report presents the results of that project, in the form of a set of sampling points at which field data might be collected, and methodology for collecting those data

METHODS

AVAILABLE DATA LAYERS

Three data layers showing some representation of aspen in the Rock Springs Field Office were used to select potential sampling points.

1. BLM Vegetation Map

In 2004, the BLM used supervised classification of Landsat images to create a vegetation map of the lands administered by the Rock Springs Field Office (Adams 2005). The dates of the Landsat images are unknown, but the vegetation map is considered relevant from 2005 onward. Data from this map were supplied to the Wyoming Natural Diversity Database in a geodatabase. Two feature classes from that geodatabase, the aspen and the aspen-conifer classes, were added as themes to an ArcMap project and merged into a single theme that was saved as a shapefile[1]. The portion of that shape file on public lands was then clipped with a shape file derived from the land ownership layer produced by the 1996 Wyoming Gap Analysis Project (Merrill, Kohley, *et al.* 1996). (Table 1 shows the values for the "Owner" and "Ownername" fields from the 1996 GAP ownership layer that were considered to be BLM-managed public lands.)

The number of polygons of each feature class and the area covered by the polygons of each feature class were calculated, and the areas of the polygons in each class were summed to give an estimate of the area of aspen forest and of aspen-conifer forest on public lands in the Rock Springs Field Office.

The cottonwood_riparian feature class also was added to an ArcView project and converted to a shape file. This data layer was later used to eliminate from consideration cottonwood stands that might be included in the deciduous forest class in the Wyoming Land Cover Data Set, as discussed below.

2. Wyoming Land Cover Data Set

The Wyoming Land Cover Data Set is a subset of the nationwide National Land Cover Dataset, a program by the U.S. Geological Survey and the U.S. Environmental Protection Agency to map 21 land cover classes through unsupervised classification of 30-meter Landsat TM scenes (U.S. Geological Survey 2001). The Wyoming data set was created as part of the regional data set for Federal Region

[1] All manipulations of spatial files were performed with the ArcMap geographic information system program, version 9.1 (ESRI, Redlands, California USA).

VIII (which consists of Wyoming, Colorado, Utah, South Dakota, North Dakota, and Montana). The portion of the Wyoming data set that covers the Rock Springs Field Office was produced from three Landsat scenes acquired in 1989 and 1991.

Two cover classes in the Wyoming Land Cover Data Set correspond to the aspen types from the BLM vegetation map and the 1996 Wyoming Gap Analysis Project. Those classes, the deciduous forest class (gridcode 41) and the mixed forest class (gridcode 43), are defined as follows:

> "41. Deciduous Forest -- Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change."
>
> 43. Mixed Forest -- Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present." (U.S. Geological Survey 2001)

Aspen forms the only deciduous forests on uplands in the Rock Springs Field Office, so cover class 41 on uplands should be the equivalent of the aspen cover class from the BLM vegetation map. For the same reason, cover class 43 on uplands should be the equivalent of the BLM aspen-conifer cover class. The aspen forest cover type from the 1996 GAP land cover layer should include both cover classes 41 and 43 from the Wyoming Land Cover Data Set.

A raster digital data set of the Wyoming Land Cover data for southwestern Wyoming (U.S. Geological Survey 2000) was converted to a shape file, and the records for the deciduous forest and mixed forest cover classes were selected and saved to a second shape file. That shape file was then clipped to extract just the records within the boundaries of the Rock Springs Field Office, and then just the records on public lands.

Because the deciduous forest and mixed forest cover classes might also include stands of cottonwoods, the common deciduous tree of riparian areas, the cottonwood riparian cover class from the BLM vegetation map was used to remove possible cottonwood stands: the intersection of the BLM cottonwood riparian shape file with the Wyoming Land Cover Data Set shape file was calculated, and that intersection file was used to erase records from the Wyoming Land Cover Data Set shape file. The effect was negligibly: only three records were removed.

3. 1996 Wyoming Gap Analysis Project Landcover Layer

The Wyoming Gap Analysis Project (GAP) (Merrill, Kohley, *et al.* 1996) released a land cover layer in 1996 (Wyoming Gap Analysis 1996) that shows, for the entire state of Wyoming, the distribution of 41 cover-types. This data layer was produced by on-screen digitizing of polygons over Landsat TM scenes from the years 1987 through 1993. The Rock Springs Field Office lies on five Landsat TM images. Four of those images, from 1988 and 1989, cover all but a sliver in the southwestern part of the field office. That small area is covered by the fifth image from 1993.

The smallest polygons shown in the GAP land-cover layer are 100 ha for uplands and 40 ha for wetlands and riparian areas. In every polygon, the cover-type occupying the most area was identified as the primary cover-type. Many polygons also were assigned a secondary cover-type (the second-most common type, if any) and an "other" type (an additional type present, if any). The GAP data layer shows the percent of each polygon's area occupied by the primary and secondary cover-types.

A digital file of the state-wide land cover layer was obtained from the University of Wyoming's Geographic Information Science Center (http://www.sdvc.uwyo.edu/24k/landcov.html). The portion of that file covering the Rock Springs Field Office was clipped out with a shape file of the boundary of that field office and saved in a second landcover shape file. From this second landcover file of all GAP landcover types in the Rock Springs Field Office, the polygons in which aspen forest (cover code 41001) was mapped as the primary cover-type, secondary cover-type, or an other cover-type were selected and saved in a third landcover shape file. The aspen forest cover-type is defined as follows:

"Forest in which aspen dominates the canopy. Includes pure aspen forest and mixed conifer/aspen forest where aspen occupies more than 50% of the total canopy. Total canopy cover by trees must be greater than 25%." (Merrill, Driese, *et al.* 1996)

Finally, the parts of this third shape file lying on BLM-managed public lands were clipped out with a shape file of land ownership produced by the 1996 Wyoming Gap Analysis Project (Merrill, Kohley *et al.* 1996), to produce the shape file "GAP_Aspen_RSFO_ onBLM.shp".

Clipping out parts of the original land-cover layer changed the areas of some polygons, so the area of each polygon in the new land-cover file, GAP_Aspen_RSFO_onBLM, was re-calculated. The percent of the area of each polygon occupied by the primary and secondary cover-types could not be re-calculated because those percentages were assigned based on interpretation of the Landsat TM scenes. The assumption was made that, for polygons split by the clipping out of the portions in the Rock Springs Field Office and on public lands, the primary and secondary cover-types occupied the same percentages of the resulting polygon as they had of the original polygon. The area (in hectares) of aspen forest in each polygon was then estimated using one of the following forumulas:

(i) Aspen forest as the primary cover-type: Ha of aspen forest = (Area of polygon) x (Primary percent)

(ii) Aspen forest as the secondary cover-type: Ha of aspen forest = (Area of polygon) x (Secondary percent)

(iii) Aspen forest as an other cover-type: Ha of aspen forest = (Area of polygon) x [100% - (Primary percent + Secondary percent)]

In a number of polygons with aspen forest as an other cover-type, the values for primary percent and secondary percent summed to 100%, and equation (iii) above produced an estimate of 0 ha of aspen forest. For these polygons, aspen forest was assigned an area of 0.001 ha. The estimated areas of aspen forest in all polygons were summed to give an estimate of the area of aspen forest on public lands in the Rock Springs Field Office. Given the assumptions involved in its calculation, this should be considered a rough estimate.

The Gap Analysis Project land cover layer includes a forest riparian layer, so the GAP aspen layer should contain few, if any, cottonwood stands. Nevertheless, the BLM cottonwood riparian shape file was used to check for possible cottonwood stands in the GAP aspen layer. The intersection of those two shape files, though, produced no records, indicating that the Gap Analysis Project probably did not map cottonwood stands in its aspen forest type.

COMBINING DATA LAYERS

The goal in selecting sampling points is to identify (as precisely as possible) locations at which aspen is likely to be found, and to identify a group of such points that represent well the variety of aspen woodlands in the field office. Of the three data layers, the BLM vegetation map and the Wyoming Land Cover Data Set allow the greatest precision in selection of sampling points, because both map their cover classes to potential minimum mapping units as small as small as 30 m x 30 m squares. The Gap Analysis Project layer, in contrast, shows upland areas as small as 100 hectares. In many of the GAP polygons, one can only say that aspen is present somewhere in the 100-hectare polygon. Consequently, for precision, selection of sampling points should rely heavily on the BLM and Wyoming Land Cover Data Set layers. The Gap Analysis Project layer, though, is useful in selecting points across the range in variation of aspen woodlands. For example, information from the GAP layer can be used to characterize aspen polygons as containing limber woodland, lodgepole pine forest, spruce-fir forest, or no conifer vegetation at all. Thus, the GAP layer can be used to sub-divide the BLM's aspen-conifer cover-class and the Wyoming Land Cover Data Set's mixed forest cover-class.

The utility of each data layer also depends on the accuracy with which their cover types were mapped. Unfortunately, the Wyoming Land Cover Data Set may be an unreliable predictor of the location of aspen stands. Accuracy of this data set was assessed across the six-state Federal Region VIII, as part of the assessment of the entire National Land Cover Dataset (U.S. Environmental Protection Agency 2006). Comparison of the land cover data set with aerial photographs was used to ascertain two measures of accuracy. The *user's accuracy rate* is the proportion of pixels in a cover-class that are correctly labeled. The user's accuracy rate is used to calculate the error of commission rate, that is, the probability that a pixel labeled as a cover-class in the data set actually is some other cover-class. The higher the error of commission rate, the greater the probability that a pixel shown in the data set as, for example, deciduous forest, actually is some other cover-class. The *producer's accuracy rate* is the proportion of pixels of a cover-class on the aerial photographs that are correctly recognized and labeled in the land cover data set. The producer's accuracy rate is used to calculate the error of omission rate, that is, the probability that an area of a given cover-class on the photograph appears incorrectly in the data set. The higher the error of omission rate, the lower the probability that a deciduous forest stand (for example) will appear as such in the data set.

Table 2 shows the accuracy rates and error rates for the deciduous forest and mixed forest cover-classes across the six-state region. If these user accuracy rates hold true for the Rock Springs Field Office, then one can expect to encounter deciduous woodland at only 16% of the pixels in which it is shown in the land cover data set, and to encounter mixed woodland at only 15% of the pixels. (These low accuracy rates may be the product of a very small sample size for both cover-classes, as shown on the U.S. Environmental Protection Agency [2006] web site.) Given these low accuracy rates, it seems that the Wyoming Land Cover Data Set should be used only in combination with the other data layers.

The metadata accompanying the BLM's vegetation map (Adams 2005) state that production of the map included field verification, but it includes no information on the accuracy rates calculated from that field verification. For the Gap Analysis Project land cover layer, 89 of the 139 polygons have been checked in the field to verify that the cover-types mapped in them actually occur there (Figure 2), but no systematic accuracy assessment has been made of the GAP layer (Kenneth L. Driese, personal communication, 11/29/06).

Using the three data layers in combination would seem to reduce the likelihood that useless sampling points (that is, points without aspen woodland) will be selected. Because of their precision, the BLM and Wyoming Land Cover layers were combined through union of the two shape files to produce the shape file, BLM_union_WyoLCD_RSFO_onBLM.shp.

If aspen woodlands were mapped in largely the same manner in the BLM and the Wyoming Land Cover Data Set layers, then it seems that most of the polygons created by the union of the two layers would represent two cover-class combinations, BLM aspen / WyoLCD deciduous forest, and BLM aspen-conifer / WyoLCD mixed forest. Unfortunately, these two desired combinations account for only 7% of the 17,927 polygons (Figure 3, Table 3). Nearly half of the polygons represent the combination of BLM aspen-conifer / neither WyoLCD class. In 83% of polygons, only one of the data layers shows a cover-class of interest; the other data layer shows no cover-class that represents aspen woodland.

Lacking accuracy assessments for the two data layers in the study area, there is no way to determine why they disagree to such an extent on where aspen woodlands grow. The high error of omission rates for the deciduous forest class (0.82) and the mixed forest class (0.99) in the larger National Land Cover Data Set across Federal Region VIII (Table 2) suggest that the Wyoming Land Cover Data Set fails to show most of the woodlands of interest in the study area. This failure would help to explain the poor agreement with the BLM vegetation map.

Two additional steps were taken to address the poor agreement between these two relatively precise data layers before they were used in selection of sampling points. First, the BLM/WyoLCD layer was combined with the Gap Analysis Program's land cover layer, as follows. The shape file of polygons from the union of the BLM vegetation map with the Wyoming Land Cover Data Set was transformed to a point shape file by conversion of the 17,927 polygons to their centroids. (Each

centroid was forced to lie within its associated polygon, so in some cases the centroid does not represent the polygon's center of gravity.) The resulting point shape file was intersected with the shape file of GAP polygons. This intersection file contained the points where a BLM polygon or a WyoLCD polygon (or both together) intersected a GAP polygon. These points were erased from the full file of BLM / WyoLCD centroids, leaving just the points representing BLM and WyoLCD polygons that did not intersect GAP polygons. Then the two point shape files, the first of the BLM/WyoLCD points intersecting GAP polygons and the second of points not intersecting GAP polygons, were combined into a single point shape file that shows all of the BLM/WyoLCD/GAP combinations.

Second, each BLM/WyoLCD/GAP combination was assigned a rank representing the likelihood that, should one go to a point on the ground representing that combination, one will find some type of aspen woodland (Table 4). Those ranks are based on two assumptions: the more data layers that map woodland at a point, the greater the likelihood of finding aspen woodland there; and the more agreement between the layers in the type of woodland, the greater the likelihood of finding aspen. These ranks were then used as the basis for allocating the sample points.

SELECTION OF POTENTIAL SAMPLING POINTS

Time and money probably will restrict field sampling to 150 or fewer points throughout the Rock Springs Field Office. Each of those points is be the centroid of a polygon resulting from the union of the BLM vegetation map with the Wyoming Land Cover Data Set, that was then intersected with the GAP landcover layer. Hence, each of the centroids can be characterized by the combination of BLM, Wyoming Land Cover Data Set, and GAP vegetation types present.

Unfortunately, the centroids with the highest likelihood of containing aspen woodlands are concentrated in a few areas, so selecting all of them for sampling would cause sampling to be concentrated in a few locations in the study area. Consequently, centroids were selected for sampling based on both the likelihood of finding aspen woodland and on the distribution of sample points throughout the Rock Springs Field Office lands.

An additional set of centroids was selected as backup points for sampling in cases where no aspen woodland is found at the potential sampling points. Each backup point lies within a buffer of 1500 meters centered on a potential sampling point. The backup points within the buffer around a potential sampling point were selected without regard to the combinations of BLM, Wyoming Land Cover Data Set, and GAP that they represent, so some potential sampling points may be replaced by backup points that represent different combinations of the cover types and even different likelihoods of aspen presence. Potential sampling points farther than 2000 meters from other centroids have no backup points associated with them.

SELECTION OF SAMPLING METHODS

In field sampling, we will collect data that allow us to describe the structure (presence and height of different vegetation layers, sizes and ages of plants in those layers) and species composition (the species that compose each layer) of the aspen vegetation, and the condition of the stands (especially the health of the aspen trees). All three features help biologists and managers understand what the future of aspen stands might be in the area, and what sort of management programs might be needed to maintain the vegetation type across the landscape.

RESULTS

DATA LAYERS

1. BLM Vegetation Map

The BLM mapped 1,623 hectares of aspen forest and 6,309 hectares of aspen-conifer forest on public lands in the Rock Springs Field Office (Table 5). The 7,662 hectares mapped as either type constitutes 0.5% of the 1,529,690 hectares of public lands in the field office. Aspen forest on the BLM map is found at relatively high elevations in the field office (Figure 4): at the southern end of the Wind River Mountains in the north, on Little Mountain and Pine Mountain in the south, and on Hickey and Cedar Mountains in the southwest. Aspen-conifer forest is more widespread; it is found at the southern end of the Wind River Mountains and on Little Mountain and Pine Mountain, and also on Steamboat Mountain and in the Jack Morrow Hills near the center of the field office, and on Quaking Asp Mountain south of Rock Springs.

2. Wyoming Land Cover Data Set

According to the Wyoming Land Cover Data Set, forests likely to contain aspen occur in 3,506 polygons and cover 2,313 hectares on public lands in the Rock Springs Field Office (Table 6). Deciduous forest accounts for 77% of the polygons and 81% of the land area. The number of polygons and the land area mapped in the land cover data set are only 30% of the number of polygons and the area of similar types mapped by the BLM (Table 5), and the ratio of deciduous woodland to mixed woodland in the land cover data set is the reverse of the percentages for similar types on the BLM map. Differences between the two data layers may result from the low accuracy rates of mapping in the Wyoming Land Cover Data Set, as suggested above. The differences might also result from the way that forests are classified in the two data sets; stands mapped as aspen-conifer forest by the BLM might have been mapped as evergreen forest (code 42) in the Wyoming Land Cover Data Set, a cover-class that was not used in this project.

Deciduous and mixed forests in the Wyoming Land Cover Data Set are concentrated on Little Mountain and Pine Mountain in the southern part of the field office (Figure 5). Both types also occur in limited amounts on Hickey Mountain and Cedar Mountain in the southwestern corner and on the southern end of the Wind River Mountains in the north.

3. 1996 Wyoming Gap Analysis Project Landcover Layer

Aspen forest was mapped in 139 polygons on public lands in the Rock Springs Field Office (Table 7). The area of those polygons, 26,941 ha, constitutes 1.8% of the 1,529,690 ha of public lands in the field office. A greater number of polygons have aspen forest as the primary cover-type than as either the secondary type or an other type, but polygons in which aspen forest is an other type account for the greatest proportion of the area covered by the polygons (Table 7). The estimate of the area actually covered by aspen forest, in contrast to the area covered by the polygons in which it occurs, is considerably smaller: aspen forest is estimated to cover only 5,229 ha, which is 19.4% of the area of the polygons in which it occurs and 0.34% of the public lands in the field office.

The distribution of the aspen forest polygons in the 1996 GAP layer (Figure 6) is similar to the distribution of aspen forest and aspen-conifer forest on the BLM map (Figure 4), with concentrations on the southern end of the Wind River Mountains, on Quaking Asp Mountain, on Little Mountain and Pine Mountain near the southern boundary, and on Hickey and Cedar Mountains. Of the 139 polygons containing aspen forest, 89 had been checked in the field as of the 1996 publication of the land-cover layer to confirm the identity of the cover-types assigned to them, and 50 had not (Figure 2). The un-checked polygons are mostly on Hickey and Cedar Mountains, on Little Mountain, and at the foot of the Wind River Mountains.

POTENTIAL SAMPLING POINTS

One hundred thirty one centroids representing the combinations of BLM, Wyoming Land Cover Data Set, and Gap Analysis Project cover-types were selected as sampling points (Table 8). Only 10 of the 507 available centroids representing the highest-likelihood combinations of cover-types (those where all three data layers mapped woodlands that might contain aspen) were selected because selection of all would have concentrated the samples in a few areas. Sixty of the sampling points were allocated to the least-likelihood combinations of cover types (those where only one of the datasets shows aspen). The 131 sample points are distributed throughout the Rock Springs Field Office (Figure 7). Fifty nine of these potential sampling points represent polygons larger than 1 hectare and 72 represent polygons smaller than 1 hectare in size.

One hundred fifty one backup points also were selected (Figure 7), each within ca. 2000 meters of a potential sampling point. Backup points are associated with 103 of the 131 potential sampling points; 28 potential sampling points had no other centroids within 2000 meters and so have no backup points. Sampling will be done at a backup point if aspen is not found at the associated sample point.

SUGGESTED SAMPLING METHODS

The field crew will use a hand-held global positioning system (GPS) receiver to navigate to the selected sampling point. If the point is in an aspen stand, then the vegetation will be sampled there. If the point is outside of but within 500 m of a stand, the point will be moved to the center of the nearest stand. If no stand is present within 500 m of the sampling point, then that point will be abandoned and the closest backup point selected.

The following features will be described for the stand:

-- the number of vegetation layers present and the height of each,
-- the percent plant canopy cover (by canopy cover class) for each growth-form (broad-leaf tree, needle-leaf tree, broad-leaf deciduous shrub, broad-leaf evergreen shrub, microphyllous shrub, graminoid, forb, vine, moss, lichen, club-moss) in each layer,
-- the percent plant canopy cover for each species in each layer (or just the common species in the herbaceous layer),
-- the length and width of the stand,
-- the precise location of a reference corner (determined with a GPS receiver),
-- the slope and aspect,
-- the topographic position, and
-- the adjacent vegetation.

Aspen stands often consist of a single tree layer, but a stand may include more than one size-class of trees, either mixed evenly with one another or growing in patches (Jones and DeByle1985, Baker *et al.* 1997). When necessary, the stand will be stratified into areas that are homogeneous for tree size (into strata, *sensu* Barnett and Stohlgren 2001). Each stratum will be homogeneous for the size of trees present, and may consist of just one size class or of a homogeneous mix of more than one class. (Homogeneity will be judged subjectively.) Saplings (stems $\leq$ 2.0 m tall) will be divided into 50-cm height classes, and trees (stems > 2.0 m tall) will be divided into 5-cm diameter classes (measured at 4.5 feet, or 1.4 m, above the ground). The percentage of the stand in each stratum will be estimated, and saplings and trees in each stratum will be sampled with at least one square plot (5 m x 5 m in dense stands, 10 m x 10 m in sparse stands). The following information will be recorded in each plot:

-- Number of saplings of each species, live vs. dead, in each 50-cm height class,
-- Number of trees of each species, live vs. dead, in each 5-cm diameter class,
-- Number of fallen stems of each species, in each 5-cm diameter class,

-- Amount of browsing on twigs up to 2.0 m height (Each stem will be scored as unbrowsed, lightly browsed [< 10% of twigs browsed], moderately browsed [10% - 50% of twigs browsed], or heavily browsed [> 50% of twigs browsed]),
-- Abundance of wounds on lowest 2.0 m of trunk (scored on each stem as absent, present [< 10% of trunk area], common [10% - 50% of trunk area], or abundant [> 50% of trunk area]),
-- Abundance of fungal fruiting bodies, cankers, galls, and rough bark on trunk or branches (scored on each stem as absent, present [< 10% of trunk area], common [10% - 50% of trunk area], or abundant [> 50% of trunk area]), and
-- Abundance of broken tops and branches (estimated percentage of stems in plot).

DISCUSSION

The three data layers paint different pictures of the distribution and abundance of aspen woodlands in the Rock Springs Field Office, especially at the lower elevation in the basins. Given its large minimum mapping unit (100 ha), one should expect the Gap Analysis Project's land cover layer to map fewer aspen stands than do the BLM vegetation map or the Wyoming Land Cover Data Set, and that is the case. The discrepancy between the latter two detailed data layers, each with a potential minimum mapping unit of 900 square meters, is puzzling. A detailed evaluation of each layer would be necessary to show how much confidence can be placed in each. That evaluation would be a substantial project in itself.

Despite the differences between the data layers, we assume that they are useful in indicating places on the ground where data can be collected about the composition, structure, and condition of aspen woodlands. The procedure suggested herein for doing so, while far from a formal evaluation of the data layers, will show something about their utility.

Because the financial resources available for collecting field data always are limited, a field sampling program always must balance the amount of data to be collected at each location with the number of locations that can be visited. The focus of this project is describing the aspen stands in the study area; hence, the methods suggested here are designed to collect a considerable amount of information at a modest number of locations. A project focussed on validating the digital maps of aspen in the Rock Springs Field Office would visit far more sites and collect little information at each.

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FIGURES

Figure 1. Location of the BLM's Rock Springs Field Office in southwestern Wyoming.

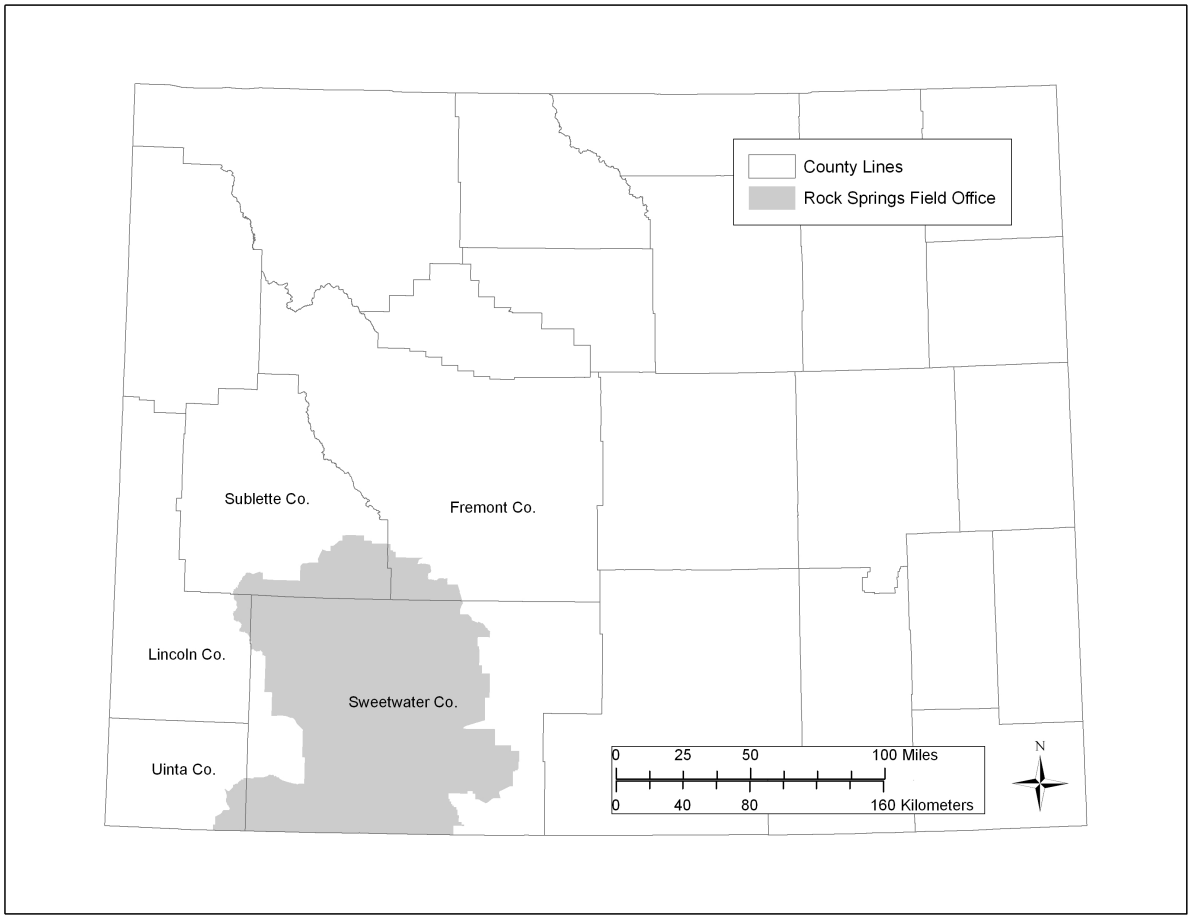


Figure 2. Status of field-checking of polygons in which the 1996 Gap Analysis Project mapped aspen forest.

Status was current at the time of publication of the land-cover layer, in 1996. See Merrill, Kohley, *et al.* (1996) for details.

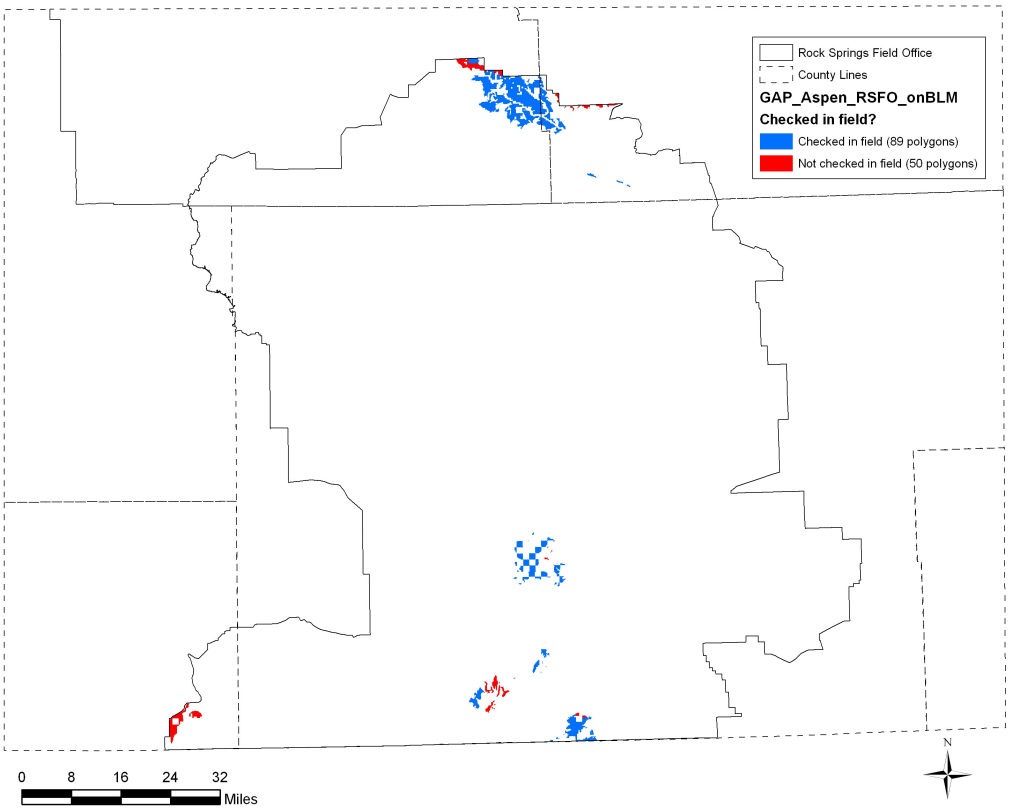


Figure 3. Numbers of polygons in each combination of BLM and Wyoming Land Cover Data Set cover-classes.

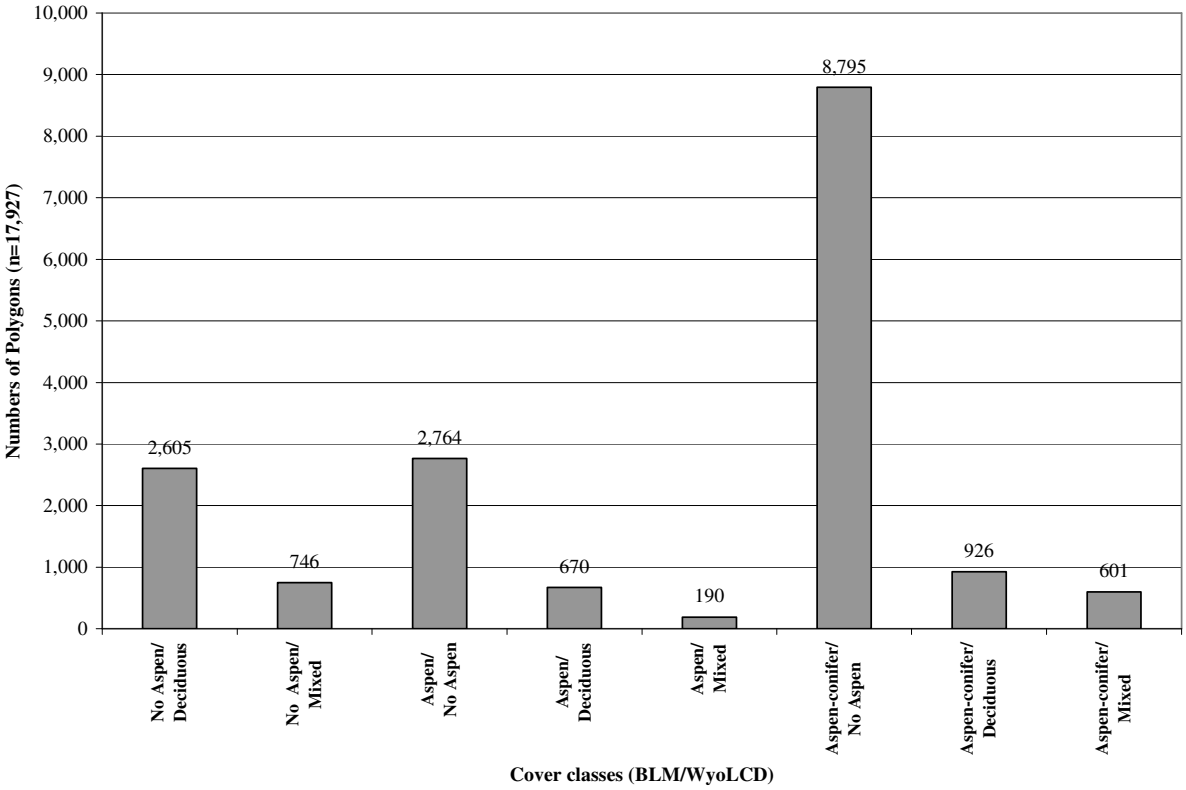


Figure 4. Areas on BLM-managed public lands in the Rock Springs Field Office where the BLM mapped aspen forest or aspen-conifer forest.

a. Entire field office

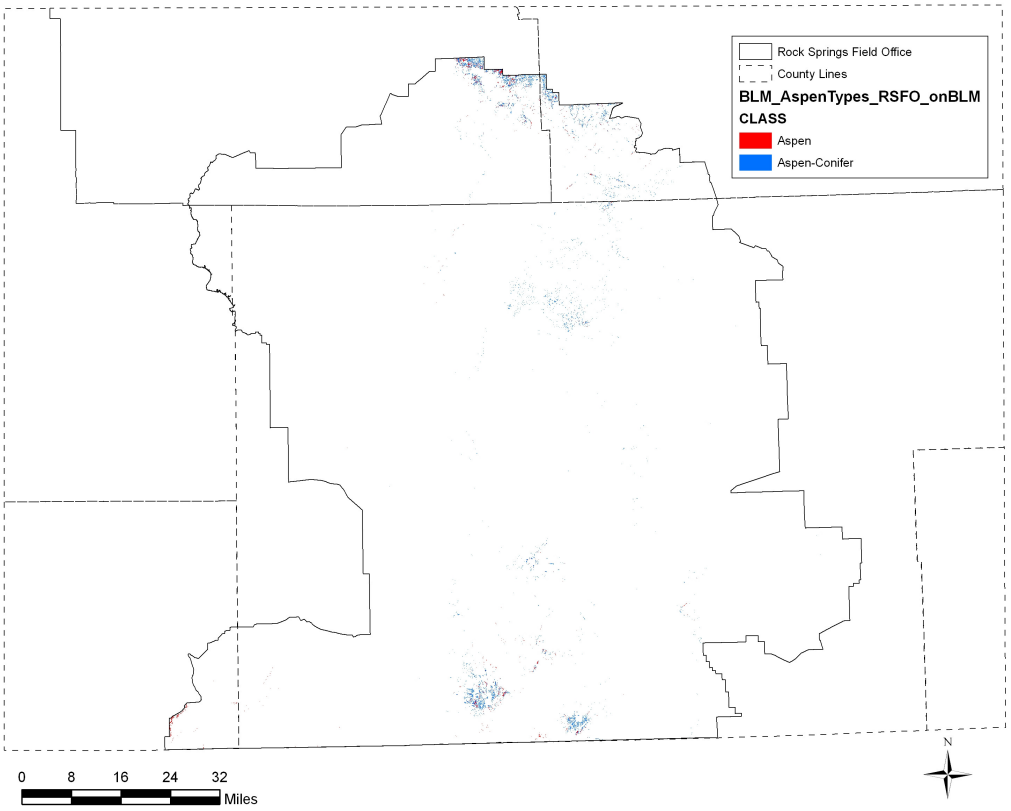


Figure 4 (continued).

b. Northern part of field office

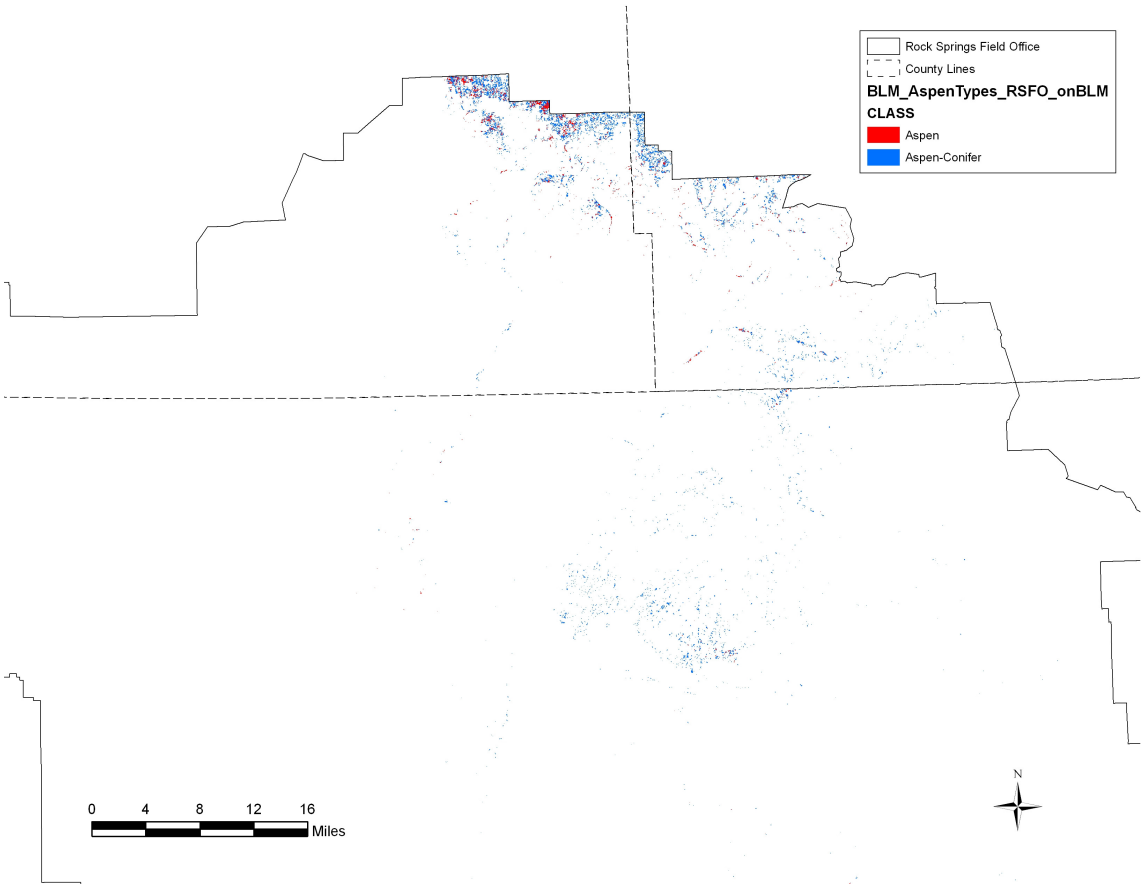


Figure 4 (continued).

c. Southern part of field office

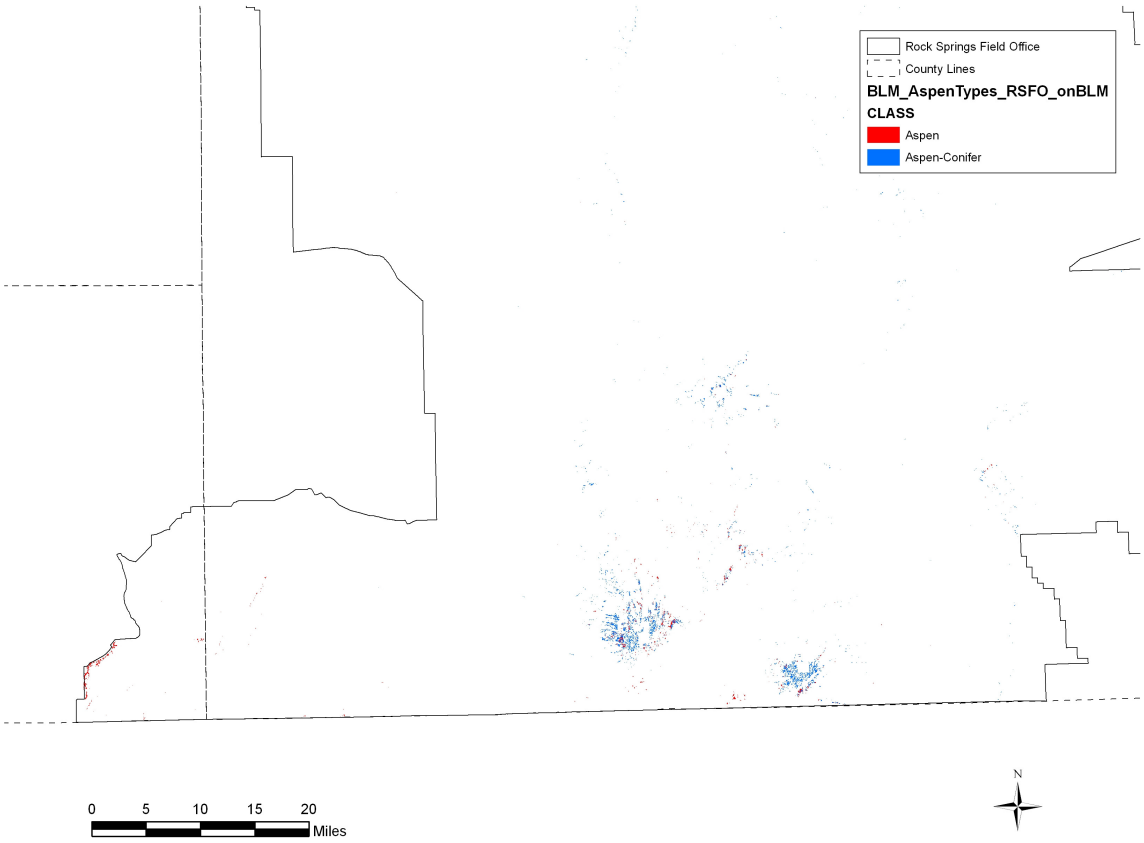


Figure 5. Areas on BLM-managed public lands in the Rock Springs Field Office where the Wyoming Land Cover Data Set shows deciduous forest or mixed forest.

a. Entire field office

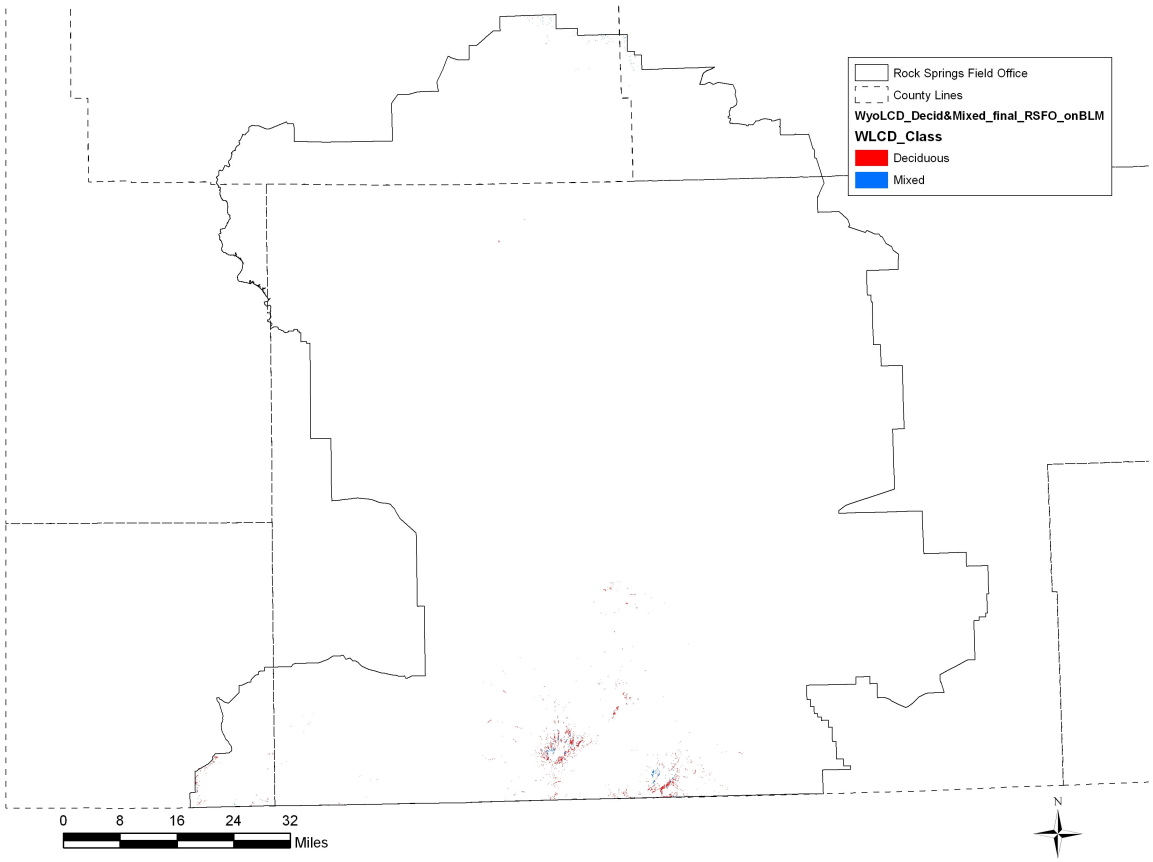


Figure 5 (continued).

b. Northern part of field office

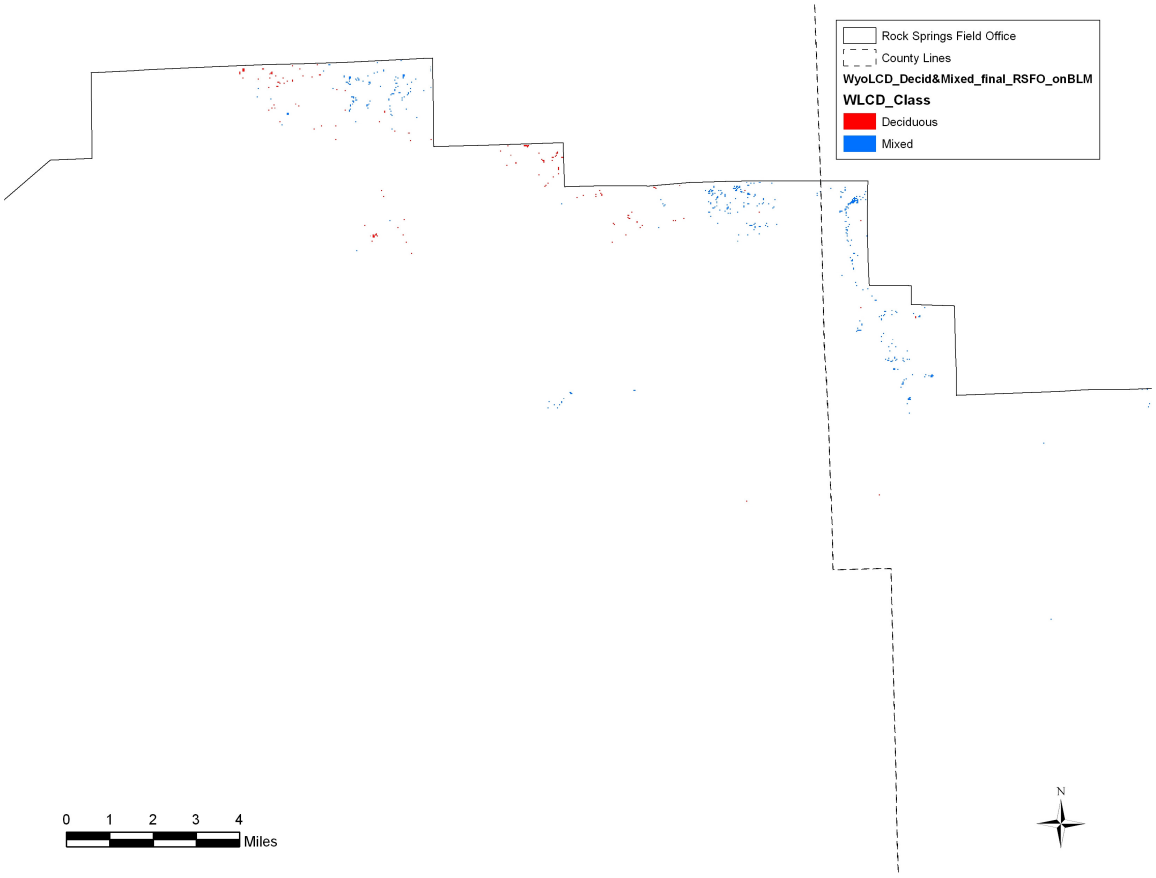


Figure 5 (continued).

c. Southern part of field office

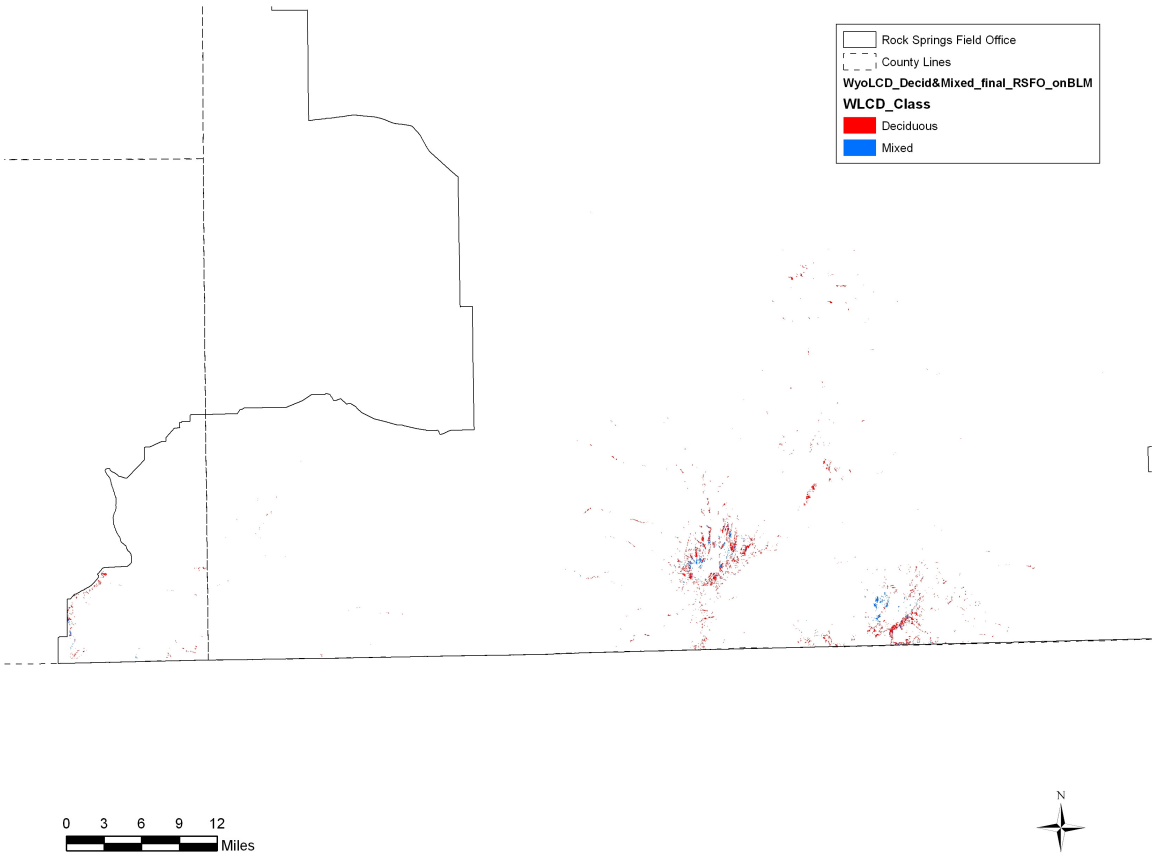


Figure 6. Areas on BLM-managed public lands in the Rock Springs Field Office where the 1996 Gap Analysis Project mapped aspen forest.

The map is from the shape file "GAP_Aspen_RSFO_onBLM.shp", in which every polygon includes aspen forest as the primary cover-type, secondary cover-type, or an other cover-type.

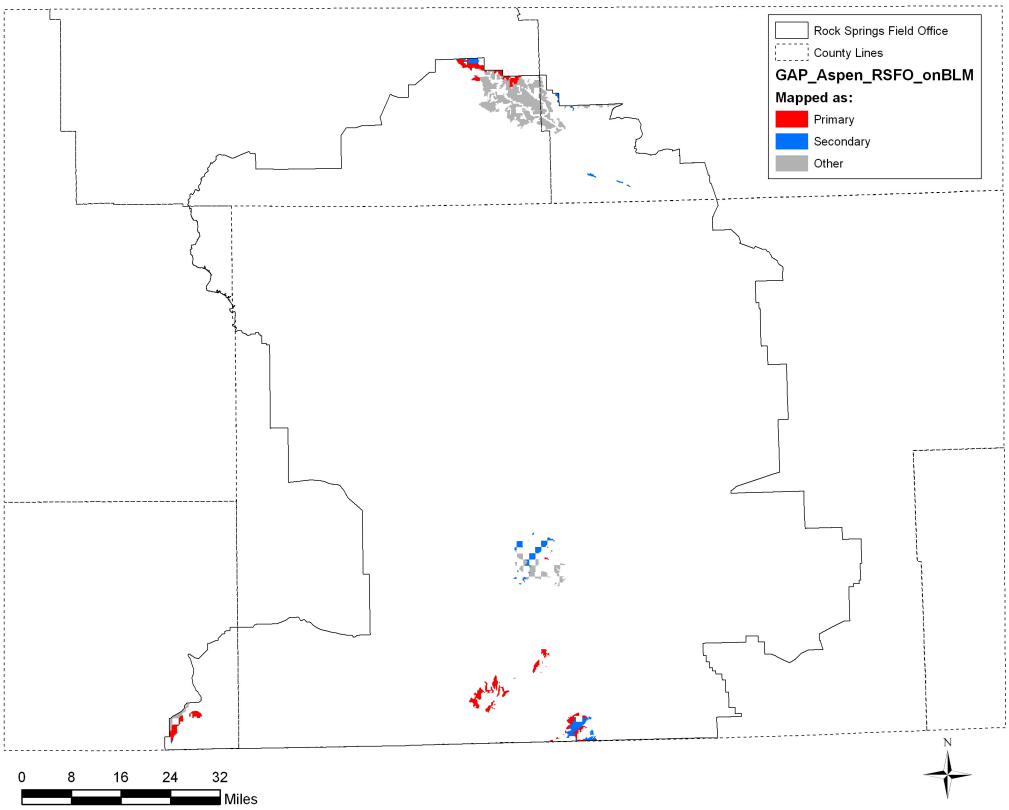
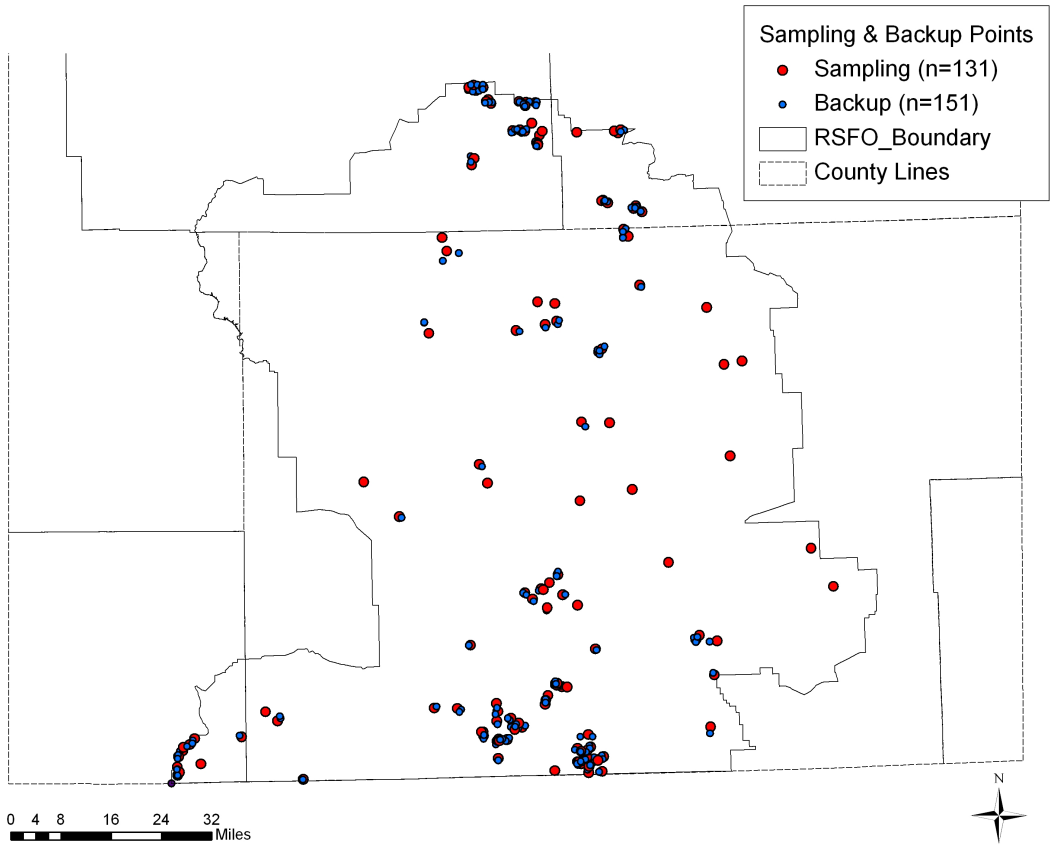


Figure 7. Distribution of centroids selected as sampling and backup points throughout the Rock Springs Field Office.



TABLES

Table 1. Values for the "Owner" and "Ownername" fields in the 1996 GAP ownership layer that were used to select BLM-managed public lands in the Rock Springs Field Office

Owner	Ownername
2	U.S. Bureau of Land Management
20	Bureau of Reclamation Withdrawal (BLM)
30	Public Water Reserve Withdrawal (BLM)
40	Power Withdrawal and Classification (BLM)
50	Department of Energy Withdrawal (BLM)
60	Federal Agency Protective Withdrawal (BLM)
70	Radio & Air Facility Withdrawal (BLM)
90	State, County, City, Wildlife, Park and Outdoor Rec. (BLM)
100	Acquired Lands (BLM)
120	Bureau of Reclamation/Federal Protection (BLM)

Table 2. Accuracy of the larger National Land Cover Data Set in showing the deciduous forest and mixed forest cover-classes in Federal Region VIII.

The National Land Cover Data Set includes the Wyoming Land Cover Data Set being used in this project. Accuracy rates for mapping the two cover-classes of interest in the larger (national) data set were calculated for the six-state region. See text for explanation.

Cover-class	Deciduous forest (code 41)	Mixed forest (code 43)
User's Accuracy Rate	0.16	0.15
Error of Commission Rate	0.84	0.85
Producer's Accuracy Rate	0.18	0.01
Error of Omission Rate	0.82	0.99

Table 3. Numbers of centroids of areas with different combinations of cover-types from the BLM vegetation map, Wyoming Land Cover Data Set, and GAP land-cover layer.

Shading of cells indicates the likelihood that a centroid in that combination represents a location where aspen actually grows; the lighter the shading, the higher the likelihood. See Table 4.

a. Numbers of centroids in each cover-type combination

BLM / Wyoming Land Cover Data Set Combinations	GAP types in polygon					
	No GAP aspen	GAP Aspen without conifer forest	GAP Aspen with Limber Pine woodland	GAP Aspen with Lodgepole pine forest	GAP Aspen with Spruce-fir forest	*Totals*
no BLM / WLCD Deciduous	**1766**	**494**	**2**	**259**	**84**	*2605*
no BLM / WLCD Mixed	**371**	**136**	**1**	**192**	**46**	*746*
BLM Aspen / no WLCD	**1677**	**633**	**55**	**353**	**46**	*2764*
BLM Aspen / WLCD Deciduous	**269**	**251**	**0**	**120**	**30**	*670*
BLM Aspen / WLCD Mixed	**57**	**57**	**0**	**53**	**23**	*190*
BLM Aspen-conifer / no WLCD	**6504**	**1313**	**99**	**799**	**80**	*8795*
BLM Aspen-conifer / WLCD Deciduous	**393**	**257**	**1**	**232**	**43**	*926*
BLM Aspen-conifer / WLCD Mixed	**295**	**50**	**1**	**226**	**29**	*601*
Totals	*11332*	*3191*	*159*	*2234*	*381*	*17297*

b. Numbers of centroids in each likelihood category

Agreement of data layers at point	Numbers of centroids
3 layers map woodland at point; 3 types are the same	**507**
3 layers map woodland at point; 2 types are the same	**866**
2 layers map woodland at point; types are the same	**2908**
2 layers map woodland at point; types are different	**2698**
1 layer maps woodland at point	**10318**
Total	*17297*

Table 4. Predicted likelihood of finding aspen woodland at points representing different combinations of the three data layers.

a. Basis for assigning predicted likelihood

Only one of the BLM types (aspen or aspen-conifer classes) and one of the WLCD types (deciduous forest or mixed forest classes) may be mapped at each point. Two GAP types may be mapped at a point, one as the primary cover-type and the other as the secondary cover-type.

Agreement of data layers at point	Relative likelihood
3 layers map woodland at point; 3 types are the same	**3.5**
3 layers map woodland at point; 2 types are the same	**3**
2 layers map woodland at point; types are the same	**2.5**
2 layers map woodland at point; types are different	**2**
1 layer maps woodland at point	**1**

b. Predicted likelihood assigned to each combination

BLM/WLCD Combinations	GAP types in polygon				
	No GAP aspen	GAP Aspen without conifer forest	GAP Aspen with Limber Pine woodland	GAP Aspen with Lodgepole pine forest	GAP Aspen with Spruce-fir forest
no BLM/WLCD Deciduous	**1**	**2.5**	**2**	**2**	**2**
no BLM/WLCD Mixed	**1**	**2**	**2.5**	**2.5**	**2.5**
BLM Aspen/no WLCD	**1**	**2.5**	**2**	**2**	**2**
BLM Aspen/WLCD Deciduous	**2.5**	**3.5**	**3**	**3**	**3**
BLM Aspen/WLCD Mixed	**2**	**3**	**3**	**3**	**3**
BLM Aspen-conifer/no WLCD	**1**	**2**	**2.5**	**2.5**	**2.5**
BLM Aspen-conifer/WLCD Deciduous	**2**	**3**	**3**	**3**	**3**
BLM Aspen-conifer/WLCD Mixed	**2.5**	**3**	**3.5**	**3.5**	**3.5**

Table 5. Number and area of polygons on BLM-managed public lands in the Rock Springs Field Office in which the BLM mapped aspen forest or aspen-conifer forest.

Mapped as:	Number of polygons	% of polygons	Area of polygons (ha)	% of polygon area
Aspen	2,810	24%	1,623	21%
Aspen-conifer	8,848	76%	6,309	79%
TOTAL	11,658	100%	7,662	100%

Table 6. Number and area of polygons on BLM-managed public lands in the Rock Springs Field Office in which the Wyoming Land Cover Data Set mapped deciduous forest or mixed forest.

Mapped as:	Number of polygons	% of polygons	Area of polygons (ha)	% of polygon area
Deciduous forest	2,694	77%	1,883	81%
Mixed forest	812	23%	430	19%
TOTAL	3,506	100%	2,313	100%

Table 7. Number and area of polygons on BLM-managed public lands in the Rock Springs Field Office in which the 1996 Gap Analysis Project mapped aspen forest.

Mapped as:	Number of polygons	% of polygons	Area of polygons (ha)	% of polygon area	Area of aspen forest (ha)
Primary	58	42%	6,629	25%	4,564
Secondary	40	29%	3,748	14%	473
Other	41	29%	16,564	61%	192
TOTAL	139	100%	26,941	100%	5,229

Table 8. Numbers of sampling points chosen in areas containing different combinations of cover-types from the BLM vegetation map, Wyoming Land Cover Data Set, and GAP land-cover layer.

Shading of cells indicates the likelihood that aspen will actually be found at that point; the lighter the shading, the higher the likelihood. See Table 4.

a. Numbers of sampling points in each cover-type combination.

BLM / Wyoming Land Cover Data Set Combinations	GAP types in polygon					
	No GAP aspen	GAP Aspen without conifer forest	GAP Aspen with Limber Pine woodland	GAP Aspen with Lodgepole pine forest	GAP Aspen with Spruce-fir forest	*Totals*
no BLM / WLCD Deciduous	**6**	**5**	**0**	**2**	**1**	*14*
no BLM / WLCD Mixed	**0**	**2**	**0**	**1**	**0**	*3*
BLM Aspen / no WLCD	**14**	**8**	**1**	**2**	**1**	*26*
BLM Aspen / WLCD Deciduous	**6**	**8**	**0**	**1**	**1**	*16*
BLM Aspen / WLCD Mixed	**0**	**1**	**0**	**1**	**0**	*2*
BLM Aspen-conifer / no WLCD	**40**	**10**	**5**	**3**	**0**	*58*
BLM Aspen-conifer / WLCD Deciduous	**4**	**5**	**0**	**1**	**0**	*10*
BLM Aspen-conifer / WLCD Mixed	**0**	**0**	**0**	**2**	**0**	*2*
Totals	*70*	*39*	*6*	*13*	*3*	*131*

b. Numbers of sampling points in each likelihood category

Agreement of data layers at point	Numbers of sampling points
3 layers map woodland at point; 3 types are the same	**10**
3 layers map woodland at point; 2 types are the same	**10**
2 layers map woodland at point; types are the same	**28**
2 layers map woodland at point; types are different	**23**
1 layer maps woodland at point	**60**
Total	*131*

APPENDIX 1. METADATA FOR THE BLM'S GEODATABASE OF VEGETATION IN THE ROCK SPRINGS FIELD OFFICE

This is the metadata for the aspen-conifer feature class, as viewed in ArcCatalog version 9.1. The information herein applies to the other feature classes in the geodatabase, including the aspen feature class.

Aspen Personal GeoDatabase Feature Class

Keywords

Theme: Vegetation

Description

Abstract

This feature class was generated using supervised classification of Landsat MS data based on ground truthed observations within the Rock Springs Field Office.

Purpose

To provide basic vegetation data of the RSFO for internal use.

Status of the data

Complete

Data update frequency: As needed

Time period for which the data is relevant

Date and time: 2005 onward

Description:

publication date

Publication Information

Who created the data: REQUIRED: The name of an organization or individual that developed the data set.

Date and time: REQUIRED: The date when the data set is published or otherwise made available for release.

Data storage and access information

File name: aspen

Type of data: vector digital data

Location of the data:

- \\wyrs6nas1\gis\Vegetation\RSFO 2004 Vegetation.mdb

Data processing environment: Microsoft Windows 2000 Version 5.1 (Build 2600) Service Pack 1; ESRI ArcCatalog 8.3.0.800

Accessing the data

Data transfer size: 0.465 MB

Constraints on accessing and using the data

Access constraints: None

Use constraints:
None

Details about this document

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Standard version: FGDC-STD-001-1998

Time convention used in this document: local time

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