WYOMING GAP ANALYSIS PROJECT LANDCOVER MAPPING SUPPORT
(Cooperative Agreement Number 06HQAG0138)
FINAL REPORT

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to Gap Analysis Program, U.S. Geological Survey

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INTRODUCTION

The U.S. Geological Survey's Gap Analysis Program is mapping landcover (using ecological systems as map units) in the northwestern states of Washington, Oregon, Idaho, Montana, and Wyoming. In June 2006, the Geological Survey and the University of Wyoming entered into Cooperative Agreement Number 06HQAG0138 for George Jones, ecologist at the University's Wyoming Natural Diversity Database, to help with development of the Wyoming portion of the map. In the following 2½ years, Jones participated in field trips with staff of the U.S.G.S. Gap Analysis Program and Sanborn Map Company to calibrate draft maps of ecological systems in Wyoming, met and corresponded with ecologists from other state natural heritage programs and from NatureServe to revise the classification of ecological systems, and reviewed the draft landcover maps.

Landcover was mapped within MRLC map zones in the state (Figure 1). Staff from Sanborn Map Company mapped the ecological systems for the map zones in all but the northwestern and western mountains in 2006 and 2007. (This large area is referred to herein as zones 22+ and 29+.) Ecological systems in the two map zones covering the northwestern mountains (referred to herein simply as zone 21) were mapped by staff of the Gap Analysis Program in 2007 and 2008.

Figure 1. MRLC map zones in and around Wyoming. Ecological systems in the shaded map zones were mapped by staff of Sanborn Map Company in 2006 and 2007. Systems in the stippled map zones were mapped by Gap Analysis Program staff in 2007 and 2008.
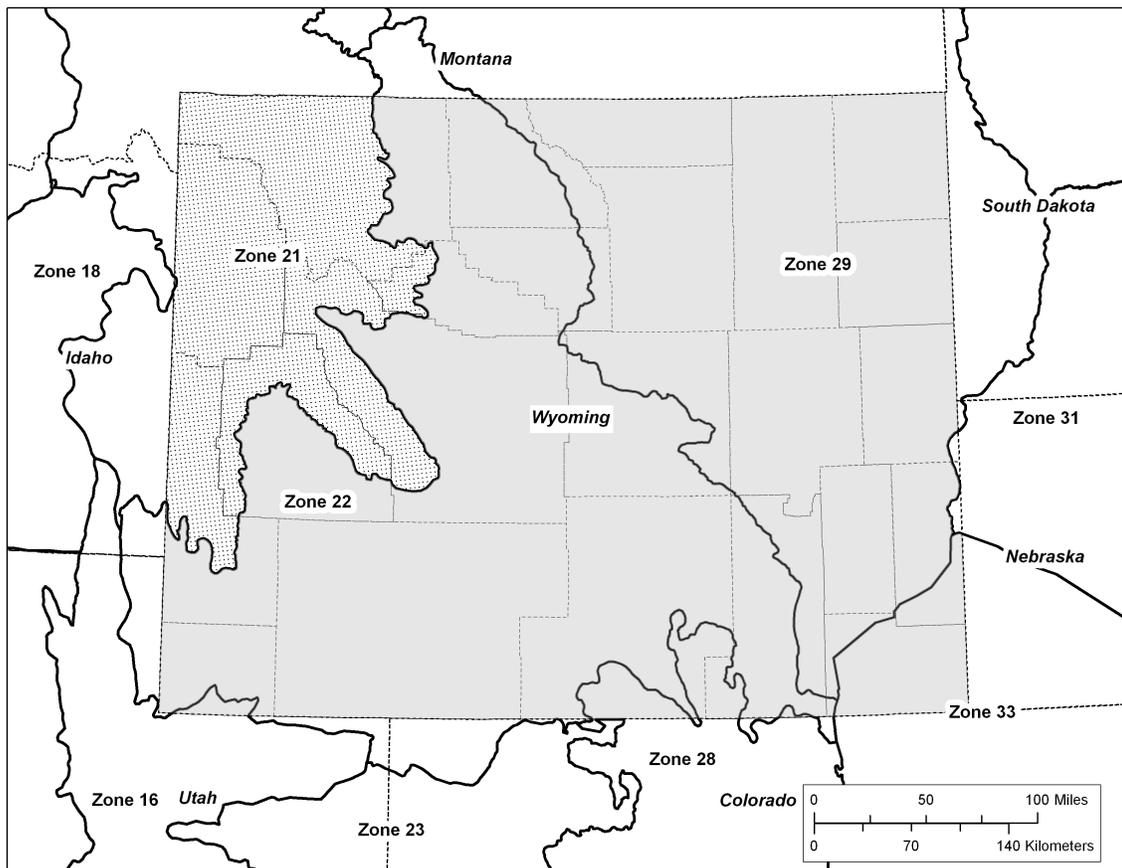
<center>**CHRONOLOGY**</center>

JUNE & JULY 2006. (1) G. Jones received from Tom Miewald (Sanborn Map Co.) and from NatureServe ecologists draft descriptions of ecological systems thought to occur in map zones 22+ and 29+. Jones consulted with Steve Cooper of the Montana Natural Heritage Program to draft keys for identifying systems in the field. (2) The Natural Diversity Database sub-contracted with Dennis Knight to obtain his services in better defining and mapping systems.

AUGUST 2006. T. Miewald and G. Jones travelled through south-central and central Wyoming to calibrate the early draft of the map for zones 22+ and 29+. Their discussions resulted in a better understanding of sparsely vegetated, shrub, shrub-steppe, and grassland systems.

OCTOBER 2006. G. Jones organized a meeting in Laramie, Wyoming attended by ecologists and mappers from the Gap Analysis Program, University of Wyoming, Sanborn Map Co., Montana Natural Heritage Program, Wyoming Game & Fish Department, Bureau of Land Management, and NatureServe, to discuss ecological systems in map zones 22+ & 29+. T. Miewald and G. Jones reported on results of their August 2006 field trip and suggested changes to descriptions of systems. This meeting resulted in revisions to the classification of ecological systems.

MARCH & APRIL 2007. (1) T. Miewald sent to G. Jones a revised draft of the map for zones 22+ and 29+. Jones commented on areas mapped as low sagebrush and some grassland types, and sent to Miewald shape files of plots sampled in those types, as well as points with cushion-plant vegetation. (See the accompanying files in the folder, Files_for_May07_Trip.) (2) NatureServe ecologists distributed descriptions of ecological systems, revised from the October, 2006 meeting, for use in the 2007 field season.

MAY 2007. T. Miewald, G. Jones, S. Cooper, and Steve Lennartz (Sanborn Map Co.) travelled through east-central and north-central Wyoming to discuss ecological systems and examine the revised draft of the map for zones 22+ and 29+. Miewald and Jones continued through south-central and west-central Wyoming, and met with Anne Davidson of the National Gap Analysis Program to look at fringes of map zone 21. This trip resulted in a better understanding of the proposed Wyoming Basins dwarf-sagebrush system, and questions about various shrub and grassland systems. Jones and Miewald submitted to heritage program and NatureServe ecologists suggestions for changes to these systems. (See the accompanying file, TMiewald_GJones_May2007_ FieldTripSummary.doc.)

JUNE - SEPTEMBER 2007. (1) G. Jones, other state heritage program ecologists, and NatureServe ecologists addressed confusion between various grassland, shrub-steppe, shrubland, and sparsely vegetated systems. The result was revised descriptions for a number of these systems as they occur throughout the northwestern U.S. (See the accompanying files in the folder, EcolSystems_ summer2007_ compiled_answers.) (2) S. Lennartz sent to G. Jones a matrix for summarizing likely causes of error in the mapping of ecological systems in zones 22+ and 29+. Jones completed and returned the matrix. (The matrix is in the accompanying file, GAP_Zones21,22+,29+_ Matrices_Wyo.xls). (3) S. Lennartz also sent to Jones the latest draft of the map for zones 22+ and 29+. Jones reviewed the map and provided minor comments to Lennartz.

OCTOBER 2008. A. Davidson (Gap Analysis Program) sent to G. Jones the draft map of ecological systems in zone 21.

NOVEMBER & DECEMBER 2008. G. Jones reviewed the draft map for zone 21 and sent to A. Davidson both comments about shrubland and grassland systems generally, and comments about specific locations. (See the accompanying files in the folder, GPJ_Comments_Zone21.)

GENERAL COMMENTS ON THE MAPS

These general remarks summarize the gist of the specific comments that G. Jones submitted to T. Miewald and S. Lennartz of Sanborn Map Company (for zones 22+ and 29+) and to A. Davidson of the national GAP program (for zone 21). The classification matrices that highlight those pairs of ecological systems especially likely to present mapping problems are shown in the accompanying digital file, GAP_Zones21,22+,29+_Matrices_Wyo.xls

The most common mistakes in mapping likely are made when an area that supports one ecological system is mapped as a different system similar in physiognomy. Close juxtaposition of similar systems on the landscape increases the risk of this error. These errors with mapping the wrong ecological systems are probably most serious within two groups of systems on the GAP maps. One group includes the Inter-Mountain Basins Big Sagebrush Shrubland, Inter-Mountain Basins Big Sagebrush Steppe, Northwestern Great Plains Mixed Grass Prairie, Wyoming Basins Low Sagebrush Shrubland & Steppe (aka Dwarf-sagebrush Shrubland and Steppe), and Inter-Mountain Basins Semi-desert Shrub Steppe. Systems in this group often occur close together or next to each other and some merge into each other both in their physiognomy and in their species composition. Consequently, there is a high likelihood of mistakes in distinguishing among these systems and mapping them accurately. Unfortunately, the abundance of these systems in map zones 22+ and 29+ (Table 1) makes this a potentially widespread problem in Wyoming.

Similar physiognomy and species composition, and co-occurrence on the landscape, present problems for tree-dominated ecological systems as well. This group includes the Rocky Mountain Lodgepole Pine Forest, Poor Site Rocky Mountain Lodgepole Pine Forest, Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland, Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland, and Middle Rocky Mountain Douglas-fir Forest and Woodland. Various members of this group could easily be confused with one another. Confusion among these systems could be a problem in all maps zones in Wyoming (Tables 1 and 2).

Many of these potential mistakes in mapping ecological systems are exacerbated by imprecise descriptions of the systems. The mappers and heritage program ecologists working in Wyoming discovered that they often had difficulty deciding in the field which ecological system to apply to a location on the ground even as they stood there with the system descriptions in hand. This problem arose most often when the choice had to be made between grassland, shrubland, or steppe ecological systems -- for example, between the Inter-Mountain Basins Big Sagebrush Steppe and the Inter-Mountain Basins Semi-Desert Shrub Steppe.

Difficulty in describing the ecological systems is a specific example of a general problem inherent in classification, and one that especially accompanies vegetation classifications. It may be worse in the classification of ecological systems than in some other vegetation or ecosystem classifications because this ecological systems classification scheme attempts to describe fairly detailed units that (in most cases) also extend across a broad geographic area. Each system is defined largely by the structure and species composition of the vegetation, but both of those frequently vary gradually across a landscape and across the region. Definitions that clearly distinguish two ecological systems from each other in a local area might fail to do so across a region, because the locally distinguishing features become blurred by the variation in the vegetation across the region.

The classification of ecological systems will change if it is applied by more ecologists working throughout the region. Better definition of the systems, perhaps on a state-by-state basis, no doubt will contribute to more accurate maps.

Table 1. Ecological systems, Zones 22+ and 29+ in Wyoming, sorted by rank (most to least pixels) in either zone 22 or zone 29. The 10 highest-ranked systems (expressed by number of pixels) in each zone are shown in bold typeface. The "Highest RANK" column shows the highest rank of a system in either map zone.

CLASS_NAME	Zone 22 PERCENT	Zone 22 RANK	Zone 29 PERCENT	Zone 29 RANK	Highest RANK
Inter-Mountain Basins Big Sagebrush Steppe	**29.56%**	**1**	**31.43%**	**1**	1
Inter-Mountain Basins Big Sagebrush Shrubland	**18.93%**	**2**	0.02%	55	2
Northwestern Great Plains Mixedgrass Prairie	**3.59%**	**7**	**28.66%**	**2**	2
Inter-Mountain Basins Mixed Salt Desert Scrub	**7.28%**	**3**	0.00%	63	3
Introduced Upland Vegetation - Annual Grassland*	0.01%	50	**4.01%**	**3**	3
Agriculture*	**3.09%**	**8**	**3.97%**	**4**	4
Wyoming Basins Low Sagebrush Shrubland	**6.90%**	**4**	**1.56%**	**9**	4
Inter-Mountain Basins Mat Saltbush Shrubland	**6.85%**	**5**	0.56%	24	5
Northwestern Great Plains Ponderosa Pine	0.02%	45	**3.79%**	**5**	5
Inter-Mountain Basins Montane Sagebrush Steppe	**3.75%**	**6**	**3.70%**	**6**	6
Pasture*	0.76%	17	**3.06%**	**7**	7
Rocky Mountain Lodgepole Pine Forest	2.04%	12	**1.73%**	**8**	8
Inter-Mountain Basins Greasewood Flat	**2.34%**	**9**	0.76%	19	9
Rocky Mountain Foothill Limber Pine-Juniper Woodland	**2.29%**	**10**	1.42%	11	10
Southern Rocky Mountain Ponderosa Pine Woodland	0.05%	38	**1.55%**	**10**	10
Inter-Mountain Basins Active and Stabilized Dune	2.11%	11	0.63%	21	11
Western Great Plains Badlands	0.00%	75	1.08%	12	12
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	0.10%	33	1.02%	13	13
Western Great Plains Riparian Woodland and Shrubland	1.56%	13	0.77%	18	13
Inter-Mountain Basins Shale Badland	1.54%	14	0.01%	60	14
Western Great Plains Shortgrass Prairie	0.05%	37	1.00%	14	14
Inter-Mountain Basins Cliff and Canyon	1.02%	15	0.03%	52	15
Western Great Plains Sand Prairie	0.00%	59	0.89%	15	15
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	0.41%	22	0.81%	16	16
Western Great Plains Saline Depression Wetland	1.02%	16	0.21%	34	16
Developed, Open Space*	0.54%	18	0.78%	17	17
Rocky Mountain Aspen Forest and Woodland	0.54%	19	0.23%	30	19
Southern Rocky Mountain Montane-Subalpine Grassland	0.18%	28	0.75%	20	20
Water*	0.50%	20	0.23%	32	20
Recently Logged Timberland*	0.43%	21	0.22%	33	21

Table 1 (continued).

CLASS_NAME	Zone 22 PERCENT	Zone 22 RANK	Zone 29 PERCENT	Zone 29 RANK	Highest RANK
Northern Rocky Mountain Conifer Swamp	0.01%	53	0.62%	22	22
Introduced Riparian Vegetation*	0.38%	23	0.07%	47	23
Northwestern Great Plains Riparian	0.04%	39	0.57%	23	23
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	0.30%	24	0.09%	43	24
Mining Operations*	0.00%	68	0.42%	25	25
Western Great Plains Floodplain	0.29%	25	0.00%	61	25
Developed, Low Intensity*	0.25%	26	0.18%	35	26
Rocky Mountain Lower Montane-Foothill Shrubland	0.13%	31	0.40%	26	26
Western Great Plains Dry Bur Oak Forest and Woodland	0.00%	76	0.40%	27	27
Western Great Plains Open Freshwater Depression Wetland	0.24%	27	0.17%	37	27
Introduced Upland Vegetation - Perennial Grassland and Forbland	0.01%	48	0.32%	28	28
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	0.10%	34	0.26%	29	29
Western Great Plains Closed Depression Wetland	0.16%	29	0.18%	36	29
Introduced Wetland Vegetation*	0.14%	30	0.00%	70	30
Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland	0.11%	32	0.23%	31	31
Northern Rocky Mountain Subalpine-Upper Montane Grassland	0.09%	35	0.00%	71	35
Developed, Medium Intensity*	0.06%	36	0.13%	40	36
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	0.03%	41	0.16%	38	38
Rocky Mountain Alpine Fell-Field	0.00%	63	0.14%	39	39
Western Great Plains Cliff and Outcrop	0.04%	40	0.03%	53	40
Western Great Plains Foothill and Piedmont Grassland	0.02%	43	0.12%	41	41
Rocky Mountain Poor-Site Lodgepole Pine Forest	0.02%	46	0.11%	42	42
Rocky Mountain Subalpine-Montane Riparian Shrubland	0.03%	42	0.01%	59	42
Recently Burned Forest and Woodland*	0.00%	72	0.09%	44	44
Rocky Mountain Subalpine-Montane Fen	0.02%	44	0.04%	51	44
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	0.02%	47	0.07%	45	45
Rocky Mountain Subalpine-Montane Mesic Meadow	0.00%	74	0.07%	46	46
Modified/Managed Upland Vegetation*	0.00%	69	0.06%	48	48
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland	0.01%	49	0.00%	72	49
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	0.00%	61	0.06%	49	49
Western Great Plains Wooded Draw and Ravine	0.00%	77	0.06%	50	50
Inter-Mountain Basins Interdunal Swale Wetland	0.01%	51	0.00%	73	51

Table 1 (continued).

CLASS_NAME	Zone 22 PERCENT	Zone 22 RANK	Zone 29 PERCENT	Zone 29 RANK	Highest RANK
Developed, High Intensity*	0.01%	52	0.01%	58	52
Northern Rocky Mountain Subalpine Deciduous Shrubland	0.00%	54	0.00%	74	54
Rocky Mountain Cliff, Canyon and Massive Bedrock	0.00%	56	0.02%	54	54
Rocky Mountain Alpine-Montane Wet Meadow	0.00%	55	0.00%	66	55
Rocky Mountain Alpine Bedrock and Scree	0.00%	62	0.01%	56	56
Introduced Upland Vegetation - Annual and Biennial Forbland*	0.00%	67	0.01%	57	57
North American Alpine Ice Field	0.00%	57	0.00%	67	57
Great Plains Prairie Pothole	0.00%	58	0.00%	69	58
Ruderal Upland - Old Field*	0.00%	60	0.00%	75	60
Northwestern Great Plains Shrubland	0.00%	71	0.00%	62	62
Introduced Upland Vegetation - Treed*	0.00%	64	0.00%	76	64
Rocky Mountain Subalpine-Montane Riparian Woodland	0.00%	65	0.00%	64	64
Recently Burned Grassland*	0.00%	73	0.00%	65	65
Inter-Mountain Basins Playa	0.00%	66	0.00%	77	66
Modified/Managed Wetland Vegetation*	0.00%	70	0.00%	68	68
TOTAL	100.00%		100.00%		

*These types are not ecological systems, but instead are taken from the National Land Cover Dataset or other sources.

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Table 2. Ecological systems, Zone 21 in Wyoming, sorted by rank (most to least pixels).

Ecological System or NLCD type	Zone 29 Percent
Rocky Mountain Lodgepole Pine Forest	12.4%
Northern Rocky Mountain Lower Montane, Foothill, and Valley Grassland	11.4%
Northern Rocky Mountain Subalpine-Upper Montane Grassland	10.4%
Inter-Mountain Basins Montane Sagebrush Steppe	8.0%
Rocky Mountain Subalpine-Montane Mesic Meadow	7.2%
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	6.1%
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	5.7%
Northern Rocky Mountain Subalpine Deciduous Shrubland	4.0%
Inter-Mountain Basins Big Sagebrush Steppe	3.6%
Inter-Mountain Basins Big Sagebrush Shrubland	3.3%
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland	2.9%
Rocky Mountain Foothill Limber Pine - Juniper Woodland	2.5%
Pasture/Hay*	2.5%
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	2.1%
Rocky Mountain Alpine Bedrock and Scree	1.8%
Rocky Mountain Aspen Forest and Woodland	1.8%
Northern Rocky Mountain Ponderosa Pine Woodland and Savanna	1.6%
Cultivated Cropland*	1.5%
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	1.5%
Northern Rocky Mountain Subalpine Woodland and Parkland	1.2%
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	0.9%
Open Water*	0.8%
Rocky Mountain Dry Tundra	0.8%
Harvested forest-tree regeneration	0.7%
Rocky Mountain Alpine Fell Field	0.7%
Developed, Open Space*	0.7%
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	0.6%
Recently burned forest*	0.5%
Harvested forest-grass regeneration*	0.5%
Harvested forest-shrub regeneration*	0.4%
Developed, Low Intensity*	0.3%
Rocky Mountain Subalpine-Montane Riparian Shrubland	0.3%
Rocky Mountain Alpine-Montane Wet Meadow	0.2%
North American Alpine Ice Field	0.2%
North American Arid West Emergent Marsh	0.2%
Quarries Strip Mines and Gravel Pits*	0.1%
Developed, Medium Intensity*	0.1%

Table 2 (continued).

Ecological System or NLCD type	Zone 29 Percent
Rocky Mountain Subalpine-Montane Riparian Woodland	0.1%
Inter-Mountain Basins Aspen Mixed Conifer Forest-Woodland	0.1%
Wyoming Basins Low Sagebrush Shrubland/WY Basins Dwarf Sagebrush Shrubland	0.1%
Rocky Mountain Alpine Dwarf Shrubland	0.1%
Rocky Mountain Poor Site Lodgepole Pine Forest	0.1%
Recently burned grassland*	0.0%
Developed, High Intensity*	0.0%
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest	0.0%
Inter-Mountain Basins Volcanic Rock and Cinder Land	0.0%
Rocky Mountain Lower Montane Foothill Shrubland	0.0%
TOTAL	100.0%

*These types are not ecological systems, but instead are taken from the National Land Cover Dataset or other sources.

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