Resources of the Red Desert and Jack Morrow Hills

FINAL REPORT

Prepared for

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TABLE OF CONTENTS

List of Tables

List of Figures

Introduction

The Red Desert and the Jack Morrow Hills are currently targeted for development by the natural gas industry. The area is also thought to have areas of biological and cultural importance by several environmental groups. A draft coordinated activity plan is currently being revised by the Bureau of Land Management (BLM) and is scheduled for release and comments in July of 2002. The William and Flora Hewlett Foundation provided funding for **W**estern **E**co**S**ystems **T**echnology, Inc. (WEST) to evaluate biological and cultural resources in the Red Desert within areas of potential oil and gas development. The purpose of the report is to provide an objective assessment of biological and cultural resources in the Red Desert and their relationship to areas of potential development. The objectives of this report are:

- Describe oil and gas resources in the Red Desert
- Identify areas with high potential for oil and gas development
- Describe the biological and cultural resources within the Red Desert
- Describe the relationship between potential oil and gas areas and biological resources

The following report will focus on two areas, the Jack Morrow Hills (JMH) analysis area as defined by the BLM (BLM 2000) and the Red Desert analysis area (Figure 1). We focus on the two areas separately due to the draft BLM JMH Coordinated Activity Plan (CAP) draft due for release in July 2002.

The Red Desert is a large area within southcentral and southwestern Wyoming known for its large expanse of remote and relatively undeveloped territory. The place name Red Desert is often used but seldom described. We define the Red Desert as the area spanning from Rawlins west to the Rock Springs uplift, south to the Colorado border, and north to Green Mountains (Figure 1). The area is delineated by the Continental Divide in combination with prominent topography in the area. This area contains the entire closed Great Divide (also known as the Red Desert) Basin, as well as portions of the Upper Green, North Platte and White-Yampa watersheds. The JMH and Red Desert analysis areas are approximately 975 mi^2 and 8,500 mi^2 in size respectively.

Methods

The information presented in this report relies heavily on existing data sources. We queried several organizations and sources for information, including the U.S. Geological Survey (USGS), Wyoming State Geological Survey (WSGS), Wyoming Game and Fish Department (WGFD), Wyoming Natural Diversity Database (WYNDD), Wyoming State Historic Preservation Office, and the BLM. Most organizations made all data available to us for the report, with the exception of the BLM. The Rock Springs Field Office is not releasing any information concerning biological or cultural resources until the revised draft of the JMH Coordinated Activity Plan is released, tentatively scheduled for July 2002 or later.

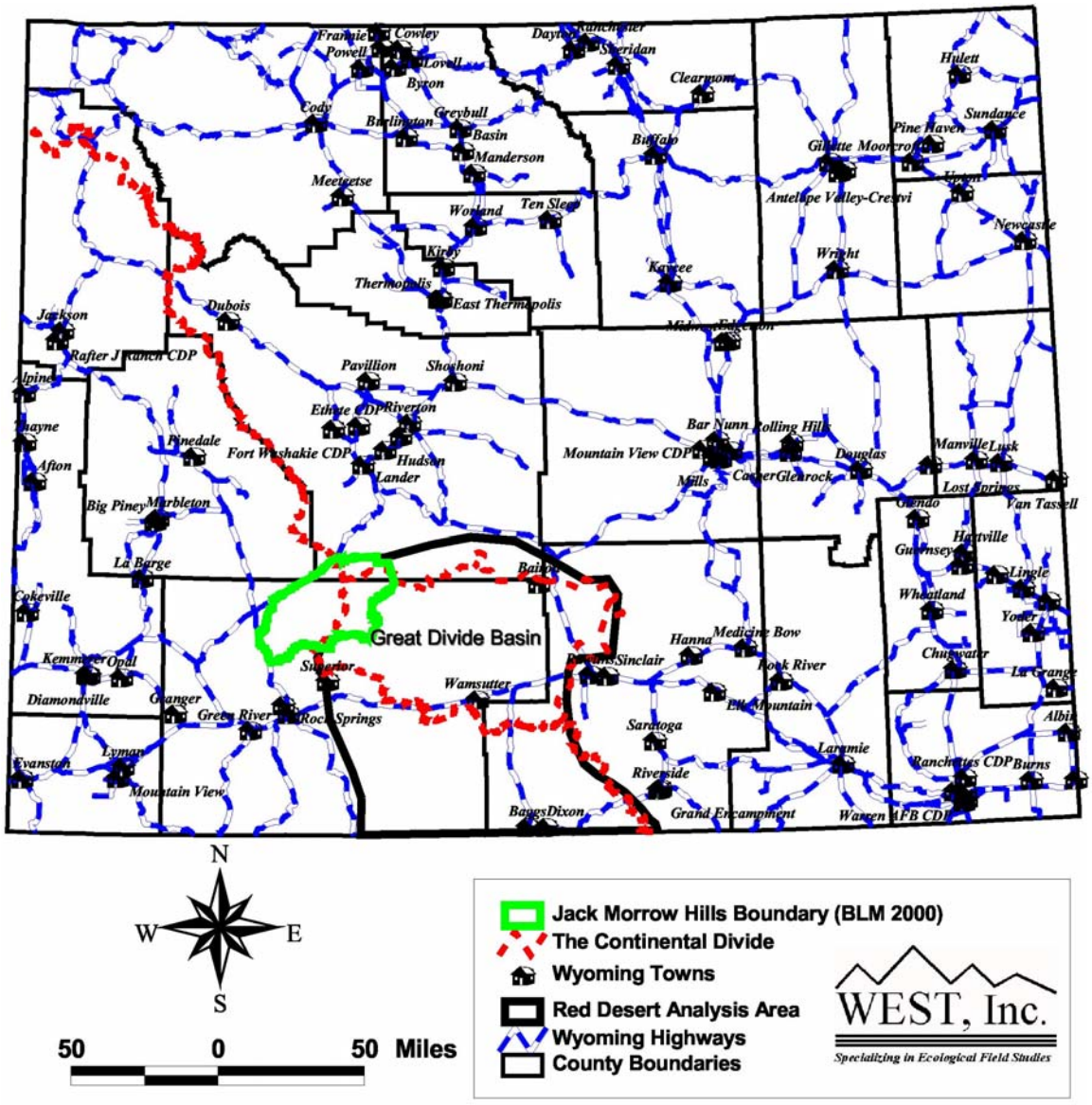

Figure 1. A map showing the locations of the Jack Morrow Hills and the Red Desert.

Energy Resources

The major sources of energy available within the Red Desert include natural gas, coal bed methane, oil and coal (Anderson *et al.* 1990). However, most of the expected oil resource is believed to have been developed within the Red Desert, and discovery of future resources is considered unlikely. Coal resources have not been widely developed due to unattractive economics, and this situation is unlikely to change in the foreseeable future for this area (L. Cook, WSGS, pers. comm.). Natural gas is currently the major source of resource extraction in the Red Desert. Currently, there are approximately

595 mi^2 of active natural gas fields within the Red Desert (WSGS unpublished data). Major fields within the Red Desert include Echo Springs, Wamsutter, Siberia Ridge, Robbers Gulch, Patrick Draw, and Hay Reservoir (Figure 2).

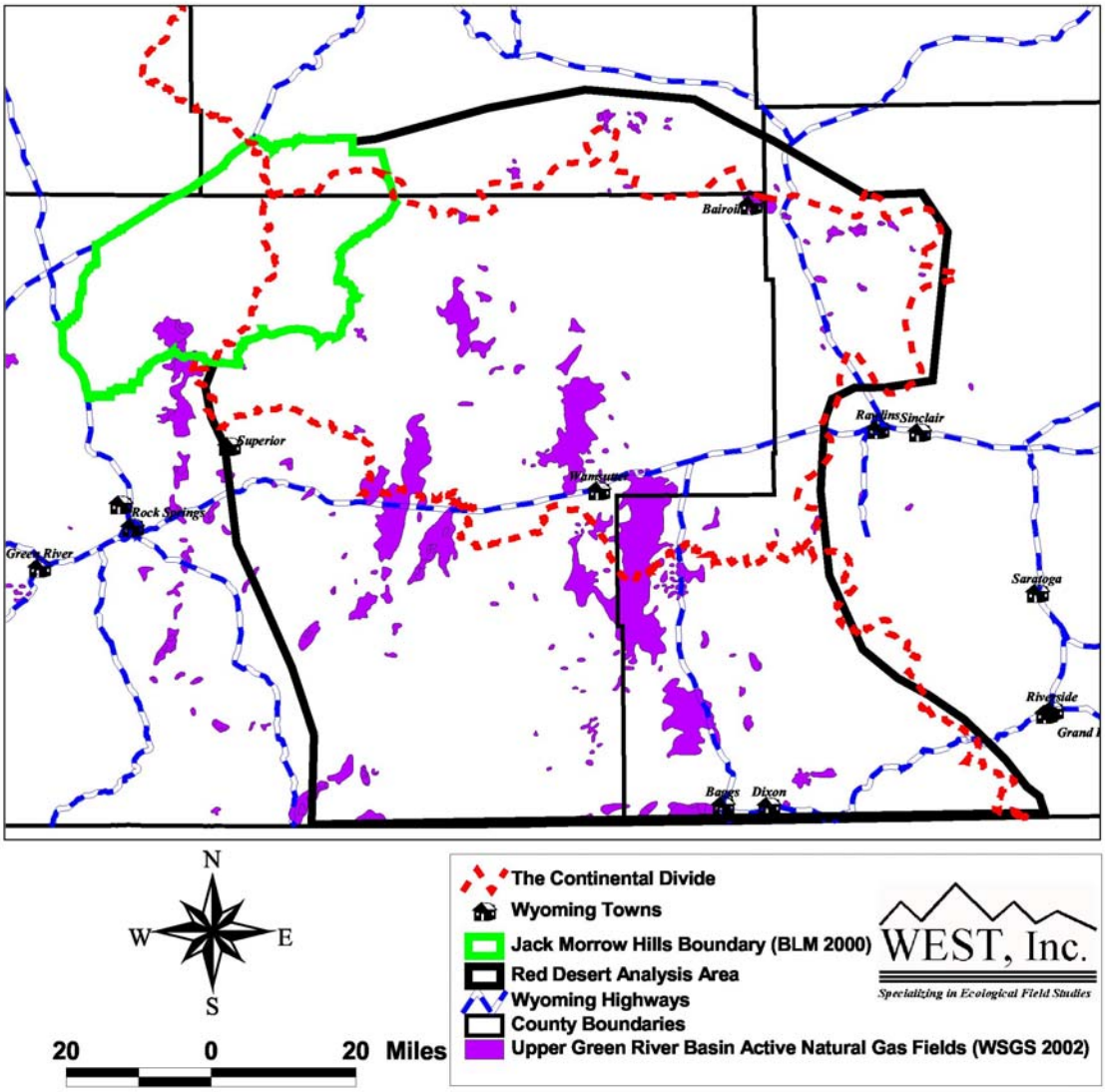

Figure 2. Active natural gas fields within the Red Desert and Jack Morrow Hills.

Red Desert

A play is a term used to describe oil and gas reserves with similar geologic characteristics (USGS 1997). Several natural gas and coal bed methane plays are present within the Red Desert. Conventional oil and gas plays include the Rock Springs Uplift, Cherokee Arch, Basin Margin Anticline and Platform (Figure 3). Conventional plays contain discrete oil and gas deposits that have been successfully extracted using traditional drilling technologies. Unconventional plays contain several types of accumulations, including most continuous type deposits such as tight sand gas, which are not extracted using typical technologies (USGS 1995).

Unconventional, hypothetical basin-centered gas plays present include the Cloverly-Frontier (Figure 4), Mesaverde (Figure 5), Fox Hills – Lance (Figure 6), Fort Union and Lewis (Figure 7). Hypothetical plays have the potential for oil and gas accumulations, but have no known oil and gas discoveries (Law 1995).

Coal bed methane plays present include Almond, Rock Springs, Iles, Lance and Fort Union (Figure 8). These plays contain coal beds less than 6000' in depth (USGS 1995).

Known Reserves. Known reserves are calculated from producing reservoirs. Outside of the JMH area, we know of no reports which summarize known oil and gas reserves within the Red Desert (L. Cook and R. Debruin, WSGS, pers. comm.). Law (1995) described known oil and gas resources from conventional plays in the Upper Green River Basin, an area which encompasses the Red Desert (Figure 3). Although the data presented by Law represent areas extending outside the Red Desert, the data provide a rough idea of the known resources present in the Red Desert (Table 1). Law (1995) also assessed the number of potential oil and gas accumulations associated with several hypothetical plays in the Upper Green River Basin which overlap with the Red Desert (Table 2). The size of potential additional gas reserves is much greater than the known reserves.

It is important to note that estimates of known and potential reserves within the Red Desert are the total amount of resource which could be developed with current and future technologies. The actual amount of resource extracted will likely be less than the estimated reserves due to several factors, including economics and infrastructure requirements, such as roads and pipelines (LaTourette *et al.* 2002).

Figure 3. Conventional oil and gas plays within the Red Desert and JMH.

Table 4. Sensitive biological resources within the JMH.

Sensitive Biological Resources	Jack Morrow Hills	
	Size (Mi^2)	*Number*
Crucial Antelope	127	1
Crucial Elk	293	1
Elk Parturition	102	4
Mule Deer Parturition	38	1
Prairie Dog Colonies	5	79
JMH Area	972	1

Figure 4. Important big game ranges within the Red Desert and JMH.

Migration Routes. The term migration route suggests a relatively narrow corridor used by generations of wildlife while moving between summer and winter ranges. Although big game within the Red Desert and Jack Morrow Hills move between summer and winter ranges during most years, the topography of the Red Desert is relatively wide open, providing few areas where migrating big game are funneled through a narrow area. Thus, in the absence of a major man made barrier such as fences, residences or other structures, big game may use fairly wide areas to move between summer and winter ranges. Although, research concerning big game movement corridors and the effects of oil and gas development are currently lacking, depending on well spacing, natural gas development may not impede big game migratory movements unless fences are built

which impede wildlife movements. Additionally, the WGFD is currently delineating and revising mapped migratory corridors throughout the state (K. Nordyke, WGFD, pers. comm.). Thus we do not depict big game migratory routes within the JMH and Red Desert for two reasons 1) lack of natural topography features which create migratory bottlenecks and 2) the lack of data regarding big game migratory corridor locations in the Red Desert.

Pronghorn migratory movements are more sensitive to fences than mule deer and elk. Deblinger (1988) found that pronghorn residing north of Interstate 80 within the Red Desert were able to migrate around a Uranium mining operation, but Interstate 80 and associated woven wire fences were a permanent barrier to north – south migratory movements across the highway. The presence of the interstate forced antelope to migrate east and west along Interstate 80 in search of wintering areas during a severe winter. Deblinger (1988) found antelope had difficulty crossing fences during the severe winter, and he documented 157 dead antelope within 10 m of fence (480 km of fenceline).

Most antelope go through, rather than over fences. The WGFD considers the optimum fence design for antelope range as a fence with three wires, a smooth bottom wire 16 inches above ground, and a total height of 38 inches. However, in areas where antelope are unaccustomed to fences or in areas with deep snow even a fence of this design can be a barrier to movements. Historically pronghorn movements in the Red Desert have been in response to storm direction rather than specific routes used from year to year, so almost any fence is more problematic than fences in areas with less severe winter weather.

Endangered Species

Relatively few species protected by the Endangered Species Act occur within the Red Desert. The Wyoming Natural Diversity Database (WYNDD 2002) and the WGFD WOS (WGFD *et al.* 1995) have documented three: 1) Bald Eagle (*Haliaeetus leucocephalus*) (Threatened), 2) Mountain Plover (*Charadrius montanus*) (Proposed as Threatened) and 3) Black-footed Ferret (*Mustela nigripes*) (Endangered).

Bald Eagle. The bald eagle rarely nests within the Red Desert due to the lack of water and fish populations within the area. The BLM office in Rawlins has one record and the WGFD WOS (WGFD *et al.* 1995) has two records of nesting bald eagles within the Red Desert. All records are within approximately 10 miles of Baggs, Wyoming. The WYNDD (2002) also has one record of a communal winter roost within 10 miles of Baggs. Outside of the Baggs area, few non-breeding records of bald eagles are present within the Red Desert (Figure 12). The Red Desert is likely only used by bald eagles occasionally during migration or winter, or during the summer by non-breeding individuals. Wintering bald eagles may also feed on carcasses found along Interstate 80 during the winter. There are only six records of bald eagles within the JMH (WGFD *et al.* 1995), although the species is a winter resident just outside of the JMH along the Green River and surrounding areas (BLM 2000). No bald eagle nests are documented within the JMH.

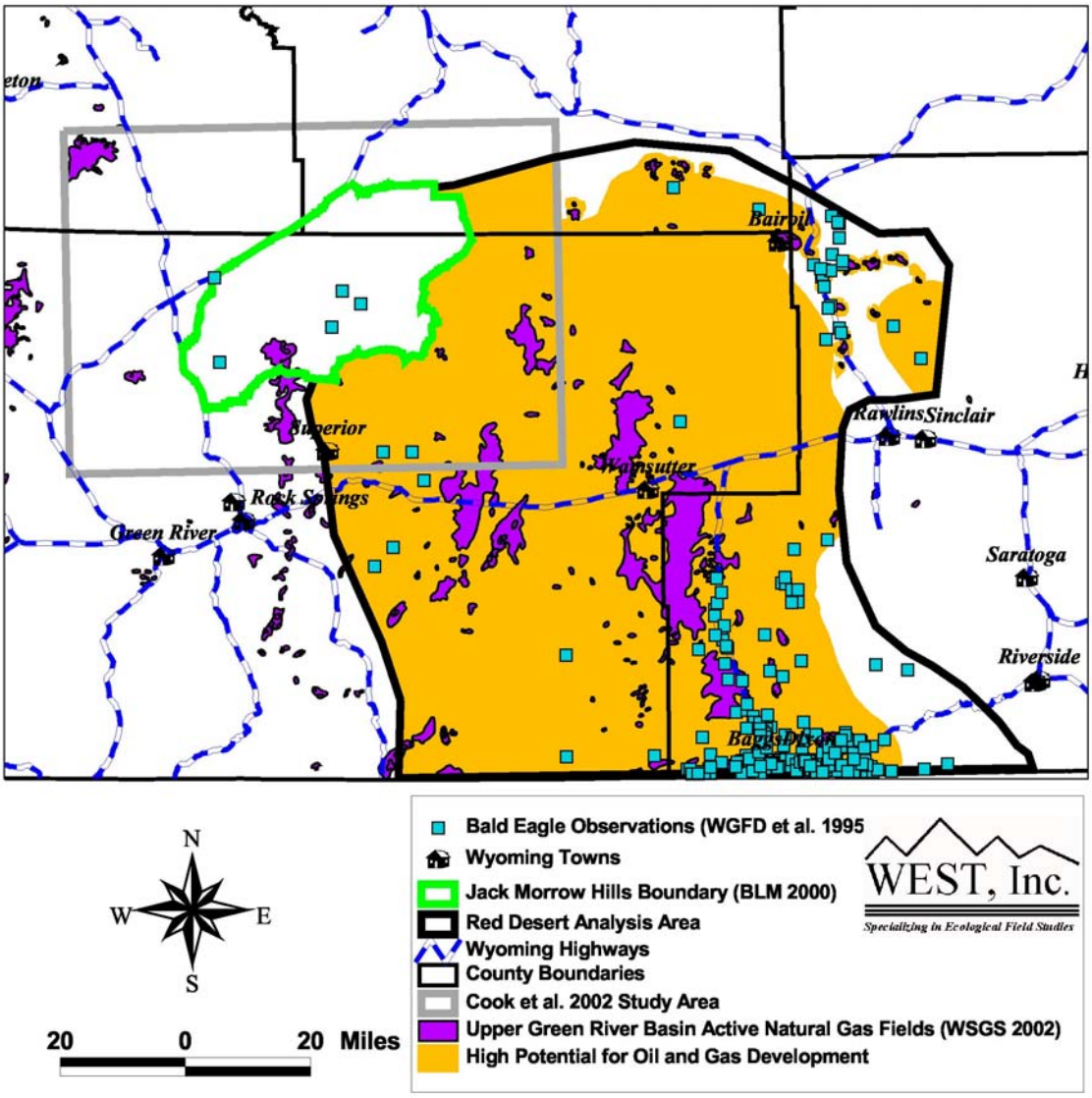

Figure 5. Bald eagle observations within the Red Desert and JMH.

Mountain Plover. The mountain plover is documented as breeding within the Red Desert (Young and Good 2000). Mountain plovers typically arrive in Wyoming in April and leave by late August (Dorn and Dorn 1999). Several habitat types considered suitable for mountain plovers occur within the Red Desert, including saltbush and several relatively unvegetated areas such as sparse arid grasslands (Knopf 1996). Mountain plovers and or suitable mountain plover habitat (flat areas with relatively large amounts of bare ground) have been detected during surveys associated with several natural gas and coal bed methane projects within the Red Desert (BLM 2000a, 2000b, 2002, 2002a). Although the GAP project (Merril *et al.* 1996) shows the majority of the Red Desert

within Wyoming big sage sagebrush, a habitat generally considered unsuitable for mountain plovers (Knopf 1996), large amounts of suitable habitat may be present in the Red Desert. The GAP vegetation layers were mapped at minimum unit of 100 ha (Merrill *et al.* 1996), and large areas of relatively bare ground are likely labeled as Wyoming big sage steppe.

Mountain plovers are documented by the WYNDD as present within the JMH (Beauvais and Smith 1999) near Bush Rim and Bear Creek. Although the authors did not observe nests or young, Beauvais and Smith (1999) observed broken wing displays, a likely indicator of mountain plover nests and young in the area. The WYNDD has 50 records of mountain plovers within the JMH.

Black-footed Ferret. The WYNDD (2002) has nine and the WGFD WOS (WGFD *et al.* 1995) has two historical observations of black-footed ferrets within the Red Desert. The WYNDD has two historical records of black-footed ferrets within the JMH. Black-footed ferrets rely on prairie dog colonies for food and shelter (Clark *et al.* 1984, Forrest *et al.* 1985). Data on prairie dog distribution within the Red Desert is sorely lacking. During surveys in 1988, the WGFD documented 383 colonies totaling 93 mi^2 in size within the Red Desert and 333 colonies totaling 67 mi^2 in high potential development areas (Figure 13). A total of 79 prairie dog colonies totaling 5 mi^2 in size were documented by the WGFD in the JMH in 1988. Most prairie dog colonies within the Red Desert are inhabited by white-tailed prairie dogs, while most black-tailed prairie dogs are found to the east of the Red Desert. It is possible, although highly unlikely that undiscovered populations of black-footed ferrets remain in Wyoming.

Endangered Fish. Four species of endangered fish may potentially occur within the Little Snake River and Green River drainages within the Red Desert and JMH (BLM 2000, 2002, Baxter and Stone 1995). Of the four species, the razorback sucker (*Xyrauchin texanus*) and the humpback chub (*Gila cypha*) may be extinct in Wyoming (BLM 2000). The bonytail chub (*Gila robusta elegans*) prefers deeper sections of the Green River, and is unlikely to occur within the JMH or Red Desert. The Colorado pikeminnow (*Ptychocheilus lucius*), formerly known as the Colorado squawfish, is likely extirpated from the Wyoming portion of the Green River, but has been recently documented within Muddy Creek near Baggs, Wyoming (BLM 2000). Of the four endangered species of fish, the Colorado pikeminnow is the only species that is likely to occur within the Red Desert, and it is restricted to the Little Snake River drainage (Figure 14).

Figure 6. Prairie dog colony locations within the Red Desert and JMH.

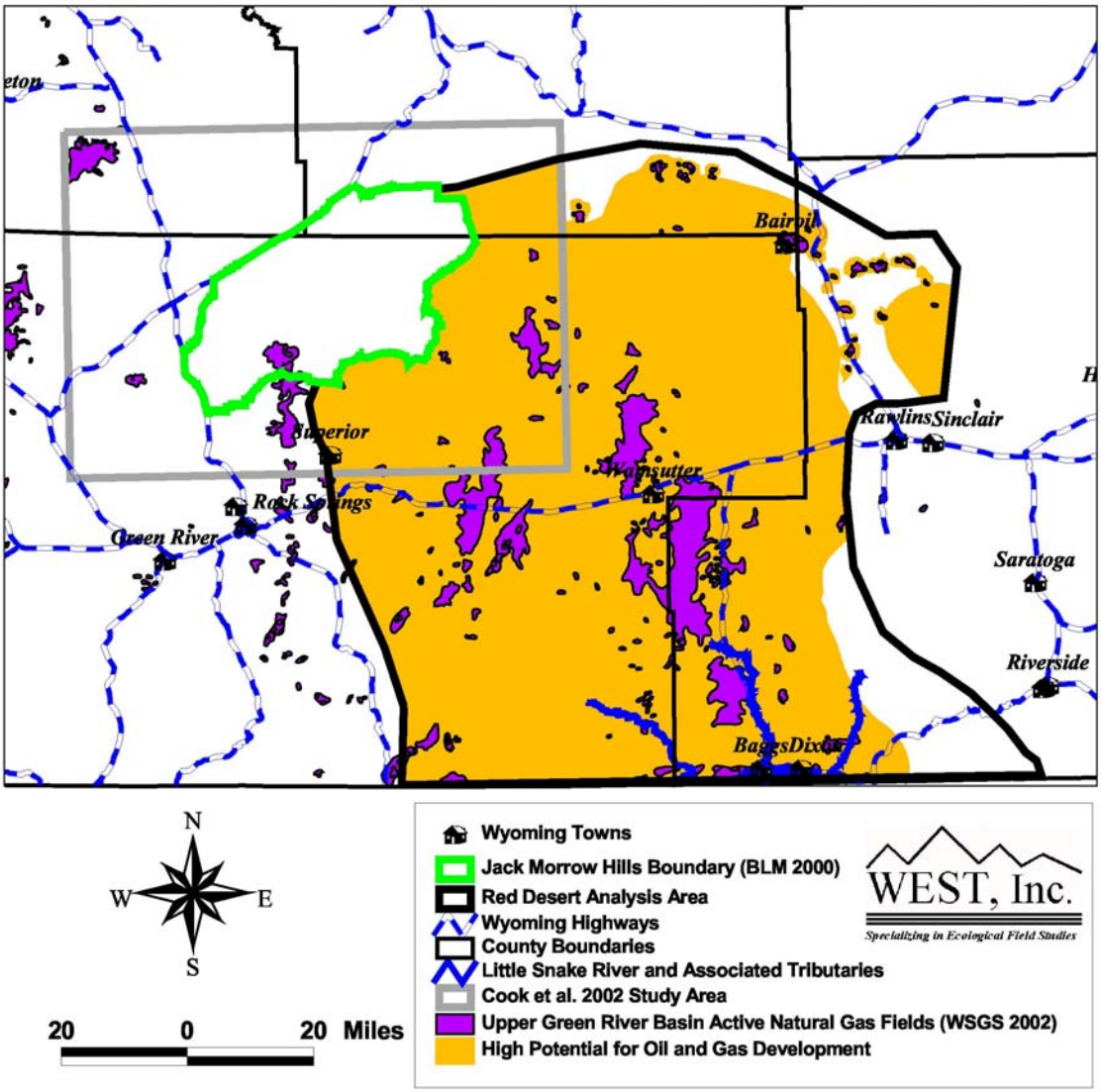

Figure 7. Little Snake River and associated drainages within the Red Desert.

Sage Grouse. The sage grouse is a year round resident throughout the Red Desert. Approximately 63 % of the Red Desert is composed of Wyoming Big Sagebrush. Sage grouse depend upon Wyoming big sagebrush for cover, food and nesting habitat (Braun *et al.* 1976). According to the WGFD (2002) a total of 213 active sage grouse leks are present within the Red Desert (Table 3). Sage grouse may be sensitive to disturbance associated with oil and gas development while breeding at lek sites (Braun *et al.* 2001). As is shown in Figure 15, sage grouse leks are distributed throughout the Red Desert, but appear to be less numerous in the southwest corner of the area. It is not clear if survey effort is lower in this area, or if sage grouse are simply less numerous. The WGFD (2002) has records for 15 active, two historical and 12 leks of unknown status within the JMH.

Figure 8. Sage grouse lek locations within the Red Desert and JMH (WGFD 2002).

The Red Desert and JMH contain large areas of potential sage grouse nesting habitat. The BLM (2000) used a two mile buffer to calculate the amount of sage grouse nesting habitat within the JMH. While Connelly *et al.* (2000) recommend protecting sage grouse nesting habitat within two miles of sage grouse leks, the authors recognize that areas where habitat is not distributed uniformly should be protected at distances greater than two miles. Preliminary data from sage grouse nesting studies in Wyoming (Heath 1997, Heath 1998, Holloran 1999, Lyon 2000) indicate that approximately 50 % of documented nests occurred within two miles (3.2 km) from the lek where sage grouse were captured (M. Holloran, Wyoming Cooperative Fish and Wildlife Research Unit, pers. comm.). Most of the documented nests (approximately 75 %) occurred within slightly less than four miles (6.2 km) of lek sites. We buffered active leks by 3.2 km and 6.2 km within the

Red Desert and JMH to determine the potential amount of sage grouse nesting habitat within the Red Desert. The areas calculated should be considered as maximum amounts of potential nesting habitat because we did not exclude potentially unsuitable habitat (roads, lakes, non-suitable habitat types) from our calculations. Additionally, microsite characteristics may vary within the nest buffers, and not all sagebrush habitat within 3.2 km or 6.2 km of leks may be suitable nesting habitat for sage grouse. Using the assumption of a 6.2 km buffer, sage grouse nesting habitat may cover up to 52 % and 57 % of the JMH and the Red Desert respectively (Table 5 and Figure 16). In reality the distribution of suitable nesting habitat does not exist in a circle around leks, but likely exits in irregular polygons influenced by vegetation, topography, and water.

Table 5. Sage grouse nesting habitat within the Red Desert and JMH in Mi^2 and percent of the total size of the area (in parentheses).

Sage Grouse Nesting Habitat	Jack Morrow Hills	Red Desert	High Gas Potential
3.2 km Buffer	179 (18 %)	2010 (25 %)	1718 (25 %)
6.2 km Buffer	506 (52 %)	4569 (57 %)	3948 (57 %)
Total Size of Area	972	8083	6953

Figure 9. Sage grouse nesting habitat within the Red Desert and JMH.

Ferruginous Hawk and Other Raptors. A total of 16 species of raptor are documented by the BLM Rawlins Field Office (Unpublished data, BLM Rawlins Field Office) as nesting within the Red Desert from 1989 to 2001 (Table 6). We present data only from the Rawlins field office. Data from the Rock Springs Field Office was not available at the time this report was written.

Table 6. Raptor nests documented that were active during at least one year from 1989 – 2001 within the Red Desert by the BLM Rawlins Field Office (BLM, unpublished data).

Species	Total
Ferruginous Hawk	967
Ferruginous Hawk (Artificial)	85
Golden Eagle	261
Golden Eagle (Artificial)	8
Red-tailed Hawk	203
Prairie Falcon	128
Cooper's Hawk	86
American Kestrel	45
Great-Horned Owl	40
Unknown Raptor	39
Swainson's Hawk	38
Swainson's Hawk (Artificial)	1
Burrowing Owl	31
Unknown Nests	26
Unknown Buteo	23
Northern Harrier	15
Long-eared Owl	9
Northern Goshawk	3
Bald Eagle	1
Sharp-shinned Hawk	1
Short-eared Owl	1
Grand Total	2011

Most species of raptor utilize the Red Desert for breeding and hunting areas during the summer and migrate south during the winter. Only a few species, such as golden eagle and rough-legged hawk winter within the Red Desert (Dorn and Dorn 1999). Raptor species are sensitive to disturbance during the nesting period, and human disturbance within close proximity of nests may cause nest abandonment. The Wyoming State Office of the U.S. Fish and Wildlife Service in Cheyenne generally recommends that construction and other activities not occur within one mile of golden eagle and ferruginous hawk nests, two miles of bald eagle nests, and 0.5 mile of other species of buteos in order to avoid disturbance to nesting raptors. Of the raptor species occurring within the Red Desert, the ferruginous hawk may be especially sensitive to human disturbance (White and Thurow 1985). The Red Desert also contains one of the highest concentrations of nesting ferruginous hawks throughout the species range (Larry Apple, BLM, pers. comm.). Thus we believe, of the nesting raptors within the Red Desert, the ferruginous hawk may be most vulnerable to natural gas development. A total of 85 artificial and 967 natural ferruginous hawk nests have been documented in the Red

Desert by the BLM Rawlins Field Office (Figure 17). A total of 34 ferruginous hawk, 25 prairie falcon, 15 golden eagle, and 19 other species of known raptor nests are present within the JMH (Biodiversity Associates 2001).

Figure 10. Ferruginous hawk nests within the Red Desert between 1989 – 2001. Locations are shown for only the BLM Rawlins Field Office.

BLM Sensitive Species

There are 38 species of birds, mammals, fish, reptiles and amphibians on the BLM sensitive species list. The list is intended to target those species which are thought to be declining but are not protected under the Endangered Species Act. Species included on the BLM sensitive species list receive special consideration in BLM planning and NEPA documents (BLM 2001a). A total of 24 and 15 BLM sensitive bird, mammal and

amphibian species have been documented by WYNDD and WOS within the Red Desert (Table 7) and JMH (Table 8) respectively.

Table 7. A list of BLM sensitive species documented within the Red Desert by WYNDD and the WGFD WOS.

Species	Scientific Name	Number of records
Dwarf Shrew	*Sorex nanus*	1
Long-eared Myotis	*Myotis evotis*	8
Pygmy Rabbit	*Brachylagus Idahoensis*	1
White-tailed Prairie Dog	*Cynomys leucurus*	462
Wyoming Pocket Gopher	*Thomonys clusius*	1
Swift Fox	*Vulpes velox*	3
White-faced Ibis	*Plegadis chihi*	23
Trumpeter Swan	*Cygnus buccinator*	1
Northern Goshawk	*Accipiter gentilis*	97
Ferruginous Hawk	*Buteo regalis*	1999
Peregrine Falcon	*Falco peregrinus*	2
Greater Sage Grouse	*Centrocercus urophasianus*	5004
Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*	362
Long-billed Curlew	*Numenius americanus*	5
Burrowing Owl	*Athene cunicularia*	248
Sage Thrasher	*Oreoscoptes montanus*	367
Loggerhead Shrike	*Lanius ludovicianus*	117
Brewer's Sparrow	*Spizella brewerii*	348
Sage Sparrow	*Amphispiza billineata*	358
Roundtail Chub	*Gila robusta*	2
Bluehead Sucker	*Catostomus discobolus*	4
Flannelmouth Sucker	*Catostomus latipinnis*	8
Northern Leopard Frog	*Rana pipiens*	8
Great Basin Spadefoot	*Spea intermontana*	13
Western Boreal Toad	*Bufo boreas boreas*	19

Table 8. A list of BLM sensitive species documented within the JMH by the WYNDD and WGFD WOS.

Species	Scientific Name	Number of Records
Bluehead Sucker	*Catostomus discobolus*	2
Brewer's Sparrow	*Spizella brewerii*	27
Burrowing Owl	*Athene cunicularia*	18
Ferruginous Hawk	*Buteo regalis*	61
Flannelmouth Sucker	*Catostomus latipinnis*	2
Great Basin Spadefoot	*Spea intermontana*	4
Loggerhead Shrike	*Lanius ludovicianus*	7
Long-eared Myotis	*Myotis evotis*	3
Pygmy Rabbit	*Brachylagus Idahoensis*	4
Roundtail Chub	*Gila robusta*	2
Greater Sage Grouse	*Centrocercus urophasianus*	579
Sage Sparrow	*Amphispiza billineata*	28
Sage Thrasher	*Oreoscoptes montanus*	25
Swift Fox	*Vulpes velox*	2
White-tailed Prairie Dog	*Cynomys leucurus*	17

Basic Vegetation Types

The University of Wyoming has completed a Gap Analysis Project (GAP) for the state of Wyoming. This project resulted in production of a GIS database describing land cover types for the entire state at a scale of 1:100,000. The minimum mapping unit used for this project was 100 ha for uplands and 40 ha for wetlands. Map polygons were drawn and described using manual digitizing of polygon boundaries and on-screen visual interpretation of Thematic Mapper imagery. Information determined for each mapped polygon included primary, secondary and "other" land cover types; crown closures for forested primary types; and types of wetlands and/or disturbance found in a polygon, if any. Polygon attributes were assigned using image interpretation, existing maps, limited field reconnaissance, and literature sources (Merrill *et al.* 1996).

In addition to the GAP project, a more intensive vegetation inventory of the Jack Morrow Hills area was conducted in 1995 by the Wyoming Natural Diversity Database (WYNDD) (Jones and Fertig 1996). This information is summarized in the *Draft Environmental Impact Statement for the Jack Morrow Hills Coordinated Activity Plan* (BLM 2000). For the DEIS inventory, vegetation types were classified according to a system developed for Wyoming by WYNDD (Jones 1992) and according to a classification developed by The Nature Conservancy for the western United States (Bourgeron and Engelking 1994). In most cases, classification of shrub stands was based

on the species contributing the most cover to the shrub and herbaceous layers in the study plots within a given stand. This classification, however, does not directly correlate with the GAP land cover types.

The GAP database and the more intensive vegetation inventory of the Jack Morrow Hills area described above are the bases for the following descriptions of the vegetation in the Red Desert and Jack Morrow Hills areas. For this project, we only report the "primary" land cover type for each polygon in the GAP database. The "primary" land cover type occupies the largest area within a given polygon, although "secondary" and "other" land cover types may also be present.

Red Desert

The GAP project identified 26 land cover types in the Red Desert area (Figure 18). The land cover types and the area of each type are shown in Table 9. In general, the distribution of the land cover types is influenced by moisture and nutrient availability, topography, and soil salinity (Knight 1994).

Shrub-dominated cover types make up, by far, the largest amount of land area, dominating approximately 87 percent of the Red Desert. Wyoming big sagebrush steppe is the largest land cover type, alone dominating over 64 percent of the Red Desert, followed by desert shrub, greasewood, mountain big sagebrush, saltbush, and a small component of mesic upland shrub. It should be noted that although the GAP analysis label "Wyoming big sagebrush steppe" indicates a prevalence of the subspecies Wyoming big sagebrush, several other species of sagebrush are also common in the Red Desert, including basin big sagebrush, mountain big sagebrush, and black sagebrush. The distribution of these species appears to be related to soils, topography, and moisture. Wyoming big sagebrush is normally less than 0.5 m tall and occupies the drier uplands, while the taller basin big sagebrush is found in comparatively moist ravines with generally deeper, sandy soils. Mountain big sagebrush is typically found in foothill shrublands adjacent to forests. Black sagebrush occurs on drier, coarser textured, shallower soils than other big sagebrush (Knight 1994). The distribution of the various other shrub species is also highly variable and dependent, in part, on soil features; for example, greasewood and saltbush are typical of fine-textured and alkaline soils (Knight 1994). The prevalence of shrubs in the Red Desert, in general, is likely dependent on climatic factors, in particular the large proportion of winter precipitation (Knight 1994).

Table 9. GAP Land Cover Types in the Red Desert Area.

GAP Land Cover Type	Acres	Square Miles	Percent
Active sand dunes	18,131.91	28.33	0.35
Alpine rock and soil	2,107.64	3.29	0.04
Aspen forest	110,208.17	172.20	2.13
Basin exposed rock/soil	119,717.60	187.06	2.31
Black sage steppe	3,808.85	5.95	0.07
Clearcut conifer	8,203.76	12.82	0.16
Desert shrub	394,527.53	616.45	7.61
Forest-dominated riparian	5,145.92	8.04	0.10
Grass-dominated riparian	1,398.46	2.19	0.03
Greasewood fans and flats	382,585.15	597.79	7.38
Irrigated crops	18,426.85	28.79	0.36
Juniper woodland	96,119.26	150.19	1.85
Limber pine and woodland	11,938.27	18.65	0.23
Lodgepole pine	95,383.89	149.04	1.84
Mesic upland shrub	10,038.98	15.69	0.19
Mixed-grass prairie	14,304.06	22.35	0.28
Mountain big sagebrush	260,449.98	406.95	5.02
Open water	5,739.24	8.97	0.11
Saltbush fans and flats	149,646.35	233.82	2.89
Shrub-dominated riparian	52,854.74	82.59	1.02
Spruce-fir	34,021.78	53.16	0.66
Subalpine meadow	7,369.75	11.52	0.14
Surface mining operations	10,613.32	16.58	0.20
Unvegetated playa	14,223.78	22.22	0.27
Vegetated dune	52,841.26	82.56	1.02
Wyoming big sagebrush steppe	3,305,154.24	5,164.30	63.74
Grand Total	5,184,960.74	8,101.50	100.00

Figure 11. Vegetation Types in the JMH and Red Desert.

Forested land cover types in the Red Desert area include aspen, juniper, limber pine, lodgepole pine, and spruce-fir. A small area of clearcut conifer cover type is also present. The forested cover types make up a relatively small percentage of the Red Desert area, approximately 7 percent. Many of the forest cover types, including spruce-fir, aspen, lodgepole pine, and clearcut conifer, are found at the higher elevations and primarily occur in the southeast portion of the Red Desert area on the west slope of the Sierra Madre mountain range. Lodgepole pine is also found on the slopes of the Green Mountains in the northeast portion of the Red Desert. Stands of juniper are found scattered in the Red Desert area; juniper usually occurs on escarpments with coarse soils (Knight 1994). Some remnant ponderosa pine occur in the Haystacks in the south central portion of the area and natural springs may support small stands of aspen throughout the area. The limber pine and woodland cover type is found at the northern end of the Red Desert in the foothills of the Green Mountains and is attributable primarily to snow accumulation.

Grass- and/or forb- dominated cover types are rare in the Red Desert; however, it should be noted that grasses and forbs are common secondary components of the shrub-dominated land cover types. Mixed-grass prairie, subalpine meadow, and vegetated dunes cover types together make up only 1.4 percent of the Red Desert area. In addition, a very small area (0.4 percent) of irrigated cropland occurs in the southern-most portion of the area. Vegetated dunes are the largest of the grass- and/or forb- dominated cover types, found primarily in the northwest portion of the Red Desert area and in the southeast portion of the area north of Baggs, Wyoming. The amount and type of vegetation found on sand dunes depends on the extent of sand stabilization, temperature, moisture, and the amount of organic matter in the sand (Knight 1994). Plant species adapted to sand dune environments and likely to be found in the Red Desert include blowout grass, Indian ricegrass, needle-and-thread grass, prairie sandreed, rusty lupine, salina wildrye, sand lovegrass, sand muhly, sandhill muhly, and scurfpea (Knight 1994). Antelope bitterbrush is also common in the sand dunes in the southeast portion of the area. An area of mixed-grass prairie occurs in the south-central portion of the Red Desert; the GAP project does not include information on the species composition of this area. The subalpine meadow cover type adjoins the spruce-fir cover type located at the higher elevations on the west slope of the Sierra Madre mountain range.

Water resources are rare in the Red Desert area, consequently riparian and open water cover types are rare, making up approximately 1.2 percent of the area. Riparian cover types include types dominated by forest, shrub, and grass species. The shrub-dominated riparian cover type is the largest riparian type, and is primarily found associated with a few of the perennial streams including Sand, Muddy, and Alkali Creeks and other scattered perennial or intermittent draws throughout the Red Desert area. The open water cover type is associated with Hay Reservoir and Lost Creek Lake in the northern portion of the Red Desert area. The forest-dominated riparian cover type is associated with Savery Creek on the west slope of the Sierra Madre range in the southeastern portion of the area. The grass-dominated riparian type is very minor, mapped only along a portion of Alkali Creek in the northern portion of the study area. Although riparian communities are rare in the Red Desert, they are particularly valuable to wildlife as a source for food,

water, shelter, and migration routes (Knight 1994). In particular, there are natural springs and seeps and abandoned wells, associated with old oil and gas drill sites, scattered throughout the desert that provide a critical source of water for native ungulates and the rather sizable herd of wild horses in the area.

Several of the cover types mapped as part of the GAP project are unvegetated or sparsely vegetated. These include active sand dunes, alpine rock and soil, basin exposed rock/soil, surface mining operations, and unvegetated playas cover types. These types occur where environmental conditions limit plant growth, such as shifting sand, exposed rock/rocky soils, or highly saline soils. Unvegetated types also occur where man has altered vegetation for surface mining operations.

Five of the land cover types do not occur in the area of medium to high gas potential, and therefore are unlikely to be affected by potential future gas activity in the Red Desert. These five types include alpine rock and soil, black sage steppe, clearcut conifer, spruce-fir, and subalpine meadow. Other cover types are also unlikely to be affected by any future gas development because the sites they occupy are not conducive to these activities. Examples include juniper woodlands, which are typically found on escarpments, and the active and vegetated sand dunes.

Since shrub-dominated cover types are the most widespread in the area of medium to high gas potential, they are most likely to be directly impacted by any future oil and gas development, particularly Wyoming big sagebrush steppe, desert shrub, greasewood fans and flats, and mountain big sagebrush cover types. Direct loss of some individuals within these types would likely occur assuming vegetation is replaced by roads, well-pads, and other facilities associated with gas development. Temporary disturbance to big sagebrush steppe would likely result in a change in species composition to more grasses and forbs, including noxious and invasive weed species, over the short term because big sagebrush does not resprout and is slow to return when removed. Poor reclamation along roads allows noxious species to spread throughout the desert and even to spread into undisturbed vegetation adjacent to roads. The likelihood of the introduction and/or spread of weedy species increases dramatically with oil and gas development. With time, however, sagebrush often regains dominance after disturbance. Careful reclamation of a pipeline right of way in western Wyoming north of Evanston, Wyoming resulted in sagebrush returning in relatively great abundance in three to five years (Strickland *et al.* 1997). Knight (1994) reports that, after disturbance, big sagebrush reinvasion increases in proportion to the amount of precipitation, amount of litter, competition from herbaceous plants, grazing intensity, number of sagebrush seeds in the soil, and the number of live shrubs that remain.

Weeds. No information was readily available on the existing condition of noxious weed species in the Red Desert; however in the adjacent Jack Morrow Hills area the following species are known to occur: halogeton, kochia, Russian thistle, perennial pepperweed, black henbane, whitetop, musk thistle, Canada thistle, and leafy spurge. The introduction and/or spread of these species will likely increase considerably in the Red Desert with increased gas activity, since many of these species are known to increase with increased

motor vehicle use. Weed seeds are also spread from the use of reclamation seed mixes that are not "weed free" and from the mulch used as a ground cover after seeding. Notwithstanding the importance of weather and post-disturbance management mentioned by Knight, the key to reducing noxious weed infestation appears to be proper reclamation of disturbed sites.

Jack Morrow Hills

In the Jack Morrow Hills area, the GAP project identified fourteen land cover types (Figure 18). The land cover types and the area of each type are shown in Table 10. It should be noted that the land cover types presented in the GAP project do not correspond directly with the vegetation inventory conducted by WYNDD. The WYNDD vegetation inventory was a more intensive study and used a different classification system, while the GAP project relied on thematic imagery interpretation; therefore some of the vegetation descriptions from the two projects do not match.

Table 10. GAP Land Cover Types in the Jack Morrow Hills Area.

GAP Land Cover Type	Acreage in Jack Morrow Hills Area	Square Miles in Jack Morrow Hills Area	Percent
Active sand dunes	25,998.15	40.62	4.18
Basin exposed rock/soil	32,441.41	50.69	5.21
Desert shrub	64,548.50	100.86	10.37
Forest-dominated riparian	2,142.99	3.35	0.34
Greasewood fans and flats	4,293.76	6.71	0.69
Irrigated crops	773.18	1.21	0.12
Juniper woodland	1,649.50	2.58	0.27
Limber pine and woodland	538.82	0.84	0.09
Mountain big sagebrush	18,128.46	28.33	2.91
Saltbush fans and flats	18,943.45	29.60	3.04
Shrub-dominated riparian	11,375.33	17.77	1.83
Unvegetated playa	801.49	1.25	0.13
Vegetated dunes	9,447.40	14.76	1.52
Wyoming big sagebrush	431,247.75	673.82	69.30
	622,330.18	972.39	100.00

By far, the largest land cover type is the Wyoming big sagebrush type, covering 69 percent of the Jack Morrow Hills area. Wyoming big sagebrush is the most common sagebrush species in this land cover type, but other sagebrush are also present, including basin big sagebrush, mountain big sagebrush, and black sagebrush. Other shrub-dominated cover types cover 17 percent of the area, including desert shrub, greasewood fans and flats, mountain big sagebrush, and saltbush fans and flats. The 1995 WYNDD

vegetation inventory identified two Wyoming big sagebrush associations: Wyoming big sagebrush/western wheatgrass association and Wyoming big sagebrush/bluebunch wheatgrass association. The Wyoming big sagebrush/western wheatgrass association occupies the lower parts of easterly slopes, benches, and valley bottoms, and typically covers from several hundred to thousands of square meters. The Wyoming big sagebrush forms a fairly sparse shrub layer, approximately 0.5 m high. Other shrubs, such as green rabbitbrush, Utah snowberry, and rubber rabbitbrush, are commonly present and western or thickspike wheatgrass dominate the understory. The Wyoming big sagebrush/ bluebunch wheatgrass association usually occupies exposed sites on southerly or westerly slopes, or the upper parts of easterly slopes. Wyoming big sagebrush, antelope bitter-brush, and green rabbitbrush form a sparse shrub layer 0.2 to 0.3 m high. Bluebunch wheatgrass dominates the herbaceous layer, and forbs such as turnip spring-parsley, granite prickly gilia, bushy bird's beak, timber milkvetch, rockcress and buckwheat are often present.

In addition to the Wyoming big sagebrush associations, the WYNDD vegetation inventory described five other shrub-dominated vegetation types:

- Gardner's saltbush-winterfat
- Mountain shrub
- Basin big sagebrush
- Mountain big sagebrush
- True mountain mahogany/bluebunch wheatgrass

Two of these vegetation types correspond well with the GAP land cover types, including the Gardner's saltbush-winterfat type, which corresponds with the GAP's saltbush fans and flats cover type, and the mountain big sagebrush type, which corresponds with the GAP land cover type of the same name. WYNDD's mountain shrub vegetation type is based on the height of the vegetation, i.e., vegetation tall enough to provide cover for elk and mule deer, and consists of a variety of shrub communities. There is no corresponding GAP land cover type. WYNDD's true mountain mahogany/bluebunch wheatgrass vegetation type consists of small, widely-scattered stands on relatively steep slopes, generally on or near sandstone outcrops. These stands were likely too small to be mapped as distinct land cover types in the GAP project, and were likely included as secondary or other components of Wyoming big sagebrush or other shrub-dominated land cover types. While some of these less common plant associations are excluded from the GAP project, they are very important as food and cover for wildlife. For example, mountain mahogany is an important browse plant for mule deer and the basin big sagebrush/basin wildrye association provides valuable food and cover for desert elk.

Interestingly, the WYNDD project reports that large stands of basin big sagebrush occur in the Jack Morrow Hills area and they describe three basin big sagebrush associations; basin big sagebrush/basin wildrye, basin big sagebrush/lemon scurfpea, and basin big sagebrush/western wheatgrass associations. However, the GAP project does not include basin big sagebrush as a land cover type. The basin big sagebrush could be a secondary component of the GAP project's Wyoming big sagebrush or other cover type, or may not

have been mapped as a separate cover type because it could not be distinguished on the GAP's thematic imagery. One of the three associations described by WYNDD, basin big sagebrush/lemon scurfpea, is found on sand dunes and is considered unique because it has not been reported from anywhere else in Wyoming or the western U.S.

The GAP project mapped two forested land cover types: juniper woodland and limber pine and woodland. These cover types are minor and make up less than one percent of the Jack Morrow Hills area (0.36 percent). These cover types appear equivalent to the Utah juniper/bluebunch wheatgrass vegetation type and a discussion of woodlands in the WYNDD vegetation inventory. WYNDD reports that Utah juniper forms scattered stands on sandstone-derived soils and on outcrops. WYNDD further reports that small isolated stands of limber pine and aspen, as well as scattered Douglas fir and lodegepole pine, are found at the higher elevations of Oregon Buttes and Steamboat Mountain in the Jack Morrow Hills area. The presence of these stands is attributable to snow accumulation and the location of springs and seeps on the slopes of the buttes.

Based on the GAP analysis, sand dunes comprise approximately 5.7 percent of the Jack Morrow Hills area. Active sand dunes, which are sparsely vegetated due to the constantly shifting sand, are more common (4.18 percent) than the more stabile vegetated dunes (1.52 percent). However, some species tolerate the unique environment found on active sand dunes. According to the WYNDD vegetation inventory, species found on active sand dunes include basin big sagebrush and rubber rabbitbrush in a shrub layer between 1 and 2.5 m tall, and lemon scurfpea, green rabbitbrush, Utah snowberry, Utah serviceberry, whisky currant, antelope bitterbrush, basin wildrye, Indian ricegrass, thickspike wheatgrass, and needle-and-thread grass in the understory.

According to the GAP project, forest- and shrub-dominated riparian cover types make up 2.17 percent of the Jack Morrow Hills area. The shrub-dominated riparian is primarily mapped along Jack Morrow Creek and the forest-dominated riparian area along the Sweetwater River and some of its tributaries. The *Draft Environmental Impact Statement for the Jack Morrow Hills Coordinated Activity Plan* reports that 20 percent of the stream riparian areas in the Jack Morrow Hills area are in "Proper Functioning Condition", while 40 percent is on an upward trend and an additional 40 percent is on a downward or "not apparent" trend (BLM 2000).

In addition to land cover types described above, two unvegetated cover types were mapped in the Jack Morrow Hills area, basin exposed rock/soil (5.21 percent) and unvegetated playa (0.13 percent). A small area of irrigated crop (0.12 percent) is also mapped. These cover types represent portions of the Jack Morrow Hills area that are sparsely vegetated due to harsh environmental conditions (e.g., rocky or saline soils) or areas where the native vegetation has been altered by man.

The discussion in the previous section regarding potential impacts of gas development activity on vegetation in the Red Desert area also applies to the Jack Morrow Hills area. In addition, the unique basin big sagebrush/lemon scurfpea association is susceptible to

impacts from development. This association occurs on sand dunes within the Jack Morrow Hills.

Weeds. According to the *Draft Environmental Impact Statement for the Jack Morrow Hills Coordinated Activity Plan*, weed populations are found scattered throughout the Jack Morrow Hills area: along main dirt roads and two-tracks (especially those that cross meadows and drainage bottoms); areas of livestock concentration such as stock reservoirs, riparian areas and sheep camps; and areas of intense recreational use, such as frequently-used dispersed camping areas (BLM 2000). Weed species have been introduced through many channels, including motorized vehicles (personal vehicles, all-terrain vehicles, and industrial vehicles); road blading (spreading mature weed seeds along roadbanks); transportation of non-local livestock into the area, or movement from a weedy area to a non-infested site; use of contaminated hay for stock animals and reclamation mulch; and overutilization and denigration of native plant communities which create openings for weed invasion (BLM 2000).

Widespread populations of halogeton, kochia, and Russian thistle are found throughout the Jack Morrow Hills area (BLM 2000). These species were introduced from Europe, but are now found on millions of acres of semi-arid desert rangelands. They tend to be found mainly on roadsides, in borrow ditches and disturbed areas, and will take over any area cleared of vegetation and not properly reclaimed. However, these species will generally decrease if native grasses and shrubs are allowed to recolonize the disturbed sites.

Extensive infestations of the noxious weed perennial pepperweed occur on streambanks in the lower portions of Jack Morrow Creek and Pacific Creek (BLM 2000). Once established, perennial pepperweed becomes very difficult to control by herbicides, and can cause loss of native grass communities in riparian areas. Black henbane is expanding in the vicinity, especially in areas near Oregon Buttes, North and South Table Mountains, in the sand dunes, along the Bar X Ranch Road, and in disturbed locations of Pacific Creek and Rock Cabin Creek. This species is commonly found along roadsides and in other waste places, and has been observed invading small open areas within native sagebrush-grass communities. This species can be treated effectively with herbicides.

Whitetop is a deep-rooted perennial that is commonly found on disturbed, alkaline soils of sagebrush-grass or riparian communities in the Jack Morrow Hills area. Small populations are evident along Pacific Creek and Bear Creek at the road crossings. It is highly competitive with native plant species once it becomes established, but can be effectively controlled with herbicides.

Scattered populations of musk thistle and Canada thistle are found in scattered meadows and in seep areas on the east side of Steamboat Mountain. Musk thistle can be an aggressive invader, forming dense stands that crowd out desirable species. Chemical herbicides are effective in controlling musk thistle, but they are less successful on Canada thistle.

A population of leafy spurge, the first noted in the Rock Springs BLM District, was found in the Honeycomb Buttes area several years ago. This species is highly undesirable as it has become one of the worst noxious weed problems in the country. Its extensive root system, and an extremely effective seed dispersal mechanism allow this species to significantly out-compete native rangeland species. The population of leafy spurge in the planning area is treated with herbicides annually and monitored. Although the population is not yet eradicated, it is under control. It is imperative that this species be restricted from further spread.

The likelihood of spreading these noxious weeds and/or introducing new weedy species increases with increased oil and gas activity. Mitigative measures should be required to minimize the introduction and spread of noxious species.

Wetlands

Information on wetlands in the study area was obtained from the U.S. Fish and Wildlife Service's National Wetland Inventory. The National Wetland Inventory (NWI) produced NWI maps showing wetlands and their classification throughout the United States (not all maps are completed). NWI maps are compiled through manual interpretation of aerial photography supplemented by soil surveys and field checking of wetlands identified from photographs. Delineated wetland boundaries are manually transferred from interpreted photos to USGS 7.5 minute topographic quadrangle maps and then manually labeled and mapped. In the treeless prairies, 1/4 acre wetlands are mapped. In forested areas, small open water and emergent wetlands are mapped. In general, the minimum mapping unit is from 1 to 3 acres depending on the wetland type and the scale and emulsion of the source aerial photography.

The wetland classification system used on NWI maps is hierarchical, with wetlands and deepwater habitats divided among five major systems at the broadest level (Cowardin *et al.* 1973). The five systems include Marine (open ocean and associated coastline), Estuarine (salt marshes and brackish tidal water), Riverine (rivers, creeks, and streams), Lacustrine (lakes and deep ponds), and Palustrine (shallow ponds, marshes, swamps, sloughs). Systems are further subdivided into subsystems that reflect hydrologic conditions. Below the subsystem is the class, which describes the appearance of the wetland in terms of vegetation or substrate. Each class is further subdivided into subclasses; vegetated subclasses are described in terms of life form and substrate subclasses in terms of composition. The classification system also includes modifiers to describe hydrology (water regime), soils, water chemistry (pH, salinity), and special modifiers relating to man's activities (e.g., impounded, partly drained).

Digital NWI data are available through the online Wyoming Geographic Information Science Center (www.sdvc.uwyo.edu). Digital wetland data were either manually digitized or scanned from copies of the 1:24,000 scale wetlands overlays registered to the standard USGS 7.5 minute quadrangles into topologically correct data files. Digital line graph files of NWI were converted into Arc/Info format, tiled into 1:100,000-scale quadrangles for distribution, and attributes standardized and checked.

In general, wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification, wetlands must have one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes (i.e., plants adapted to grow in water or seasonally wet environments); 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

Red Desert. Wetlands within the Red Desert area, according to the NWI maps, are shown in Figure 19. As shown, wetlands are either linear features associated with drainages or small polygons associated with lakes, springs, seeps, or other similar features. All wetlands in the Red Desert are classified as either palustrine or riverine at the broadest level. Table 11 presents a breakdown of the types and amounts of wetlands. For the purposes of this document, the wetland type includes the system, subsystem, and class levels of the hierarchical classification. Further information on the classification of each wetland, including the subclasses and modifers, is available from the U.S. Fish and Wildlife Service National Wetland Inventory or online on the Wyoming Geographic Information Science Center website (www.sdvc.uwyo.edu).

According to the NWI maps, the large majority of linear wetlands in the Red Desert area (90 percent) are either "riverine intermittent streambed" (54 percent) or "palustrine emergent" (36 percent). Most polygonal wetlands are "palustrine emergent" (48 percent). These types are scattered throughout the Red Desert, however, the palustrine emergent wetlands are more prevalent on the slopes of the Sierra Madre and Green Mountains. "Palustrine scrub-shrub" wetlands make up an additional 8 percent of linear wetlands and "riverine upper perennial unconsolidated bottom" wetlands make up 2 percent of linear wetlands, though these types are found only on the slopes of the Sierra Madre and Green Mountains. "Palustrine scrub-shrub", "palustrine unconsolidated bottom", and "lacustrine littoral unconsolidated shore" and "aquatic bed" are other common polygonal types. The remaining wetland types are very minor.

The "riverine intermittent streambed" type includes 1,298 miles of linear wetlands and 3,585 acres of of polygonal wetlands. In the Red Desert, these wetland habitats are contained in natural or artificial channels that contain flowing water only part of the year, but may contain isolated pools when the flow stops (U.S. Fish and Wildlife Service website www.nwi.fws.gov). The substrate and form likely vary considerably depending on gradient, soils, and other factors. The streambed may be unvegetated or may be colonized by herbaceous annuals or perennials.

Table 11. Wetland types in the Red Desert Area.

NWI Wetland Classification*	Linear Wetlands (length in miles)	Percent	Polygonal Wetlands (area in acres)	Percent
PAB	3.28	0.14	1,960.57	4.35
PEM	861.72	35.67	21,566.55	47.80
PFO	2.20	0.09	868.35	1.92
PSS	193.94	8.03	4,314.66	9.56
PUB	0.04	0.00	147.82	0.33
PUS	4.84	0.20	4,080.51	9.04
R2UB	0.61	0.03	499.05	1.11
R2US	0.39	0.02	418.81	0.93
R3UB	50.00	2.07		0.00
R3US	0.70	0.03	106.99	0.24
R4SB	1,297.99	53.73	3,585.14	7.95
L1UB			456.01	1.01
L2UB			172.98	0.38
L2AB			2,784.56	6.17
L2US			4,159.17	9.22
	2,415.70	100.00	45,121.17	100.00

*System , Subsystem (if applicable), and Class levels (subclass and modifiers are not shown)

PAB Palustrine Aquatic Bed
PEM Palustrine Emergent
PFO Palustrine Forested
PSS Palustrine Scrub-Shrub
PUB Palustrine Unconsolidated Bottom
PUS Palustrine Unconsolidated Shore
R2UB Riverine Lower Perennial Unconsolidated Bottom
R2US Riverine Lower Perennial Unconsolidated Shore
R3UB Riverine Upper Perennial Unconsolidated Bottom
R3US Riverine Upper Perennial Unconsolidated Shore
R4SB Riverine Intermittent Streambed
L1UB Lacustrine Limnetic Unconsolidated Bottom
L2UB Lacustrine Littoral Unconsolidated Bottom
L2AB Lacustrine Littoral Aquatic Bed
L2US Lacustrine Littoral Unconsolidated Shore

Figure 12. Wetlands within the Red Desert and JMH.

Approximately 862 miles of linear "palustrine emergent wetlands" and 21,567 acreas of polygonal "palustrine emergent wetlands" occur in the Red Desert area. Palustrine wetlands include, in part, all nontidal wetlands dominated by trees, shrubs, emergents, mosses, or lichens. Wetlands lacking such vegetation are also included if they are less than 8 hectares (20 acres), do not have an active wave-formed or bedrock shoreline feature, and have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin. Additional definition of palustrine wetlands relates to tidal areas and is not applicable here (U.S. Fish and Wildlife Service website www.nwi.fws.gov). Emergent wetlands, by definition, are characterized by erect, rooted, herbaceous hydrophytes (usually perennial plants), that are present for most of the growing season in most years (U.S Fish and Wildlife Service website www.nwi.fws.gov). In the Red Desert, typical emergent wetlands are likely to consist of low spots or drainages in which the soils are inundated or saturated for a period long enough during the growing season to support various rushes, sedges, cattail, and/or other hydrophytes. "Palustrine unconsolidated bottom" wetlands are similar to emergent wetlands, except that they have less than 30 percent areal cover of vegetation (other than pioneering plants) and unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock

"Palustrine scrub-shrub" wetlands are also primarily found in drainages on the slopes of the Sierra Madre Mountains in the southeast corner of the Red Desert area. These wetlands are characterized by woody vegetation less than 6 m (20 feet) tall, and may include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions. In the study area, various willow species are likely to be dominant. "Riverine upper perennial unconsolidated bottom" are similar to the "riverine intermittent streambed", however the water regime is perennial and is typified by a high gradient and fast water velocity. The substrate is typically rock, cobbles, or gravel with occasional patches of sand, and there is very little floodplain development (U.S Fish and Wildlife Service website *www.nwi.fws.gov)*. Vegetative cover is usually less than 30 percent. In the Red Desert area, these wetlands are associated with perennial creeks such as Savery and Battle Creeks.

Lacustrine wetlands are situated in a topographic depression or a dammed river channel. They lack trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% aerial coverage and the total area exceeds 8 hectares (20 acres). The littoral subsystem refers to wetland habitats in the lacustrine system that extend from the shoreward boundary to 2 meters (6.6 feet) below annual low water or to the maximum extent of non-persistent emergents, if these grow at depths greater than 2 meters. The unconsolidated shore class refers to unconsolidated substrates with less than 75% aerial cover of stones, boulders, or bedrock; less than 30% aerial cover of vegetation other than pioneering plants; and a variety of water regimes. The aquatic bed class includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years. Aquatic beds generally occur in water less than 2 meters (6.6 feet) deep and are placed in the Littoral Subsystem (if in Lacustrine System). In the Red Desert, lacustrine wetlands are associated with scattered lakes, reservoirs, stockponds, and other natural or man-made depressions.

Potential future gas development could affect wetlands in the Red Desert area, depending on the locations of development facilities. A road network associated with such development would likely cross various drainages that may contain wetlands. The wetland types, according to the NWI maps, most likely to be affected are "riverine intermittent streambed" and "palustrine emergent" because these are the types that are most common in the medium to high development area. Filling of wetlands requires a permit from the Army Corps of Engineers. The Army Corps of Engineer's definition of a wetland does not necessarily correspond to the NWI mapping. "Palustrine emergent" wetlands are likely to be considered jurisdictional wetlands by the Corps and require permitting and mitigation for impacts from oil and gas or other development activity. The "riverine intermittent streambed" type may not be considered a jurisdictional wetland by the Army Corps of Engineers (this would have to be determined on a case by case basis). Avoidance of wetlands by development activity would be preferred in order to protect these scarce resources and the functions they provide for wildlife, water quality, and other resources.

Water is often a byproduct of oil and gas development. The proper management of water resources developed during and after oil and gas projects provide the industry an opportunity to mitigated impacts to springs, seeps and small wetlands. However, manmade wetlands often do not function as well as natural wetlands and most require ongoing maintenance.

Jack Morrow Hills Area. Wetlands within the Jack Morrow Hills based on NWI maps area are shown in Figure 19. As in the Red Desert area, nearly all the wetlands are linear features associated with drainages, and all are classified as either palustrine or riverine at the broadest level. Table 12 shows a breakdown of the types and amounts of wetlands in the Jack Morrow Hills area. For the purposes of this document, the wetland type includes the system, subsystem, and class levels of the hierarchical classification. Further information on the classification of each wetland, including the subclasses and modifiers, is available from the U.S. Fish and Wildlife Service National Wetland Inventory or online the Wyoming Geographic Information Science Center website (www.sdvc.uwyo.edu).

As in the Red Desert area, "riverine intermittent streambed" and "palustrine emergent" wetland types make up the large majority of wetland types found in the Jack Morrow Hills area, together totaling 97 percent of linear wetland types and 78 percent of polygonal wetland types. Other linear wetland types are very minor, and other relatively common polygonal wetlands include "palustrine scrub-shrub" and "palustrine unconsolidated bottom". These wetland types were described above in the previous section on Red Desert wetlands.

The discussion in the previous section regarding potential affects to wetlands in the Red Desert area resulting from future oil and gas development activity also applies to the Jack Morrow Hills area.

Table 12. Wetlands types in the Jack Morrow Hills Area.

NWI Wetland Classification*	Linear Wetland (length in miles)	Percent	Polygonal Wetland (area in acres)	Percent
PAB	0.17	0.07	116.16	4.63
PEM	70.42	30.23	1,884.12	75.14
PSS	1.23	0.53	238.42	9.51
PUB			7.25	0.29
PUS	0.05	0.02	207.52	8.28
R2UB	6.01	2.58	0.32	0.01
R2US	0.15	0.06	1.34	0.05
R4SB	154.88	66.50	24.06	0.96
L2AB			28.35	1.13
	232.91	100.00	2,507.53	100.00

*System , Subsystem (if applicable), and Class levels (subclass and modifiers are not shown)
PAB Palustrine Aquatic Bed
PEM Palustrine Emergent
PSS Palustrine Scrub-Shrub
PUB Palustrine Unconsolidated Bottom
PUS Palustrine Unconsolidated Shore
R2UB Riverine Lower Perennial Unconsolidated Bottom
R2US Riverine Lower Perennial Unconsolidated Shore
R4SB Riverine Intermittent Streambed
L2AB Lacustrine Littoral Aquatic Bed

Special Status Plant Species

Special status plants are those which are officially listed as Threatened or Endangered (T&E), proposed for listing or candidates for listing as T&E by the Secretary of the Interior under the provisions of the federal Endangered Species Act. In addition, special status species include those listed on the BLM's sensitive species list. The BLM is mandated by law and policy to protect and manage threatened, endangered, candidate, and sensitive plant species and their habitat identified by the U.S. Fish and Wildlife Service. BLM is also required to protect and manage for sensitive species jointly identified and agreed to with the appropriate state agency. Former candidate species are provided the same protection as candidates under the BLM Manual Section 6840 Special Status Species Management. The State of Wyoming does not have an official list of sensitive, threatened, or endangered plant species.

WYNDD maintains information on the biology, location and status of native plant species and natural communities. Information is gathered from on-the-ground surveys, published literature, unpublished reports, collections in museums and herbaria, and biologists and other knowledgeable individuals. Information in the files is constantly updated with new data. As more information becomes available, the status of each species or community is re-evaluated, and any necessary changes are made in the database (WYNDD website: http://uwadmnweb.uwyo.edu/WYNDD).

Red Desert. According to WYNDD, the Red Desert has no documented or likely populations of federally-listed threatened or endangered plant species. However, the area has an exceptionally high concentration of species designated by WYNDD as state plant species of special concern (112 records of 46 species) (Table 5). These include many species of narrow distribution that are state or regional endemics. Some have their centers of distribution in this area. The seven species below are state or regional endemics.

- *Antennaria arcuata* (meadow pussytoes) is a regional endemic.
- *Astragalus nelsonianus* (Nelson's milkvetch) is a state endemic.
- *Cirsium aridum* (Cedar Rim thistle) is a state endemic.
- *Descurainia torulosa* (Wyoming tansymustard) is a state endemic with its center of the distribution to the north, but this outlying record may be of genetic significance.
- *Ipomopsis aggregata* ssp *weberi* (Weber's scarlet-gilia) is a regional endemic.
- *Lesquerella macrocarpa* (large-fruited bladderpod) is a regional endemic.
- *Penstemon gibbensii* (Gibbens' beardtongue) is a state endemic known only from 4 populations; 3 are in the study area.

In addition, *Elymus simplex* var novum (dune wildrye) is an undescribed variety recognized in the current state flora (Dorn 2001) though it is not treated as sensitive by the Wyoming BLM. It is only known from 2 populations; both are in the area.

Impacts to special status plant species resulting from potential future oil and gas development are difficult to assess. Most of the known occurrences are found within the area of high oil and gas potential area (Figure 20). Often special status plants are located in specialized habitats that are unlikely to be affected by oil and gas activity, such as rock outcrops or wetlands, however this is not always the case. Development activity should be reviewed on a case by case basis to determine if the activity would affect special status plants. Indirect, as well as direct impacts, should be considered for each case, including whether large-scale change could affect survival of any special status species.

Jack Morrow Hills Area. Information on special status plant species in the Jack Morrow Hills area was described in the *Draft Environmental Impact Statement for the Jack Morrow Hills Coordinated Activity Plan* (BLM 2000). The information below is abstracted almost entirely from this account. Additional data on known locations of special status plant species were obtained from WYNDD; in some cases, only the township was provided (Figure 20). The WYNDD database includes seven additional species not described in the *Draft Environmental Impact Statement for the Jack Morrow Hills Coordinated Activity Plan.* These species include *Arabis pendulina* var. *resseola, Astragalus bisulcatus* var. *haydenian, Descriainia pinnata* ssp. *paysonii, Draba densifolia, Elymus simplex* var. *luxurians, Opuntia polyacantha* var. *rufispina,* and *Stipa nevadensis.*

Table 13. Special Status Plant Species in the Red Desert Area.

Scientific Name	Common name	Heritage Rank	BLM Status
Androstephium breviflorum	purple funnel-lily	G5/ S1	
Antennaria arcuata	meadow pussytoes	G2/ S2	BLM Sensitive
Arabis crandallii	Candall's rock-cress	G2/ S1	
Arabis selbyi	Selby rock cress	G4?Q/S1	
Astragalus bisulcatus var. *haydenian*	Hayden's milkvetch	G5T4?/S1	
Astragalus nelsonianus	Nelson's milkvetch	G2/S2	BLM Sensitive
Atriplex wolfii	Wolf's orache	G3G4/S1	
Bahia dissecta	dissected bahia	G5/ S1S2	
Carex egglestonii	Eggleston's sedge	G4/S1	
Carex limosa	mud sedge	G5/S2	
Chrysothamnus greenei	greene rabbitbrush	G5/S1?	
Cirsium aridum	Cedar Rim thistle	G2Q/S2	BLM Sensitive
Cypripedium fasciculatum	clustered lady's-slipper	G4/S2S3	
Descurainia pinnata ssp *paysonii*	Payson's tansymustard	G5T3?/S2	
Descurainia torulosa	Wyoming tansymustard	G1/S1	BLM Sensitive
Draba spectabilis var. *oxyloba*	showy draba	G3?T3Q/SH	
Elymus simplex	dune wildrye	G4?QT?/ S1	
Eriastrum wilcoxii	Wilcox eriastrum	G5/ S1S2	
Erigeron consimilis	San Rafael daisy	G4G5/S1	
Erigeron elatior	tall fleabane	G4/S2	
Erigeron pinnatisectus	pinnate fleabane	G4/S2	
Eriogonum corymbosum var. *corymbosum*	crisp-leaf wild buckwheat	G5T5/S1	
Eriogonum divaricatum	divergent wild buckwheat	G4G5/ S1	
Galium coloradoense	Colorado bedstraw	G4/S1	
Gymnocarpium dryopteris	oak fern	G5/S1	
Heterotheca pumila	little golden-aster	G4/S2?	
Ipomopsis aggregata ssp. *weberi*	Weber's scarlet-gilia	G5T2/S1	BLM Sensitive
Lesquerella macrocarpa	large-fruited bladderpod	G2/S2	BLM Sensitive
Ligusticum tenuifolium	slender-leaved lovage	G5/S1?	
Machaeranthera coloradoensis	Colorado tansy-aster	G2/S1	
Mentzelia rusbyi	Rusby's stickleaf	G4?/S1	
Monolepis pusilla	red poverty-weed	G5/S1	
Opuntia polyacantha var. *rufispina*	rufous-spine prickly-pear	G5T5/S2	
Penstemon gibbensii	Gibbens' beardtongue	G1/S1	BLM Sensitive
Phacelia demissa	intermountain phacelia	G5/S1	
Phacelia glandulosa var. *deserta*	desert glandular phacelia	G4T1T2/S1?	
Phacelia salina	Nelson phacelia	G3?Q/S1	
Phacelia tetramera	tiny phacelia	G4/S1	
Populus deltoides var. *wislizenii*	Fremont cottonwood	G5T?/S1	
Pyrrocoma crocea	western goldenweed	G4?/S1	
Rorippa calycina	persistent sepal yellowcress	G3/ S2S3	BLM Sensitive
Sambucus cerulea var. *cerulea*	blue elderberry	G5?/S1	
Senecio spartioides var. *multicapita*	many-headed broom groundsel	G4/S1	

Stipa nevadensis	Nevada needlegrass	G4/S1	
Trillium ovatum	western trillium	G5/S2	
Vaccinium myrtillus var. *oreophilum*	dwarf bilberry	G5T?/S1	

A significant amount of information on the vegetation and plant associations of the Jack Morrow Hills area has been accumulated by the BLM, general floristic inventories conducted in the Continental Divide region by botanists from the University of Wyoming Rocky Mountain Herbarium in 1994 and 1995, and a specific survey of plant communities and species of special concern by the WYNDD in 1994 and 1995 (Jones and Fertig 1996). The Jones study provided information on 10 species of special concern including four species not previously known from the ecosystem. Six other species of concern are known from the area based on recent or historical herbarium specimens. In all, nineteen plant species of concern are now confirmed from the Jack Morrow Hills area (Table 6).

Table 14. Special Status Plant Species in the Jack Morrow Hills Area.

Name of Plant	Heritage Rank	WYNDD List	Range	USFWS Status	Other Federal Status
Antennaria arcuata Meadow pussytoes	G2/S2	GR	R	*	SS-BLM
*Arabis pusill*a Small Rockcress	G1/S1		E		SS-BLM
Astragalus nelsonianus Nelson's milkvetch	G3/S2	LD	R		
Carex parryana var. *parryana* Parry sedge	G4T4/S2	SR	P		
Cryptantha scoparia Desert cryptantha	G3/S1	SR	R		
Eriastrurn wilcoxii Wilcox eriastrurn	G5/S1S2	SR	P		
Erigeron uintahensis *(E. speciosus* var. *uintahensis*) Uintah fleabane	G4/S1	SR	R		
Eriogonum divaricatum Divergent buckwheat	G4G5/S1	SR	P		
Ipomopsis crebrifolia Compact gilia	G3/S2S3	LD	R		
Lesquerella macrocarpa Large-fruited bladderpod	G2/S2	GR	E	*	SS-BLM
Monolepis pusilla Red poverty-weed	G5/S1	SR	P		
**Oryzopsis contracta* Contracted Indian ricegrass	G3/S3		R		SS-BLM
Oxytheca dendroidea Tree-like oxytheca	G4/SH	SR	P		
*Penstemon haydeni*i Blowout penstemon	G1/S1		R	E	

Pensternon paysoniorum Payson beardtongue	G3/S3		E		
Phacelia demissa Intermountain phacelia	G5/S1	SR	P		
Phacelia salina Nelson phacelia	G3Q/Sl	SR	P		
Phacelia scopulina var. scopulina Prostrate phacelia	G4/S1		P		
Spiranthes diluvialis Ute ladies'-tresses	G2/S1	S		T	

* Formerly designated as a Category 2(C2) candidate by the U.S. Fish and Wildlife Service. In July, 1995, USFWS revised its candidate system and eliminated the C2 designation. *Oryzopsis contracta* had previously been recommended for downgrading to 3C status by Fertig (1994).
T = threatened
E = endangered

Heritage Rank: G = global rank, S=state rank, T=trinomial rank.
1 Critically imperiled because of extreme rarity (often known from 5 or fewer extant occurrences or very few remaining individuals) or because some factor of a species' life history makes it vulnerable to extinction.
2 Imperiled because of rarity (often known from 6-20 occurrences) or because of factors demonstrably making a species vulnerable to extinction.
3 Rare or local throughout its range or found locally in a restricted range (usually known from 21-100 occurrences).
4 Apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.
5 Demonstrably secure, although the species may be rare in parts of its range, especially at the periphery.
H Known only from historical records. 1950 is the cutoff for plants
Q Questions exist regarding the taxonomic validity of a species, subspecies, or variety.

WYNDD List: GR=globally rare, LD=limited distribution, SR=state rare, S=sparse

Range: R=regional endemic, E=state endemic, P=peripheral

SS-BLM – BLM sensitive species

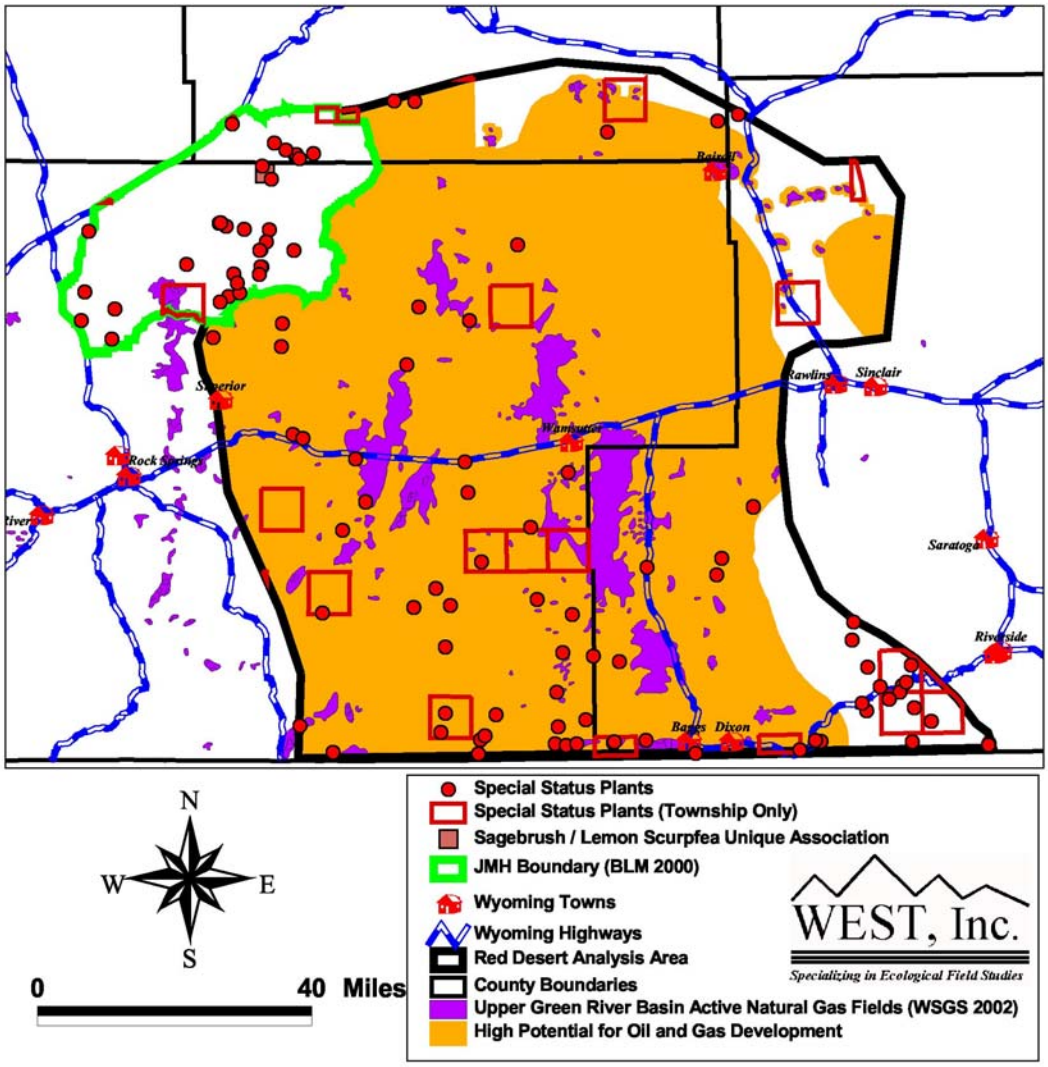

Figure 13. Special status plant locations within the Red Desert and JMH (WYNDD 2002).

Threatened, Endangered and Candidate Species

Ute ladies'-tresses *(Spiranthes diluvialis*). The Ute ladies'-tresses is listed as a threatened species by the U.S. Fish and Wildlife Service under the Endangered Species Act. This species, a member of the orchid family, occurs in three general areas of the interior western United States: near the base of the eastern slope of the Rocky Mountains in southeastern and central Wyoming and north-central and central Colorado and Montana; in the upper Colorado River basin, particularly in the Uinta Basin; and along the Wasatch Front and westward in the eastern Great Basin, in north-central and western Utah and extreme eastern Nevada. The total population is approximately 20,500 individuals. The riparian and wetland habitats required by this species have been heavily impacted by urban development, stream channelization, water diversions and other watershed and stream alterations that reduce the natural dynamics of stream system,

recreation, and invasion of habitat by exotic plant species (USFWS 1995). Heavy grazing by domestic livestock and wild horses can also be very detrimental to these habitats.

The Ute ladies'-tresses reaches a height of eight to 14 inches and is marked by an open cluster of several small white flowers arranged in a spiral resembling braids—a characteristic accounting for its name. The plant grows along streams, rivers, ponds, reservoirs, in bogs, or in wetland, riparian or seepage areas. This species has been found associated with cottonwood, willow, and prairie grassland communities. It generally blooms in late July through August and occasionally into September. It has been found in locations between 4,300 and 7,200 feet in elevation.

The Ute ladies'-tresses has not been found in southwest Wyoming, although BLM-authorized searches for the species have been performed at several locations along the Green River. The closest known location of the Ute ladies'-tresses to the Jack Morrow Hills area is on the Green River at Brown's Park, Utah. Potential suitable habitat in the planning area may be found on Jack Morrow Creek and its tributaries (Rock Cabin Creek); Pacific Creek; the meadows at Crookston Ranch (located on Nitchie Creek); the Sweetwater River and tributaries such as Oregon Slough, Harris Slough, Long Slough and Dickie Springs Creek; the sand dune ponds (flockets); and the perennial/intermittent streams in the Red Desert area (Bush Creek, Bear Creek, Red Creek, and Sand Creek). It is likely that this species will be found eventually in southwest Wyoming due to the proximity of the other populations and the similarity of riparian habitat types. In order to gather as much information about this species as possible and comply with the provisions of the Endangered Species Act and BLM national policy, the Rock Springs BLM requires surveys of all suitable areas that could provide habitat for these species prior to surface disturbing activities.

Mandatory surveys and avoidance of this species would prevent adverse effects. Consultation procedures with the U.S. Fish and Wildlife Service as mandated under Section 7 of the Endangered Species Act would be required for any future oil and gas project that would involve potential or known habitat areas for the Ute ladies'-tresses.

Small Rockcress *(Arabis pusill*a). Small rockcress was formerly proposed for listing under the Endangered Species Act as either Threatened or Endangered. It has been dropped from consideration due to the protection currently afforded the species but may be proposed again in the future if any threats are identified. The Nature Conservancy ranks this plant as G1S1, extremely vulnerable to extinction globally and extremely vulnerable to extirpation statewide. Small rockcress is known from only one location in the southern Wind River Range in Fremont County, Wyoming. The single known population occurs on about 6 acres of suitable habitat just north of the planning area boundary, on public land managed by the BLM.

Small rockcress is found in rock crevices and on sparsely vegetated, very coarse soil in granite-pegmatite outcrops surrounded by sagebrush grassland. Most granite-pegmatite outcrops in the South Pass area were surveyed in 1986 by the Nature Conservancy-WYNDD (Mariott 1988). Other suitable habitats along the Lander Cutoff were spot-

checked. No other populations were located during that survey. More plants were found in the immediate area during a later survey conducted for the U.S. Fish and Wildlife Service (Dorn 1990). The entire population size is estimated at 600 individuals. Motorized recreational activity and livestock grazing in the area have been identified as threats to the population. The extremely restricted geographic range of this species makes it highly vulnerable to extinction.

A Habitat Management Plan/Environmental Assessment was developed for the protection of the small rockcress and its habitat in 1994. Protective management actions that have been implemented include designation of the species' habitat and surrounding area part of the Special Status Plant Area of Critical Environmental Concern (ACEC); construction of a 500-acre exclosure around the plants and their habitat; closure and rehabilitation of two-track trails through the ACEC, annual monitoring of the plant populations, closure within the ACEC to motorized vehicles, surface disturbing activities and livestock grazing; a No Surface Occupancy designation for mineral leasing; and institution of a permanent mineral withdrawal (signed February 4, 1998). This species is also included in the Special Status Plant ACEC which closes the habitat to surface disturbing activities.

Although it is not likely that this species occurs within the Jack Morrow Hills area due to limited habitat, granitic outcrops along the Sweetwater River may provide suitable habitat. Searches for the small rockcress would be required in suitable habitat prior to any surface disturbing activities associated with future oil and gas development by authorization of the Green River RMP/Record of Decision (BLM 1997) and the BLM Manual Section 6840.

Blowout penstemon (*Penstemon haydenii*). Blowout penstemon is listed as an Endangered species by the U.S. Fish and Wildlife Service under the Endangered Species Act. This species, a member of the figwort family, occurs in two general areas of the interior western United States: in the Sand Hills of central Nebraska and a recently discovered location in the sand dune country south of the Ferris Mountains in south central Wyoming. The total population consists of thirteen local populations in Nebraska containing 3,000 - 5,000 individuals and approximately 300 to 500 plants in one location of less than 20 acres in Wyoming. Threats to the species include off-road vehicle traffic, removal of fire, and leveling of the sand dunes.

Blowout penstemon is a perennial herb reaching 1 foot tall with one to many stems. It has milky-blue to pale lavender flowers that are 1 inch long and found in 6 to 10 whorls. It is found in sparsely vegetated, actively shifting sand dunes and blow-out depressions. It is commonly found with thickspike wheatgrass, lemon scurf-pea, and rubber rabbitbrush. It flowers from late June to early July.

Since sand dunes are present in the Jack Morrow Hills area, there is potential for this species to occur. Surveys for this species should be conducted prior to any future oil and gas development activity in this habitat.

Other Special Status Plants

General floristic inventories were conducted in the Jack Morrow Hills area by botanists from the University of Wyoming Rocky Mountain Herbarium and WYNDD between 1994 and 1996. Species specific status surveys were performed for large-fruited bladderpod (*Lesquerella macrocarpa*) (1994) and meadow pussytoes (*Antennaria arcuata*) (1994); permanent transects have been established and baseline information gathered for these species. In addition, the 1995 WYNDD vegetation inventory provided information on 10 species of special concern found within the planning area.

Large-Fruited Bladderpod. The large-fruited bladderpod is a former Category 2 Candidate. The Nature Conservancy ranks this plant as G2S2, very vulnerable to extinction globally and very vulnerable to extirpation statewide. Prior to 1992, the large-fruited bladderpod was thought to be endemic to the northern Great Divide Basin in Sweetwater and Fremont counties, Wyoming. However, during a vegetative survey, it was located near the town of Opal in Lincoln County, Wyoming (USDI BLM 2000). Most of the known large-fruited bladderpod populations occur on public land northeast of Steamboat Mountain on Bush Rim, near Continental Peak, and in the Oregon Buttes area. The species has been collected from sparsely vegetated clay flats, benches, slopes, and hills. It commonly grows in association with Gardner's saltbush between 7,200 and 7,700 feet in elevation.

Sites surveyed in 1981 ranged in size from 80 to over 1,000 acres, with estimates ranging from several hundred to tens of thousands of plants. Large-fruited bladderpod population sizes fluctuate from year to year, apparently in response to moisture availability. During dry years, when populations are small, the species is much more vulnerable to adverse impacts. Its overall limited range and small population sizes in dry years qualify large-fruited bladderpod as a candidate species. No threats are known at this time. A monitoring program was established in 1988 by WYNDD (Marriott 1988), but was not considered a good baseline because of the effect of drought conditions on the population size. A status survey was conducted for this species in cooperation with the Rawlins BLM Field Office in the summer of 1994.

Meadow Pussytoes. Meadow pussytoes is a former Category 2 Candidate. The Nature Conservancy ranks this plant as G2S2, very vulnerable to extinction globally and very vulnerable to extirpation statewide, due to its restricted range. Meadow pussytoes has been found in Idaho (one site in Blaine County near Carey) and Nevada (two sites in Elko County). Twenty sites are known from Wyoming, all in Fremont County. Most known locations are east and southeast of Atlantic City, while two occurrences are in the Granite Mountains northwest of Jeffrey City. Two populations are found on public land southwest of South Pass City. One population is found along Fish Creek approximately 1 mile west of Wyoming Highway 28; the other is located about 1.5 miles east of Wyoming Highway 28 on Pine Creek. Populations of meadow pussytoes at these sites are small compared to those near Atlantic City and in the Granite Mountains. Only one of the twenty Wyoming populations was previously known to extend into the Rock Springs BLM District at Long Slough, near South Pass City. However, a status survey of meadow

pussytoes, conducted in 1995 for the BLM (Fertig 1996) discovered a single new population of meadow pussytoes in the Oregon Gulch drainage, approximately four miles west of Continental Peak. These two populations are the only known occurrences in the Jack Morrow Hills area. Surveys in other areas of potential habitat along Dickie Springs, Alkali Creek and west Pacific Creek were unsuccessful.

Meadow pussytoes occurs in hummocky or level, subirrigated, grassy drainages which remain moist late into the summer. Known populations occur primarily on soils derived from sandy alluvial deposits. These soils may have a whitish, alkaline crust and a well-developed layer of mosses and cryptograms on the surface. On more level sites with bare soil, the plants occasionally form vegetative mats. Individual Wyoming occurrences range in size from two to over 90 acres and are often divided into numerous smaller subpopulations in areas of suitable habitat. Total actual habitat acreage in Wyoming for meadow pussytoes is estimated at 400-500 acres. Actual habitat for this species within the planning area is approximately 5 acres. Trend data are available for twelve of the Wyoming occurrences surveyed in 1995. Six of these occurrences show an apparent downward trend since 1982, four show an increase, and one is stable. Overall, the total state population appears to be stable to slightly declining since 1982. Grazing may be compatible with the species, based on studies at other sites, however stocking rates must be appropriate to avoid impacts from trampling.

In 1995 permanent monitoring transects were established at Long Slough and Harris Slough, both near Atlantic City. In addition, a floristic inventory of the Great Divide Basin area during 1994 and 1995 documented the new location of meadow pussytoes at Oregon Gulch. Potential habitat in the area of Atlantic City and South Pass City has been adequately inventoried, and additional survey is not a high priority. Searches for this species in suitable potential habitat would be required in the planning area prior to surface disturbing activities. Avoidance of the species is the preferred form of protection where possible. Mineral withdrawals to protect the plant and its habitat will be pursued by the BLM.

Species of Special Concern

The remaining 14 species of special concern in Table 6 are considered by WYNDD as state and regionally rare plant species lacking formal federal status or protection, but potentially threatened within the ecosystem. These species include annuals or biennials like Common Name (*Cryptantha scoparia*), *Eriastum wilcoxii, Eriogonum divaricatum, Monolepis pusilla, Oxytheca dendroidea, Phacelia demissa*, and *Phacelia salina* that have fluctuating population sizes in response to favorably moist years. Such species are dependent on the establishment and maintenance of adequate seedbanks for long-term survival. The habitats of these plants may be threatened by impacts from vehicles, mineral development activities, or livestock. Equally threatened are desert riparian species like *Carex parryana* which occur in habitats that are highly sensitive to disturbances. Several rare species of the Jack Morrow Hills have small global ranges but are often locally abundant within areas of suitable habitat. Such species require little or no formal protection as long as areas of representative habitat are maintained in good

condition. These species include *Astragalus nelsonianus, Ipomopsis crebrifolia, Penstemon paysoniorum*, and *Phacelia scopulina*.

Historic and Cultural Resources

Red Desert

The Red Desert is a unique formation in southwestern Wyoming where the Continental Divide splits to surround a basin, which drains to neither the Atlantic nor the Pacific. Uplifted formations in the desert west of Rawlins are among the most ancient rocks exposed on the planet. Archaeological resources on public lands and Indian lands are an accessible and irreplaceable part of the Nation's heritage. Cultural and historical resources can be found throughout the region.

The National Register of Historic Places is the nation's official list of cultural resources worthy of preservation. The National Register of Historical Places lists over 9,300 sites in the database within the Red Desert (State Historic Preservation Office 2002). To be eligible properties must retain integrity and be historically significant under at least one of the following criteria:

A. Associated with events that have made a significant contribution to the broad patterns of our history; or that are associated with the lives of persons significant in our past; or
B. Embody the distinctive characteristics of a type, period, or method of construction; or
C. Represents the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
D. Have yielded, or may be likely to yield information important in prehistory or history.

Cultural resources in the Red Desert and Jack Morrow Hills area include habitation features, rock or landscape features, bone or grave sites, rock art and multi-component sites. A few of the more significant sites are described in this report, and shown in Figure 21.

Jack Morrow Hills

The Jack Morrow Hills are located in the northwest region of the Red Desert. Cultural and historical resources within the Jack Morrow Hills include the following: Oregon Buttes, South Pass historic landscape, White Mountain petroglyphs, continental peak trail, historic trails, Indian Gap, Crookston Ranch, expansion era roads, and tri-territory marker.

Figure 21. Cultural resources and historic landmarks within the Red Desert and JMH.

Multi-component sites

The historic trails are multi-component sites containing evidence of use by different cultural groups that traveled through the landscape, or by the same group over different periods of time. These sites include diagnostic artifacts and potential for buried remains, important in providing evidence of settlement, use of the land, information on technology and the migrations of people.

The historic trails were the only pathway of commerce, settlement and development for the lands west of the Rocky Mountains. Tracks of the historic trails still remain etched in the landscape, as well as cultural resources representing groups of people through several eras in time. These cultural artifacts are important in providing information on the belief systems and social structures of past people, and may also provide information on ancestry and migrations.

South Pass Historic Landscape Area. South Pass was significant in the development of the United States as a Nation and was designated as a National Historic Landscape in 1959. Beginning in the winter of 1812-1813, this singular overland passage allowed emigrants to move to the fertile farmlands of western coastal valleys and rich hardrock mining bonanzas throughout the west. It is estimated that over a half million people and probably five times as many livestock traversed South Pass on the Oregon, Mormon Pioneer, Pony Express, and California national historic trails.

The BLM developed a management plan for the South Pass Historic Landscape within the Green River Resource Management Plan (BLM 1997). Management prescriptions for the South Pass Historic Landscape ACEC prohibit development that would be visible within three miles of the historic trails corridor. Geographic information systems (GIS) analysis of this area (viewshed) was conducted to determine what lands are visible from the historic trails corridor. Analysis of the vista indicates that within an arbitrary three-mile distance from the main National Historic Trail corridor about 24,000 acres are visible from the trails, while about 26,000 acres are shielded from view by topography (BLM 1997). The Green River RMP requires special management for the South Pass Historic Landscape and concentrates protective management upon areas visible from the trails corridor.

The Oregon National Historic Trail. The Oregon Trail (1843-1868) is a distinct wagon road that stretched 1,932 miles from Courthouse Square in Independence, Missouri to Oregon City on the Willamette River in the Oregon territory. The route was known to mountain men, fur trappers, traders and missionaries in the 1820's and 1830's but was not successfully negotiated by a wagon train until 1843 (BLM 2002).

Originally called "The Emigrant Road", the route became commonly known as "The Oregon Trail". The trail entered Oregon Territory when it crossed the Continental Divide at South Pass in what is now western Wyoming. The Oregon Trail was designated a National Historic Trail by Congress in 1978.

Mormon Pioneer National Historic Trail. On April 5, 1847, Mormon Church leader Brigham Young headed a train of 72 wagons and 148 Latter-day Saints west from Winter Quarters (present-day Omaha, Nebraska) toward the Great Salt Lake Valley. At the time the migration began, most maps left the region between the Missouri River and Rocky Mountains blank and labeled it "Indian Country". By 1848, Mormon operated trading posts spaced along the Trail and ferry boat operations at major river crossings had been established (BLM 2002c).

The Mormon migration had a major impact on the overall character of the great migration along the trails system. For twenty years, continuing through the California Gold Rush and on through the completion of the transcontinental railroad, the Mormon presence along the trails made the journey much easier, safer and swifter. The Mormon Pioneer Trail followed the Oregon Trail, and branched off at Fort Bridger. The Mormon Pioneer Trail was designated a National Historic Trail by Congress in 1978.

The California National Historic Trail. The California Trail (1841-1868) extended from Independence and Saint Joseph, Missouri, and Council Bluffs, Iowa, to various points in California and Oregon. The route was approximately 5,700 miles, including all routes and cutoffs. The California Trail carried an incredible amount of traffic during the California Gold Rush years of 1849 through the mid- 1850's. The California Trail shares its route with the Oregon and Mormon Pioneer Trails from Fort Laramie through South Pass, and was designated a National Historic Trail by Congress in 1992 (BLM 2002c).

The Cherokee Trails. Several emigrant parties including both whites and members of the Cherokee Nation journeyed to California in the first two years of the Gold Rush. Starting in western Arkansas and eastern Oklahoma, they blazed the first wagon trails through the Rocky Mountains that did not use South Pass. The 1849 wagon trains chose a route across the Laramie Plains and the Red Desert that closely parallels present Interstate 80, connecting with the Oregon-California trail at the junction of Hams Fork and Blacks Fork rivers. The 1850 parties pioneered a completely different route, which traveled along the Wyoming-Colorado border until reaching Fort Bridger. Some combination of both routes created Ben Holladay's Overland Trail in 1862 (BLM 2002c).

The Pony Express National Historic Trail. The Pony Express Trail (1860-1861) follows the Oregon and California trail routes through eastern Wyoming and South Pass to Fort Bridger, crossing through Sweetwater County. From Fort Bridger the Pony Express Trail follows the Mormon Pioneer Trail into the Salt Lake valley. The Pony Express Trail enabled California and Oregon to be connected with the rest of the United States. Expert riders carried an estimated 35,000 pieces of mail between St. Joseph, Missouri and Sacramento, California, usually in 10 days (BLM 2002c, Sweetwater County Historical Museum 2002). The trail route was approximately 1,900 miles, including the original route and subsequent route changes. The Pony Express Route was designated as a National Historic Trail in 1992, in recognition of the significance of carrying United States mail from settlements in the east to the west coast during the Civil

War, thus helping to preserve political control over western regions by the United States government.

The Continental Divide National Scenic Trail. The Continental Divide National Scenic Trail extends from the Montana-Canada border to the New Mexico-Mexico border, a trail of approximately 1,300 miles. The trail route follows the crest of the Rocky Mountains, and offers access to aesthetic, cultural and historic values.

Expansion-era roads. Expansion era (1870-1940) roads were started from three railheads on the Union Pacific: Point of Rocks, Green River and Bryan. These roads linked communities along the railroad with newly developing mining, agricultural and military settlements in the hinterlands of the central Rocky Mountains. Several stage stations and freighter's camp locations associated with these expansion era roads are known including Freighter's Gap, Fourteen Mile, and the Wells within the Jack Morrow Hills planning area.

Rock Art

Independence Rock. Independence Rock is a famous landmark on the Oregon Trail, and is located on the north band of Sweetwater River in central Wyoming. Pioneers from the Oregon, California, and Mormon trails all passed Independence Rock. Travelers would carve their names into the rock, also known as the "registrar of the desert" (Gibson 1999).

Indian petroglyphs have also been carved into Independence Rock. Petroglyphs are images that are carved, ground, incised or pecked into the rock surface that depict iconography on stone surfaces. Traditional rock art marks localities that were important or sacred to past populations. These sites are important because they depict iconography of prehistoric people and may provide information on ceremony or subsistence related topics.

The White Mountain Petroglyphs. The White Mountain Petroglyphs site is located in the southwest corner of the Jack Morrow Hills planning area. Historic and prehistoric images have been carved into rock within the past 500 years. This rock art is representative of several different styles of human forms. The site and surrounding ¼ mile is protected (BLM 2000).

Landscape Features

A prehistoric cultural landscape is any setting that was used frequently over a prolonged period of time by one or more cultural groups. Native landscapes encompass cultural materials, cultural features, intentional or casual modifications to the landscape and resources or physiographic features that made that landscape culturally important. The entire location and setting must be considered in terms of the historic character, that is the

sum of all visual aspects, features, materials, and spaces associated with the historic context of the landscape.

Oregon Buttes. This area was designated as an area of critical environmental concern (ACEC) in April 1982 to protect the scenic integrity as a historic landmark. At the Oregon Buttes, the Continental Divide splits into east and west rims which rejoin at Bridgers' Pass, south of Rawlins, and encloses an area known as the Great Divide Basin. The Oregon Buttes were often noted by emigrants using the Oregon Trail, marking the halfway point in their journey from Independence, Missouri to the Pacific Ocean. Three wilderness study areas overlap the ACEC; therefore the ACEC is closed to oil and gas leasing and is also closed to surface disturbing activities and motorized vehicle use (BLM 2000).

Crookston Ranch. Crookston Ranch is a historic site (40 acres) that is potentially eligible for the National Register of Historic Places as a representative example of vernacular architecture within the Wyoming Basin homesteading era.

Native American Cultural Resources. The Ute and Shoshoni were historically the primary occupants of what is now Sweetwater County; however, other Plains tribes entered the area to hunt. For thousands of years the Red Desert has been a sacred place of worship for the Shoshone and Ute tribes (Conservation Coast to Coast, the Wilderness Society 2000).

Traditional elders have expressed interest in several landforms including Steamboat Mountain and Boars Tusk, and North and South Table Mountains, and Pilot Butte. Consultation visits with traditional elders indicated that these landmarks, and the landscape vista of which they are a part, are associated with the physical remains of a number of respected places associated with Native American religious practices (BLM 2000). The exact locations of these sites and the religious practices they represent are kept confidential at the request of tribal elders. However, at least some of these sites are probably Traditional Cultural Properties warranting special protective measures in compliance with the National Historic Preservation Act, the American Indian Religious Freedom Act and Executive Order 13007.

Native Americans often held conspicuous landmarks, prominences, and high locations in reverence. For Native Americans, the unique setting of mountain vistas, volcanic cones, and flat-top mesas against a backdrop of white drifting sand dunes is a spiritual experience. Distinctive natural water bodies and confluences of flowing streams and rivers were considered by many tribes to be sources of power and inspiration, and mirrors of the inner spirit. Stone intaglios and effigies, some rock alignments, and many ancient rock cairns mark traditionally significant locations (BLM 2000).

Indian Gap. A Native American trail was traveled between the Ute Reservation in Utah and the Eastern Shoshone Reservation in the Wind River Basin. The trail passed through the "gap" between Essex Mountain and Steamboat Mountain.

Chinese Cultural Resources. In 1874, Chinese arrived in Rock Springs and Evanston to work in the Union Pacific Coal Company mines. There were approximately 700 to 900 Chinese in Rock Springs by 1885, representing over 65 percent of the population. In 1885, white miners drove the Chinese out of town, burning down their houses and killing at least 50 Chinese (also known as the Chinese Massacre of 1885) (Sweetwater County Historical Museum 2002). Chinese artifacts have been collected and are on display at the Sweetwater County Historical Museum. While there is not a particular archaeological site designated for protection, the potential exists for the discovery of Chinese artifacts in and around Rock Springs.

Paleontology

Red Desert

The southwestern desert country in Wyoming was once a large inland freshwater lake called Lake Gosiute. About 50 million years ago, Lake Gosiute covered as much as 15,000 square miles in southwestern Wyoming. Dinosaurs reportedly foraged on riparian vegetation surrounding the lake, and a variety of fish, amphibians, birds, reptiles, and mammals now occur fossilized in the shale layers of the ancient sea bed. Fossil Butte National Monument west of Kemmerer explores and presents the flora and fauna of this historic semi-tropical region (Tracks across Wyoming 1999).

Como Bluff. Como Bluff, located ten miles east of Medicine Bow, was first excavated in 1878. Fossils representing 26 new species of dinosaur and 45 species of Jurassic mammals have been recovered at Como Bluff (The Town of Medicine Bow, Wyoming 1999). These bone quarries supplied dinosaur displays to most of the world's museums during the late 1800's. New discoveries continue to be made every year (Tracks across Wyoming 1999). Thirty-six million-year old fossils of snails, clams and leaves have been found in the Pinnacles area of the Red Desert.

Jack Morrow Hills

Significant archaeological resources such as the Finley and Krmpotich, Eden-Farson and Morgan sites are located in the Jack Morrow Hills area. The Finley and Krmpotich sites hold cultural evidence from some of the earliest inhabitants of the continent, and "they are some of the most intact manifestations of such archeological evidence known anywhere on the continent" (Frison 1998 *in* BLM 2000). Paleosol deposition occurs across broad regions of the Jack Morrow Hills area; sites of great antiquity and tremendous scientific significance are expected to be found where the paleosol is preserved (Biodiversity Associates 2001).

Cultural and Historic Resources Summary

The Red Desert and Jack Morrow Hills contain a high density of cultural resources (Wyoming State Historic Preservation Office 2001). Historical, cultural and paleontology resources are protected through a number of protocols, management plans and regulations. However, there is significant concern regarding potential impacts to historic and cultural values that are currently unrecorded. Only about two percent of the region has been formally inventoried, therefore, "a much larger number of resources should be expected in the area." (BLM 2000). Managers of ground-disturbing activities on federal and tribal lands should make themselves aware of the statutory provisions for inadvertent discoveries of Native American remains, archaeological and cultural objects.

Recommendations and Conclusions

The amount and location of potential resource extraction within the Red Desert and JMH are very difficult to predict due to 1) lack of information regarding existing resources within the Red Desert and JMH, 2) the role of future technology in facilitating the extraction of resources, and 3) the role of economics. When discussing the potential for future resource extraction and important biological and cultural resources, assessments must take place on relatively broad scales. Based on the evidence we could find it appears that the entire JMH and much of the Red Desert have potential natural gas and or coal bed methane reserves.

The Red Desert and JMH contain a variety of biological and cultural resources. We identified those resources, which in our opinion are the most sensitive to resource extraction and associated human activity. Both the Red Desert and the JMH contain crucial winter ranges for elk, mule deer, and pronghorn, as well as other important big game ranges. Although research concerning the effects of oil and gas development on big game populations is currently lacking, the potential effects of natural gas development on big game populations will depend largely upon the location of the development, well spacing, and the associated roads, fences and other development facilities. The primary issues relative to the impact of gas development on big game crucial habitat encompass both direct habitat loss and the possible indirect impacts from habitat fragmentation and increased human access into the area. These major issues included the: 1) disturbance of large, unbroken blocks of native habitat; 2) increased animal displacement; 3) increased human presence from project operations and improved road access; 4) effects to the herd from improved hunter success; 5) increased disturbance or harassment of big game from noise, illegal shooting, and off-road vehicle use; and 6) possible increased vehicle-related animal fatalities. Although the greatest impact to wildlife populations from oil and gas development has generally been considered to be habitat loss, including both the direct loss from development and the indirect loss from human disturbance (Karpowitz 1984), habitat fragmentation from the access road network would likely have the greatest impact to big game. Wells located outside of crucial ranges and sensitive areas will likely have less impact on big game populations than well fields placed in sensitive areas. Similarly, potential effects to the unique basin big sagebrush/lemon scurfpea association and other rare and endemic plant species, and scarce wetland resources will depend on the location of development facilities.

The Red Desert and JMH contain relatively large areas of potential sage grouse nesting habitat. The sage grouse is declining throughout much of its range (Braun *et al.* 2001), and future drilling activities could potentially reduce the suitability of habitat for breeding sage grouse. However, research regarding the effects of oil and gas activity on sage grouse populations is lacking, making predictions regarding the future of sage grouse in the Red Desert and JMH impossible.

The Red Desert and Jack Morrow Hills hold relatively little habitat for threatened and endangered species. Breeding habitat for the mountain plover, a species proposed for listing as threatened under the Endangered Species Act, is found within the Red Desert and Jack Morrow Hills. The effect of natural gas development on mountain plovers is poorly understood. Mountain plovers prefer nesting in areas with large amounts of bare ground (Knopf 1996). While increased human activity may cause disturbance to breeding birds, areas surrounding well pads which are cleared of vegetation may increase the amount of suitable breeding habitat for mountain plovers. The effects of natural gas development on mountain plovers within the Red Desert requires further research before impacts associated with development can be properly assessed.

The Red Desert contains one of the highest concentrations of breeding ferruginous hawk throughout the species range (L. Apple, Wildlife Biologist, BLM, pers comm.). The ferruginous hawk may be especially sensitive to human disturbance (White and Thurow 1985). Larry Apple, BLM, Rawlins is currently conducting a study of ferruginous hawk nesting ecology within the Red Desert, including the effects of oil and natural gas development on breeding ferruginous hawks.

While the BLM has collected several locations of ferruginous hawk nests within the Red Desert, some key information regarding other biological and cultural resources is lacking. We have identified a few areas that will require further research in order to adequately protect and evaluate the observed effects of future gas development on biological and cultural resources:

1) Identification of crucial big game ranges. More long-term research is needed to identify crucial ranges for big game in the Red Desert. The use of radio telemetry and spatially explicit tracking studies would greatly enhance the ability of the WGFD and BLM to more accurately identify important big game ranges and to evaluate species response to various activities within individual animal home ranges.
2) Baseline level inventories for T&E and BLM sensitive species. Currently inventories are typically conducted only after a project is proposed, and often within a few days of well construction. Large-scale surveys would allow for more informed planning decisions (see Mitigation Measures).
3) Inventories for cultural and archeological resources throughout the Red Desert and Jack Morrow Hills. A Class III field inventory should be conducted in proposed areas of disturbance prior to construction activities in accordance with Section 106 of the National Historic Preservation Act.

Mitigation Measures

Designing mitigation for impacts caused by energy development is usually hampered because of the lack of quantification of impacts. Additionally, research examining the effects of natural gas development on wildlife species and habitat is sorely lacking. We believe the first step in effective mitigation is to accurately assess potential impacts. To do that we recommend the baseline (i.e. current status with and without development) of resources be established and monitored during future developments. We suggest that this monitoring effort would help clarify the magnitude of impacts of development and assist in developing mitigation for existing and future impacts associated with development. The BLM has the opportunity to begin such baseline studies in the immediate future. Within the Rawlins Management District, as of July 3, 2002, there are 54 wells which are permitted, but have not yet been drilled (Debra Olson, BLM, Rawlins, pers. comm.). The BLM could institute baseline studies at the well locations prior to drilling and begin to assess the effects of drilling on wildlife and habitat.

The adaptive approach to mitigation would be most effective with a region wide development plan for the Red Desert. Adaptive management operates on the premise that a) uncertainty exists in a managed system, and reduction of uncertainty should improve management (including mitigation); b) management decisions must be made periodically despite that uncertainty; c) monitoring and research programs are in place for evaluation of management decisions; and d) learning about the effects of management contributes toward adjusting management objectives.

Baseline monitoring and development plans are long-term solutions, and some obvious existing methods of development that minimizes or mitigates impacts from development are available to the natural gas industry. Molvar (2002) provides a detailed summary of horizontal drilling and cluster development. Horizontal drilling allows wells to be placed up to 29,000 ft (5.5 miles) from the natural gas reservoir. By placing a cluster of wells in locations away from sensitive biological and cultural areas, resources may be extracted and ecological impacts lessened. Not only is the amount of area disturbed by wells lowered, but the size and distance of road networks are also minimized. Horizontal drilling has been successfully applied to geologic formations within the Red Desert (Cook *et al.* 2002). Although horizontal drilling may not be feasible in every situation, 504 active horizontal wells were present in Wyoming as of October 2001 (Molvar 2002). Creative uses of horizontal drilling and cluster development may lessen ecological impacts while making resources available for extraction.

In addition, implementation of existing environmental review processes should be adhered to, including the National Environmental Policy Act, where applicable, and the accompanying public input process. Coordination among land management and regulatory agencies should be encouraged at all levels, including federal, state, and local. We believe coordination would best serve the natural gas industry and biological

resources if it comes in the form of a Red Desert wide resource development plan guided by a committee of all interested parties, including the natural gas industry, state and federal natural resource agencies and environmental groups. Currently, projects are evaluated on a case by case basis, and cumulative impact analyses of biological and cultural resources are often inadequate. Several benefits may be realized by formulating a region-wide development plan that incorporates aspects of adaptive management:

1) Uncertainties involving oil and gas impacts to biological resources may be resolved. By implementing a phased approach to development in which rigorous and defendable scientific studies of wildlife and habitat are early in the process, impacts can be quantified and results applied throughout the Red Desert. Currently, the findings of many NEPA documents are questioned by both industry and environmental representatives due to uncertainties associated with documented effects of resource extraction on the affected biological and cultural resources.
2) Adaptive management can identify and lessen potential and realized impacts to biological resources. By identifying potential impacts and causes of impacts in the early phases of development, the resource development process can be adjusted to lessen documented impacts.
3) Industry representatives will face less uncertainty regarding the location and spacing of gas wells. Currently many proposed development projects are approved by the BLM and the results of the NEPA analyses questioned in court by environmental groups, which can delay or potentially stop proposed projects. By involving environmental groups and wildlife regulatory agencies in the development of a region-wide plan, opposition to proposed projects may be lessened or eliminated.
4) Important biological and cultural resources may be protected while allowing for resource extraction. The Red Desert may contain significant natural gas reserves. As demand for natural resources within the U.S. increases, it is almost inevitable that resources within the Red Desert will eventually be developed. By formulating a collaborative, region-wide plan biological and cultural resources will be better managed and protected while natural resources are developed.

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