

INVENTORY AND MAPPING OF PLANT COMMUNITIES IN THE  
SAND DUNES WILDERNESS STUDY AREA,  
SWEETWATER COUNTY, WYOMING.

A Report Prepared for the Bureau of Land Management  
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## INTRODUCTION

In July 2000, the Bureau of Land Management and the Wyoming Natural Diversity Database (WYNDD) of the University of Wyoming entered into a cooperative project to characterize the vegetation and other botanical values of four wilderness study areas, including the Sand Dunes WSA in the Rock Springs Field Office (Figure 1). The information gathered in this project will be used by BLM to evaluate the degree to which the Sand Dunes WSA represents vegetation types and landtypes present on BLM-managed lands and to help set management goals for the WSA. The WYNDD will use the information in its efforts to describe the composition and distribution of the state's vegetation types and the distribution and abundance of Wyoming's rare plants.

This report is based mainly on information about vegetation, landforms, rare plant species, and noxious weeds collected by WYNDD staff during field work in the WSA from August 8 - 11, 2000. A complete survey of the WSA was impossible, so the field work was planned to allow WYNDD staff to visit sites that appeared to represent the land forms and the vegetation types of the WSA. Other information was provided by field survey by WYNDD's botanist during July 2000, and by staff of the BLM's Rock Springs Field Office.

## METHODS

### FIELD SURVEY

The boundary of the Sand Dunes WSA shown in the BLM's Wyoming Wilderness Study Areas final inventory report (USDI Bureau of Land Management 1981) was adopted as the boundary for the study area in this project (Figure 2). The public lands within that boundary were identified on the Rock Springs and Farson 1:100,000-scale topographic maps (USDI Bureau of Land Management 1988 and 1989). Landforms were identified on the 1:24,000-scale topographic quads, and rock types on the 1:500,000-scale bedrock geology map of Wyoming (Love and Christiansen 1985). Variation in the vegetation of the area was ascertained from two sets of aerial photographs. All but the northern and eastern fringes of the WSA are shown on a National Aerial Photography Program 1:40,000-scale, color infrared photo provided by the BLM. The entire WSA is shown on black-and-white, 1:24,000-scale digital orthophotoquad quarters downloaded from the web site of the University of Wyoming's Geographic Information Sciences Center (<http://www.sdvc.uwyo.edu/doqq/>). The color infrared and the black-and-white photographs were photocopied for use in the field.

Review of these maps and photographs showed three major categories of substrate, with characteristic landforms, in the WSA. These combinations of substrate and landforms are mapped as general cover-types (Figure 3). Active aeolian sand dunes cover large parts of the south-central and central parts, stabilized dunes cover much of the southern two-thirds, and sedimentary bedrock covers the northern third and is mixed with stabilized sand in the south. Portions of the stabilized sand in the south and along the western boundary contain small ponds.

During field work, sampling locations were subjectively chosen within each of these general cover-types. The sampling locations were near the WSA boundaries

(Figure 4), close to roads. At some of the sampling locations (those with *classification plots*), quantitative data on the structure and species composition of the vegetation were collected by George Jones and Amy Shelley in modified-Whittaker nested plots (Stohlgren *et al.* 1995). Canopy cover of each vascular plant species was estimated by percentage classes in ten 1-square-meter microplots, and the presence of additional species (i.e., those not noted in the microplots) was recorded in the 10-, 100-, and 1000-square meter plots (Figure 5). At each location, the slope angle and slope azimuth were measured, the UTM coordinates of one corner of the macroplot were recorded with a Trimble GeoExplorer II global positioning system receiver, surface soil texture was determined by a single hand-texture, signs of disturbance were noted, the vegetation was described, and a photograph was taken.

At the other locations (those with *reconnaissance plots*), the vegetation was described in less detail: the height of each vegetation stratum was estimated and the most common species in each stratum recorded. Additional information on the vegetation and the environment was recorded as for the classification plots.

Vascular plants were identified to species in the field when possible, using Dorn (1992). When that proved impossible, specimens were collected for later identification. Some specimens were also collected to verify the identifications made in the field.

Virtually the entire WSA can be viewed from roads around the boundary, and observations through binoculars showed that the landforms, substrate, and vegetation in the interior of the WSA are similar to those at the sampling locations. Note, though, that no information was recorded at sampling locations in the interior of the study area.

Before field work, Jones reviewed specimens in the Rocky Mountain Herbarium of the plant species on the State of Wyoming's list of designated noxious weeds. The locations of any of these species observed in the WSA were to be recorded during field work. Notes were made on miscellaneous biological features and on signs of human impacts observed during field survey.

## REPORT PREPARATION

The cooperative agreement governing this project requires that three classification systems be used to indicate the ecosystems present in the WSA: the classification of 41 land cover-types used in a state-wide land cover map, the landtypes from the federal Ecomap project, and the vegetation types from the National Vegetation Classification System. The 41 land cover types are those in the coverage produced in 1996 by the Wyoming Gap Analysis Project (Merrill *et al.* 1996) and distributed by the University of Wyoming's Geographic Information Science Center (Wyoming Gap Analysis 1996). A map of those cover-types in the study area was produced in ArcView 3.2 by using the boundary of the WSA to clip the relevant portion of the state-wide land cover-type layer.

Units from the Ecomap project are represented by the landtypes and landtype associations delineated for southwestern Wyoming by Reiners and Thurston (1996). A *landtype* is mapped at a scale of 1:60,000 to 1:24,000 and covers ten to hundreds of acres. A *landtype association*, in contrast, is a unit of the National Hierarchical Framework of Ecological Units (used in the Ecomap project) one level higher than the landtype. A landtype association typically is mapped at a scale of 1:250,000 to 1:60,000, covers hundreds to thousands of acres, and includes a number of landtypes. The map of southwestern Wyoming produced by Reiners and Thurston (1996) is primarily a map of

landtype associations but also shows three landtypes. A modified, digital version of their map is available that shows only landtype associations (Reiners *et al.* 1999). For this report, an approximation of Reiners's and Thurston's original map of landtypes and landtype associations was constructed in ArcView 3.2 with their digital map of landtype associations as the base. The dune field and playa landtypes were added to that map by clipping the areas of Quaternary sand and Quaternary lacustrine deposits, respectively, from the digital Wyoming bedrock geology map (USDI Geological Survey 1994) and laying them over the top of the landtype associations. This was the same information used by Reiners and Thurston (1996) to map those landtypes.

The final indicator of ecosystem types, the National Vegetation Classification System, is a hierarchical classification of vegetation units, with plant alliances and associations constituting the most detailed levels (Grossman *et al.* 1998). Those plant alliances and associations are listed (and many are described) on the web site of NatureServe (2001). The information on species composition and structure of the vegetation (and, to a lesser extent, on the physical environment) at the sampling locations in the Sand Dunes WSA was compared to the information available on the NatureServe web site (NatureServe 2001) to determine which plant alliances and associations are present in the WSA.

Plant species names used in this report are from the USDA Natural Resources Conservation Service (2002).

## RESULTS

Information was collected from eight detailed (classification) plots and 14 less-detailed (reconnaissance) plots in the WSA (Figure 4, Table 1). Note that these locations all are near the periphery of the WSA. No information was collected at locations in the interior of the WSA, but observations from the roads around the boundary suggest that the substrates, landforms, and vegetation in the interior are similar to those around the periphery, so the information from the peripheral sampling locations may still give a reasonable picture of the entire study area.

The aerial photographs and observations made during field survey indicate that the substrate in most of the WSA is aeolian sand dunes of the Killpecker Dune Field (Figure 3, Table 2). Active sand dunes cover much of the center and the southern half of the area. More of the dunes in the area are vegetated (Stable Sand on Figure 3), although they have the choppy form or north-south ridges characteristic of the active dunes. In the southern end of the WSA (Older Stable Sand on Figure 3), the sand substrate is particularly well vegetated with grassland and sagebrush shrub stands, and the landforms there consist of small dunes with flats or depressions between them. In some areas of vegetated sand (Stable Sand/Ponds), small ponds are common in the depressions. In a band across the southern part of the WSA (Stable Ridge on Figure 3), the dunes have the form of long, east-west ridges, rather than the choppy form or the north-south ridges characteristic of the other areas of stabilized sand.

Tertiary-age sedimentary bedrock is exposed in the northern quarter of the WSA, north of the Killpecker Dunes (Sedimentary on Figure 3). The southern end of the WSA also seems to contain some Tertiary bedrock mixed with stabilized sand (Sand/Sedimentary, Figure 3). Areas in the southern end of the WSA that appear as light-

colored patches on the aerial photos contain saline or alkaline bedrock and sand (Light Patch on Figure 3).

## ECOSYSTEMS IN THE WSA

### Wyoming GAP cover-types

A brief explanation of how GAP mapped their cover-types is needed for a clear understanding of how the area of each type in the WSA was estimated. For most polygons in the state-wide landcover layer, GAP mapped a primary and a secondary cover-type and estimated the percentage of the polygon that is each type. If it were possible to use those percentages from the GAP layer, then the actual area of a cover-type in the WSA could be estimated as:

$$\text{Area of a type} = \sum_{\substack{\text{polygons} \\ \text{with that} \\ \text{type}}} [(\text{area of polygon})(\% \text{ as primary type}) + (\text{area of polygon})(\% \text{ as secondary type})]$$

But the boundaries of the WSA cut across GAP polygons, so when the land area of the WSA was clipped out of the state-wide layer, some of the polygons were split. There is no reason to assume that the percentage of a given cover-type in each of the resulting polygons is the same as its percentage in the original polygon, so the percentages from the GAP layer were not used in calculating the areas of cover-types in the WSA. Rather, the area shown in this report for a cover-type in the WSA is the sum of the areas of the polygons in which it is mapped as the primary cover-type. This is the same method used for calculating the areas of GAP cover-types in Wyoming (Table 2.2 of Merrill *et al.* 1996). It may result in an over-estimate of the amount of a cover-type in the WSA because the type occupies substantially less than 100% of the area of the polygons in which it is the primary type. Or it may under-estimate the amount of the cover-type because it ignores the polygons in which that cover-type is the secondary type.

The Wyoming Gap Analysis Project (Merrill *et al.* 1996) mapped six landcover-types as primary cover-types in the WSA (Figure 6). Of these, the Active Sand Dunes type is the most common (Table 3). Wyoming Big Sage Steppe and Vegetated Dunes are the only other major GAP cover-types in the WSA (Table 3). Correspondence between the GAP cover-types and the WYNDD general cover-types mapped from the aerial photos and field survey (Figure 3) is good for most types. The major differences between the GAP cover-type map and WYNDD's map are the greater area mapped by GAP as Active Sand Dunes, and the mapping of the northern quarter of the WSA as partly Vegetated Dunes by GAP but as entirely sedimentary bedrock by WYNDD.

Not only are the GAP Active Sand Dunes and Vegetated Dunes cover-types two major components of land cover in the Sand Dunes WSA, the WSA is unusual in the degree to which it encompasses these cover-types (Table 3). According to the Wyoming GAP report (Merrill *et al.* 1996), Active Sand Dunes are the primary cover-type on only 17,708 ha (43,739 acres) in Wyoming, and 81% of that area, or 14,314 ha (35,356 acres), is managed by BLM. This represents only 0.2% of the lands managed by BLM. But within the Sand Dunes WSA, the Active Sand Dunes cover-type accounts for 41% of the land area, and the WSA constitutes a third of the area of Active Sand Dunes on BLM-managed lands in Wyoming.



Similarly, the WSA has a large representation of the GAP Vegetated Dunes cover-type (Table 3). This is the primary cover-type on 0.17% of Wyoming's surface and 0.35% of BLM-managed lands, but it accounts for 19% of the WSA (Table 2). The WSA encompasses 8.7% of the area of this cover-type that lies on BLM-managed lands in Wyoming.

Wyoming Big Sagebrush Steppe is the third cover-type mapped by GAP as the primary type in a substantial part of the WSA, but the WSA is unimportant in representing this type on BLM-managed lands. This is the most common of the GAP cover-types in Wyoming and on BLM-managed lands (Table 2.2 of Merrill *et al.* 1996), accounting for over 57% of the latter (Table 3). The WSA accounts for < 1% of the area of this type on BLM-managed lands (Table 3). According to the GAP map (Figure 6), much of the vegetation in WYNDD's stable sand area (Figure 3) is Wyoming Big Sage Steppe.

The Desert Shrub cover-type is a minor type in the WSA, mapped by GAP as the primary vegetation at the northern and southern ends. Both of these places have been mapped by WYNDD as entirely or partly sedimentary bedrock, so it is not surprising that desert shrub vegetation would be found there. The Greasewood cover-type occurs along the western edge of the WSA in an area so small that it appears on the map only at very large scale. Both of these types are more common on BLM-managed lands than they are in the WSA (Table 3).

Basin Rock and Soil is common in the southern half of the WSA, mainly in the southwestern corner in an area mapped by WYNDD as the light-patch cover type and stable sand. The other large polygon of this type is along the WSA's eastern boundary, where WYNDD mapped stable sand. This type represents a larger proportion of the WSA than it does of BLM-managed lands throughout the state (Table 3). Information from the sampling points in this cover-type (Table 1) show that it contains grass-dominated vegetation, with varying amounts of shrub cover.

In summary, the map of GAP cover-types indicates that the Sand Dunes WSA is unusual for BLM-managed lands in Wyoming by virtue of the amount of sandy substrate ecosystems that it contains. In contrast, it contains only a very small proportion of the areas of other basin ecosystems.

### Landtypes

One landtype and four landtype associations delineated by Reiners and Thurston (1996) occur in the Sand Dunes WSA (Figure 7). The great majority of the WSA (84% of the surface area) is mapped as the Dune Field landtype, and the three landtype associations each account for less than 10% of the WSA (Table 4).

A comparison of Figure 7 with Figures 8 and 9 indicates the degree to which the Sand Dunes WSA includes the landtype associations and landtypes of southwestern Wyoming. For Figure 8, the 46 landtype associations delineated by Reiners *et al.* (1999) were reduced to 14 categories, three of which occur in the WSA. A comparison of Figure 8 with Figure 9 shows, though, that landtype associations in the WSA are largely masked by the Killpecker Sand Dunes, which constitute the Dune Field landtype. Two other landtypes of southwestern Wyoming (Figure 12 of Reiners and Thurston 1996), the Playa landtype and the Badland landtype, are not mapped in the WSA.

Using landtypes and landtype associations as indicators of ecosystems in the Sand Dunes WSA yields much the same result as does use of GAP cover-types as indicators: the area contains predominantly those ecosystems found on sandy substrates. The widespread, common ecosystems of southwestern Wyoming's basins are, at best, rare in the WSA.

#### National Vegetation Classification System types

Information collected at the sampling locations (Appendix 1) suggests that two shrub vegetation alliances, two shrub vegetation associations, and one herbaceous vegetation association from the National Vegetation Classification System are present in the Sand Dunes WSA (Table 5). None of those associations is thought to be rare, as indicated by the high conservation ranks assigned to them. (Alliances are not assigned conservation ranks.) Each of the vegetation types is briefly discussed below. Detailed descriptions of some, and an explanation of conservation ranks, can be found on the NatureServe web site (NatureServe 2001). More complete information and photographs from field sampling are included in Appendices 1 and 2, respectively.

#### -- *Artemisia tridentata* spp. *wyomingensis* / *Achnatherum hymenoides* (Wyoming big sagebrush / Indian ricegrass) Shrubland association

This association is found on loamy sand and sandy loam soils and constitutes much of the vegetation in the stable sand and older stable sand general cover-types (Table 6 and Figure 3). GAP apparently has mapped most of the area where this association occurs as Wyoming Big Sagebrush, Vegetated Dunes, and Active Sand Dunes cover-types (Table 7 and Figure 6). It seems to occur mainly in the Dune Field Landtype and the Killpecker Rolling Plains Landtype Association (Table 8 and Figure 7). This vegetation consists of a grass-and-forb stratum where *Achnatherum hymenoides* (Indian ricegrass), *Hesperostipa comata* (needle-and-thread grass), and *Psoralidium lanceolatum* (lemon scurfpea) usually are common, and a short shrub stratum (usually  $\leq 50$  cm tall) in which *Artemisia tridentata* spp. *wyomingensis* (Wyoming big sagebrush) and *Ericameria nauseosa* (rubber rabbitbrush) are the most common species. *Artemisia tridentata* ssp. *tridentata* may be present. The vegetation usually is open and the shrubs contribute < 25% canopy cover.

This is a poorly described vegetation type, meriting only weak confidence in its place in the national classification (NatureServe 2001). It is thought to be common (G5 conservation rank).

#### -- *Artemisia tridentata* ssp. *tridentata* (Basin big sagebrush) Shrubland Alliance

This vegetation of tall shrubs (1.5 - 2.5 m tall) grows over much of the area mapped as stable sand and stable sand/ponds general cover types (Table 6 and Figure 3). It seems to be one of the major types in the area mapped by GAP as Active Sand Dunes and Vegetated Dunes cover-types (Table 7, Figure 6) and on the Dune Field Landtype (Table 7, Figure 7). No plant association in the national classification (NatureServe 2001) seems to accurately describe this vegetation type. *Artemisia tridentata* ssp. *tridentata* (basin big sagebrush) dominates a tall shrub layer, or co-dominates with *Ericameria nauseosa* (rubber rabbitbrush). The herbaceous undergrowth usually is sparse and contains *Psoralidium lanceolatum* (lemon scurfpea), *Achnatherum*

*hymenoides* (Indian ricegrass), and *Hesperostipa comata* (needle-and-thread grass) as the common species.

Based on previous work in the Killpecker Dunes (Jones and Fertig 1996), the Wyoming Natural Diversity Database has suggested the addition of an *Artemisia tridentata* ssp. *tridentata* / *Psoralidium lanceolatum* Shrubland plant association to represent this vegetation in the national classification, but this suggestion has yet to be formalized.

-- *Artemisia tridentata* - *Atriplex confertifolia* (big sagebrush - shadscale saltbush) Shrubland association

Vegetation with a low shrub layer dominated by *Artemisia tridentata* (big sagebrush, either ssp. *wyomingensis* or ssp. *tridentata*) and containing *Atriplex confertifolia* (shadscale saltbush), *Chrysothamnus viscidiflorus* (Douglas rabbitbrush), *Sarcobatus vermiculatus* (black greasewood), and *Tetradymia canescens* (horsebrush), with an undergrowth of *Elymus lanceolatus* var. *lanceolatus* (thickspike wheatgrass), *Hesperostipa comata* (needle-and-thread grass), *Achnatherum hymenoides* (Indian ricegrass), *Phlox hoodii* (Hood's phlox) and other graminoids and forbs, grows widely across the sedimentary bedrock in the northern part of the WSA. Two plant association in the national classification (NatureServe 2001) may correspond to this vegetation. The *Artemisia tridentata* - *Atriplex confertifolia* Shrubland association (identification code CEGLO00993) has been described from the Northern Great Plains and the basins of Wyoming, and the *Artemisia tridentata* ssp. *wyomingensis* - *Atriplex confertifolia* Shrubland association (identification code CEGLO01040) has been described from the Great Basin to the west. These two associations seem to differ mainly in the sagebrush taxon, and more information may indicate that they can be merged.

This shrub association corresponds to the sedimentary general cover-type in the northern part of the WSA (Table 6, Figure 3), with the GAP's Desert Shrub and Wyoming Big Sagebrush cover-types (Table 7, Figure 6), and with the rolling plains and upland landtype associations (Table 8, Figure 7).

-- *Ericameria nauseosa* (rubber rabbitbrush) Shrubland alliance

Vegetation with a shrub layer dominated or co-dominated by *Ericameria nauseosa* (rubber rabbitbrush) and a sparse herbaceous undergrowth of *Psoralidium lanceolatum* (lemon scurfpea), *Achnatherum hymenoides* (Indian ricegrass), *Elymus lanceolatus* var. *lanceolatus* (thickspike wheatgrass), *Hesperostipa comata* (needle-and-thread grass), and a few other species grows in areas of the WSA mapped as stable ridge, stable sand, stable sand/ponds, and active sand general cover types (Table 6 and Figure 3). It occurs in the GAP Active Sand Dunes and Vegetated Dunes cover-types (Table 7 and Figure 6) and in the Dune Field Landtype (Table 8 and Figure 7).

The national vegetation classification includes an *Ericameria nauseosa* / *Leymus flavescens* / *Psoralidium lanceolatum* Shrubland plant association described only from the Snake River Plains of southern Idaho, where it is considered a mid-seral vegetation type on stabilized sand (NatureServe 2001). The species composition and the environment of that association closely resemble those of the *Ericameria nauseosa* vegetation from the Sand Dunes WSA, except for the difference in wheatgrasses present (*Leymus flavescens* in Idaho, *Elymus lanceolatus* var. *lanceolatus* in the Sand Dunes

WSA). A thorough comparison of data from the two locals may indicate that the Sand Dunes WSA vegetation should be included in that association.

-- *Distichlis spicata* - (*Scirpus nevadensis*) (saltgrass - Nevada bulrush) Herbaceous Vegetation association

Mesic meadows of short vegetation (<25 cm tall) among and near the dunes in the southern part of the WSA seem to belong to this association. *Distichlis stricta* (syn. *D. spicata*, inland saltgrass), *Spartina gracilis* (alkali cordgrass), *Juncus balticus* (baltic rush), *Sporobolus airoides* (alkali sacaton), *Triglochin* sp. (arrowgrass), *Scirpus nevadensis* (Nevada bulrush), *Aster pauciflorus* (syn. *Almutaster pauciflorus*, alkali marsh aster), *Eleocharis* sp. (spikerush), *Hymenoxys acaulis* var. *acaulis* (syn. *Tetranneuris acaulis* var. *acaulis*, stemless four-nerve daisy), and *Glauca maritima* (sea milkwort) are common species. This meadow vegetation occurs in the sand/sediment and stable sand/ponds general cover-types (Table 6, Figure 3), the GAP Vegetated Dunes, Basin Rock and Soil, and (perhaps) Wyoming Big Sagebrush Steppe cover-types (Table 7, Figure 6), and the Dune Field Landtype (Table 8 and Figure 7).

-- Unidentified Vegetation Type

Several patches of sparse *Psoraleidium lanceolatum* (lemon scurfpea) and *Elymus simplex* var. *luxurians* (syn. *Leymus simplex*, alkali wildrye), growing either singly or together, were noted in the active dunes of the WSA. (See Appendix 1, plot 00SD04.05 and Appendix 2, images 00GJ02.17 and 02.18.) Both species are strongly rhizomatous and therefore can survive in the moving sands. The national vegetation classification (NatureServe 2001) contains no alliances or associations that describe this sparse vegetation. *Elymus simplex* var. *luxurians* is a rare variety in Wyoming, known only from sand dunes in north-central Sweetwater County (Heidel *et al.* 2001).

## FLORA OF THE WSA

### Rare Plants

The only rare plant species known to occur in the Sand Dunes WSA is *Elymus simplex* var. *luxurians* (alkali wildrye, synonym *Leymus simplex*), a rhizomatous wheatgrass that grows mainly in the Green River Basin of southwestern Wyoming and northwestern Colorado (Fertig *et al.* 1998, Heidel *et al.* 2001). A population of this species grows in the active sand dunes in the southwestern part of the WSA, and was collected at sample location 00SD04.05 (Figure 4).

Another rare plant species deserves mention even though it is not known to occur in the WSA. *Penstemon haydenii*, blowout penstemon, is a federally endangered species known from the Ferris Dunes some 100 miles (160 km) east of the Sand Dunes WSA. The Killpecker Dunes might seem to be suitable habitat for this species, and indeed Fertig (2001) developed a habitat-based model that identifies areas of the Killpecker Dune Field within the WSA as possible habitat for *P. haydenii*. Survey by Fertig and the field work for this project, both conducted in 2000, failed to find the species there.

### Noxious Weeds

Walt Fertig, former WYNDD botanist, (personal communication) has reported *Tamarix chinensis* (five-stamen tamarisk) growing on the margin of a pond in the southwestern part of the WSA. This is the only plant on Wyoming's Weed and Pest Control Act Designated List (Wyoming Department of Agriculture, no date) noted in the WSA. Unfortunately the exact location and number of shrubs are unknown. No tamarisk was noted during this survey, so the species may be uncommon or rare, perhaps restricted to that pond.

Although no Canada thistle (*Cirsium arvense*) was noted during the field survey, this species is likely to be present around ponds in the western and southern part of the WSA, and along streams in the northern part. This noxious weed is ubiquitous in western Wyoming.

### Other Exotic Plants

The information from the sampling locations (Appendix 1) suggests that introduced plants are a minor part of the vegetation in the WSA. Crested wheatgrass (*Agropyron cristatum*) grows in the western part of the area, near the abandoned railroad right-of-way where it appears to have been planted. Kochia (probably common kochia, *Kochia scoparia*) has been found in the southwestern part of the WSA (Bernie Weynand, BLM Rock Springs Field Office, personal communication).

Of particular interest is the absence of cheatgrass (*Bromus tectorum*) from the sampling locations in the WSA. This introduced, winter-annual grass is widespread in Wyoming and the Intermountain West, and its presence in the upland grasslands and shrublands of the WSA would not be at all surprising. Although this species blooms and sets fruit in spring and early summer, and the field work for this project was conducted well after that time, it is unlikely that the survey missed any substantial populations of the plant. It is distinctive and easily identified even in late summer and fall.

## CONCLUSIONS

As its name suggests, the Sand Dunes Wilderness Study Area is unusual for Wyoming landscapes in the amount of active and stabilized sand dunes that it contains. Information from the Wyoming Gap Analysis Program (Merrill *et al.* 1996) and from maps of landtypes and landtype associations (Reiners and Thurston 1996, Reiners *et al.* 1999) show that ecosystems of sandy substrates are present in the WSA in far greater proportions than would be expected from their abundance in southwestern Wyoming. Moreover, the Gap Analysis Program data on land cover-types show that the WSA contains 34% of the active dunes and nearly 9% of the vegetated dunes on BLM-managed lands in the state. The WSA contains very little area of the other ecosystem types more typical of Wyoming's basins.

The vegetation of the WSA is predominantly shrublands of rubber and green rabbitbrush (*Ericameria nauseosa* and *Chrysothamnus viscidiflorus*) and tall basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) with an undergrowth dominated by plants of sandy substrates: lemon scurfpea (*Psoralidium lanceolatum*), Indian ricegrass (*Achnatherum hymenoides*), and needle-and-thread grass (*Hesperostipa comata*). Exotic

plants are minor components of this vegetation. In this sense, the WSA contains good-condition examples of the vegetation on sandy substrates typical of Wyoming's basins. The tall basin big sagebrush stands are unusual for Wyoming and, in fact, the Killpecker Dunes where the WSA lies may be the only place in the state where this tall sagebrush vegetation occupies a significant portion of the landscape. Elsewhere, it is restricted to narrow bands and small patches in draws. Neither the basin big sagebrush shrublands nor the rubber rabbitbrush shrublands seem to be described well enough in the national vegetation classification (NatureServe 2001) for an assessment of their rarity on a national scale. The rubber rabbitbrush shrublands, though, closely resemble a very rare type described from southern Idaho. One rare plant species, alkali wildrye (*Elymus simplex* var. *luxurians*), has been found in the WSA. This rhizomatous wheatgrass is known in Wyoming only from the WSA. It grows in patches in the active sand dunes of the southern WSA, but its extent and abundance have not been carefully documented.

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## TABLES

Table 1. Sampling plots in the Sand Dunes WSA.  
(See Figure 4.)

Plot Number	Plot Type	UTM Northing (NAD83)	UTM Easting (NAD83)	GAP Primary Cover-type	WYNDD General Cover Type
00SD01.01	classification	4647124	650118	Wyo Big Sagebrush Steppe	Older Stable Sand
00SD01.02	classification	4647120	650143	Wyo Big Sagebrush Steppe	Older Stable Sand
00SD03.01	classification	4647199	646357	Basin Rock and Soil	Older Stable Sand
00SD03.02	classification	4647225	646386	Basin Rock and Soil	Older Stable Sand
00SD04.01	classification	4649554	645984	Vegetated Dunes	Stable Ridge
00SD04.07	classification	4651167	644616	Vegetated Dunes	Stable Sand/Ponds
00SD05.01	classification	4653313	644406	Vegetated Dunes	Stable Sand
00SD09.01	classification	4656866	644753	Wyo Big Sagebrush Steppe	Stable Sand
00SD02.01	reconnaissance	4647139*	648255*	Basin Rock and Soil	Stable Sand
00SD02.02	reconnaissance	4647115*	648414*	Basin Rock and Soil	Light Patch
00SD04.02	reconnaissance	4649648	646269	Vegetated Dunes	Stable Ridge
00SD04.03	reconnaissance	4650214	646710	Vegetated Dunes	Stable Sand/Ponds
00SD04.05 ELYMUS	reconnaissance	4650566	646505	Active Sand Dunes	Active Sand
00SD04.06	reconnaissance	4651060*	645750*	Active Sand Dunes	Active Sand
00SD06.01, NORTH	reconnaissance	4651769	653663	Wyo Big Sagebrush Steppe	Stable Sand
00SD06.01, SOUTH	reconnaissance	4651599	653249	Wyo Big Sagebrush Steppe	Stable Sand
00SD06.02	reconnaissance	4651601	653338	Wyo Big Sagebrush Steppe	Stable Sand
00SD06.03	reconnaissance	4651666	653068	Wyo Big Sagebrush Steppe	Active Sand
00SD06.04	reconnaissance	4651606	652998	Wyo Big Sagebrush Steppe	Stable Sand
00SD07.01	reconnaissance	4660237	652210	Active Sand Dunes	Stable Sand
00SD07.02	reconnaissance	4660631	651797	Wyo Big Sagebrush Steppe	Sedimentary
00SD08.01	reconnaissance	4663551	647573	Wyo Big Sagebrush Steppe	Sedimentary

\*Coordinates were not recorded in the field for these sampling points. Their coordinates were estimated later from locations marked in the field on the 1:24,000-scale topographic maps.

Table 2. General cover-types mapped by WYNDD in the Sand Dunes WSA.

Cover-Type	Ha	Acres	% of WSA
Active Sand	2,699	6,694	23.9%
Light Patch	330	818	2.9%
Longitudinal Ridge	398	987	3.5%
Older Stable Sand	434	1,076	3.8%
Sand/Sedimentary	149	370	1.3%
Sedimentary	1,763	4,372	15.6%
Stable Sand	5,055	12,536	44.7%
Stable Sand / Ponds	484	1,200	4.3%
WSA TOTAL	11,312	28,053	100.0%

Table 3. Areas of GAP cover-types in Wyoming and in the Sand Dunes WSA.

Note that the tables from Merrill *et al.* (1996) from which the values for Wyoming and for BLM-managed lands in Wyoming are taken show the areas of the polygons in which these are the primary cover-types, not the actual areas of these cover-types. Hence these values probably are over-estimates. (See Merrill *et al.* (1996), Table 2.2, for an explanation.) The values from the WSA also are for the polygons in which these cover-types were mapped as the primary types. (See text of this report for explanation.)

	Active Sand Dunes	Vegetated Dunes	Wyo. Big Sage Steppe	Desert Shrub	Grease-wood	Basin Rock and Soil
ALL WYOMING						
Hectares <sup>(1)</sup>	17,708	44,193	8,385,650	971,983	362,857	351,361
Acres	43,739	109,157	20,712,556	2,400,798	896,257	867,862
% of state <sup>(2)</sup>	0.07%	0.17%	33.19%	3.85%	1.44%	1.39%
BLM IN WYOMING						
Hectares <sup>(1)</sup>	14,314	24,851	4,129,989	543,064	153,798	184,228
Acres	35,356	61,382	10,201,073	1,341,368	379,881	455,043
% of BLM lands <sup>(3)</sup>	0.20%	0.35%	57.51%	7.56%	2.14%	2.57%
BLM as % of state	80.83%	56.23%	49.25%	55.87%	42.39%	52.43%
SAND DUNES WSA <sup>(4)</sup>						
Hectares	4,689	2,167	3,430	148	2	876
Acres	11,629	5,374	8,506	367	5	2,172
% of WSA	41.5%	19.2%	30.3%	1.3%	<0.1%	7.7%
WSA as % of BLM lands in state	33.9%	8.7%	0.08%	0.03%	<0.01%	0.48%

(1) Merrill *et al.* (1996), Appendix 5.1

(2) Area of Wyoming = 25,263,316 ha (62,400,391 ac); Merrill *et al.* (1996), Table 4.3

(3) Area of BLM-managed lands = 7,181,183 ha (17,737,522 ac); Merrill *et al.* (1996), Table 4.3

(4) From this report.

Table 4. Areas of the dune field landtype and three landtype associations (LAs) in the Sand Dunes WSA

LANDTYPE / LANDTYPE ASSOCIATION NAME <sup>(1)</sup>	HA	ACRES	% OF WSA
Dune Field Landtype	9,512	23,590	84.1%
Lower Green R. Basin Rolling Plains & Tablelands LA	905	2,244	8.0%
Steamboat Mtn. - Ore. Buttes Upland LA	513	1,272	4.5%
Killpecker Cr. Rolling Plains LA	382	947	3.4%
Entire WSA	11,312	28,053	100.0%

1. Reiners and Thurston (1996)

Table 5. Plant alliances and associations of the National Vegetation Classification System present in the Sand Dunes WSA.

ALLIANCE / ASSOCIATION	CLASSIF. CODE <sup>1</sup>	CONS. RANK <sup>2</sup>	REPRESENTED BY PLOTS <sup>3</sup>	CERTAINTY OF PRESENCE IN WSA <sup>4</sup>
<i>Artemisia tridentata ssp. wyomingensis</i> / <i>Achnatherum hymenoides</i> Shrubland association	CEGL001046	G5	00SD03.02, 00SD06.01, 00SD06.04, 00SD07.02	Uncertain. This association undescribed.
<i>Artemisia tridentata ssp. tridentata</i> Shrubland Alliance	none	none	00SD01.01, 00SD01.02, 00SD02.02?, 00SD03.01?, 00SD04.01, 00SD06.02	Certain.
<i>Artemisia tridentata</i> - <i>Atriplex confertifolia</i> Shrubland association	CEGL000993	G4	00SD08.01	Uncertain
<i>Ericameria nauseosa</i> Shrubland Alliance	none	none	00SD04.06, 00SD04.07, 00SD05.01, 00SD06.03, 00SD07.01, 00SD09.01	Uncertain. Vegetation and environment resemble description from SE Idaho
<i>Distichlis spicata</i> - ( <i>Scirpus nevadensis</i> ) Herbaceous Vegetation association	CEGL001773	G4	00SD02.01, 00SD04.02, 00SD04.03	Uncertain. This association undescribed.
Unidentified Vegetation Type			00SD04.05	No type apparent in NVCS

Notes:

1. A classification code is assigned to each association in the national classification. Alliances have no codes.
2. Conservation rank represents the commonness or rarity of an association. G1 associations are very rare and (usually) are threatened by introduction of exotics, habitat loss, or alteration of the ecological processes upon which they depend. G5 associations are common and unthreatened. See NatureServe (2001) for an explanation.
3. The alliance or association is represented by these plots in the Sand Dunes WSA
4. Only when the description of vegetation and physical environment from a sample location in the WSA (see Appendix 1) matches reasonably well with the description of an association or alliance from the national classification can that type be said with certainty to occur in the WSA. Associations and alliances that are only listed in the national classification but have not been described cannot be said with certainty to occur in the WSA.

Table 6. Plant alliances and associations present in the general cover-types of the Sand Dunes WSA.

ALLIANCE / ASSOCIATION	GENERAL COVER-TYPES							
	Active Sand	Sand/ Sediment	Stable Sand	Stable sand/ponds	Stable Ridge	Older Stable Sand	Light Patch	Sedimentary
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Achnatherum hymenoides</i> Shrubland association	?	P?	<b>C</b>	?	A?	<b>C</b>	P?	A?
<i>Artemisia tridentata</i> ssp. <i>tridentata</i> Shrubland Alliance	P?	P?	<b>C</b>	<b>C</b>	P	P?	?	A?
<i>Artemisia tridentata</i> - <i>Atriplex confertifolia</i> Shrubland association	A	A	A	A	A	A	A?	<b>C</b>
<i>Ericameria nauseosa</i> Shrubland Alliance	A?	P	P	P	<b>C</b>	P?	A?	A
<i>Distichlis spicata</i> - ( <i>Scirpus nevadensis</i> ) Herbaceous Vegetation association	P?	<b>C</b>	P?	<b>C</b>	A?	A?	P?	A?

**C** = alliance or association is a common vegetation type in this general cover-type

P = Present in this general cover-type

A = Absent from this general cover-type

? = Relationship of alliance or association to general cover-type unknown

Table 7. Plant alliances and associations present in the GAP cover-types in the Sand Dunes WSA.

ALLIANCE / ASSOCIATION	GAP COVER-TYPES					
	Active Sand Dunes	Vegetated Dunes	Desert Shrub	Grease-wood	Wyo. Big Sage	Basin Rock & Soil
<i>Artemisia tridentata ssp. wyomingensis</i> / <i>Achnatherum hymenoides</i> Shrubland association	<b>C?</b>	<b>C</b>	?	?	<b>C</b>	A?
<i>Artemisia tridentata ssp. tridentata</i> Shrubland Alliance	<b>C</b>	<b>C</b>	?	?		A?
<i>Artemisia tridentata</i> - <i>Atriplex confertifolia</i> Shrubland association	A	A	<b>C</b>	?	<b>C</b>	?
<i>Ericameria nauseosa</i> Shrubland Alliance	<b>C</b>	<b>C</b>	A?	?	?	A?
<i>Distichlis spicata</i> - ( <i>Scirpus nevadensis</i> ) Herbaceous Vegetation association	P?	<b>C</b>	?	?	P?	<b>C</b>

**C** = Common vegetation type in this GAP cover-type

P = Present in this GAP cover-type

A = Absent from this GAP cover-type

? = Relationship of alliance or association to GAP cover-type unknown

Table 8. Plant alliances and associations present in the landtypes and landtype associations of the Sand Dunes WSA.

ALLIANCE / ASSOCIATION	LANDTYPE / LANDTYPE ASSOCIATION			
	Dune Field Landtype	Lower Green R. Basin Rolling Plains & Tablelands LA	Steamboat Mtn. - Ore. Buttes Upland LA	Killpecker Cr. Rolling Plains LA
<i>Artemisia tridentata ssp. wyomingensis</i> / <i>Achnatherum hymenoides</i> Shrubland association	<b>C</b>	A?	A?	<b>C</b>
<i>Artemisia tridentata ssp. tridentata</i> Shrubland Alliance	<b>C</b>	A?	A?	<b>C</b>
<i>Artemisia tridentata</i> - <i>Atriplex confertifolia</i> Shrubland association	A?	<b>C</b>	<b>C</b>	A?
<i>Ericameria nauseosa</i> Shrubland Alliance	<b>C</b>	A?	A?	A?
<i>Distichlis spicata</i> - ( <i>Scirpus nevadensis</i> ) Herbaceous Vegetation association	<b>C</b>	A?	A?	A?

**C** = Common vegetation type in this landtype or landtype association

A = Probably absent from this landtype or landtype association



## FIGURES

Figure 1: Location of the Sand Dunes WSA in southwestern Wyoming.

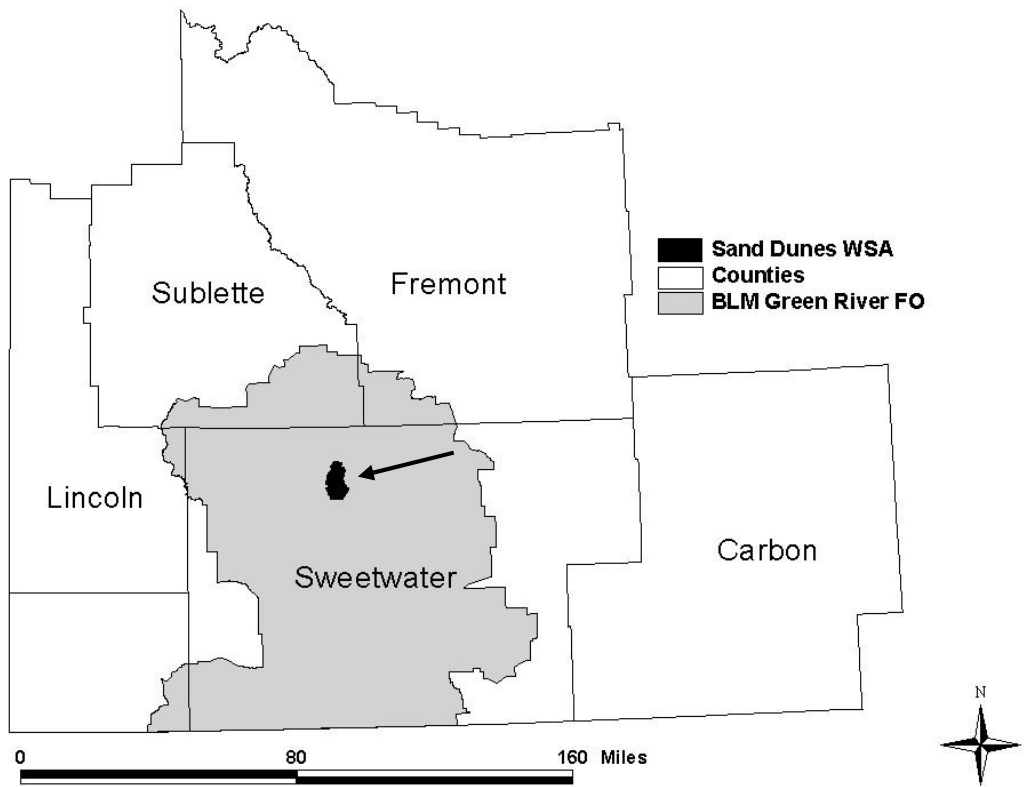


Figure 2. Boundary of the Sand Dunes WSA.

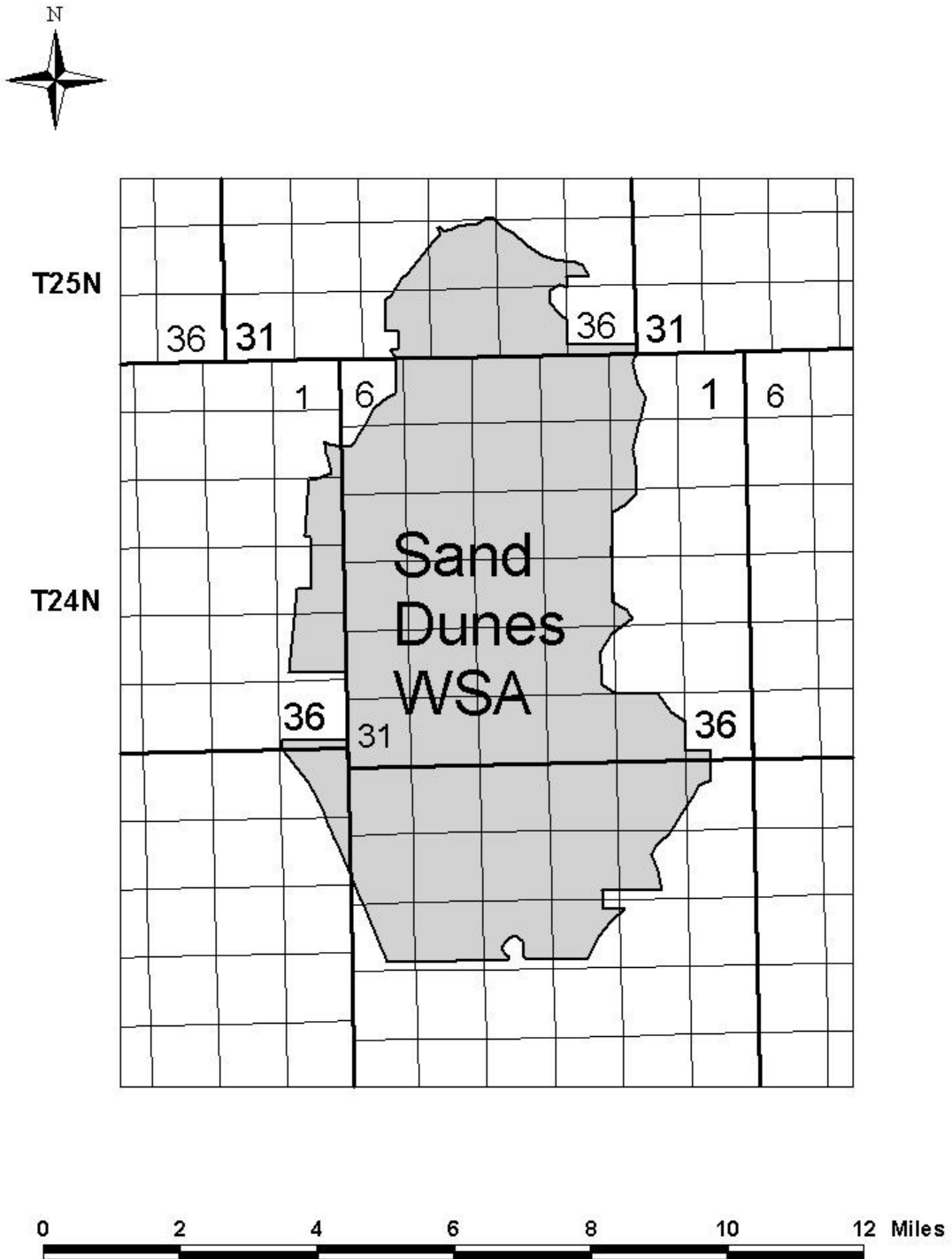


Figure 3. General cover-types in the Sand Dunes WSA.

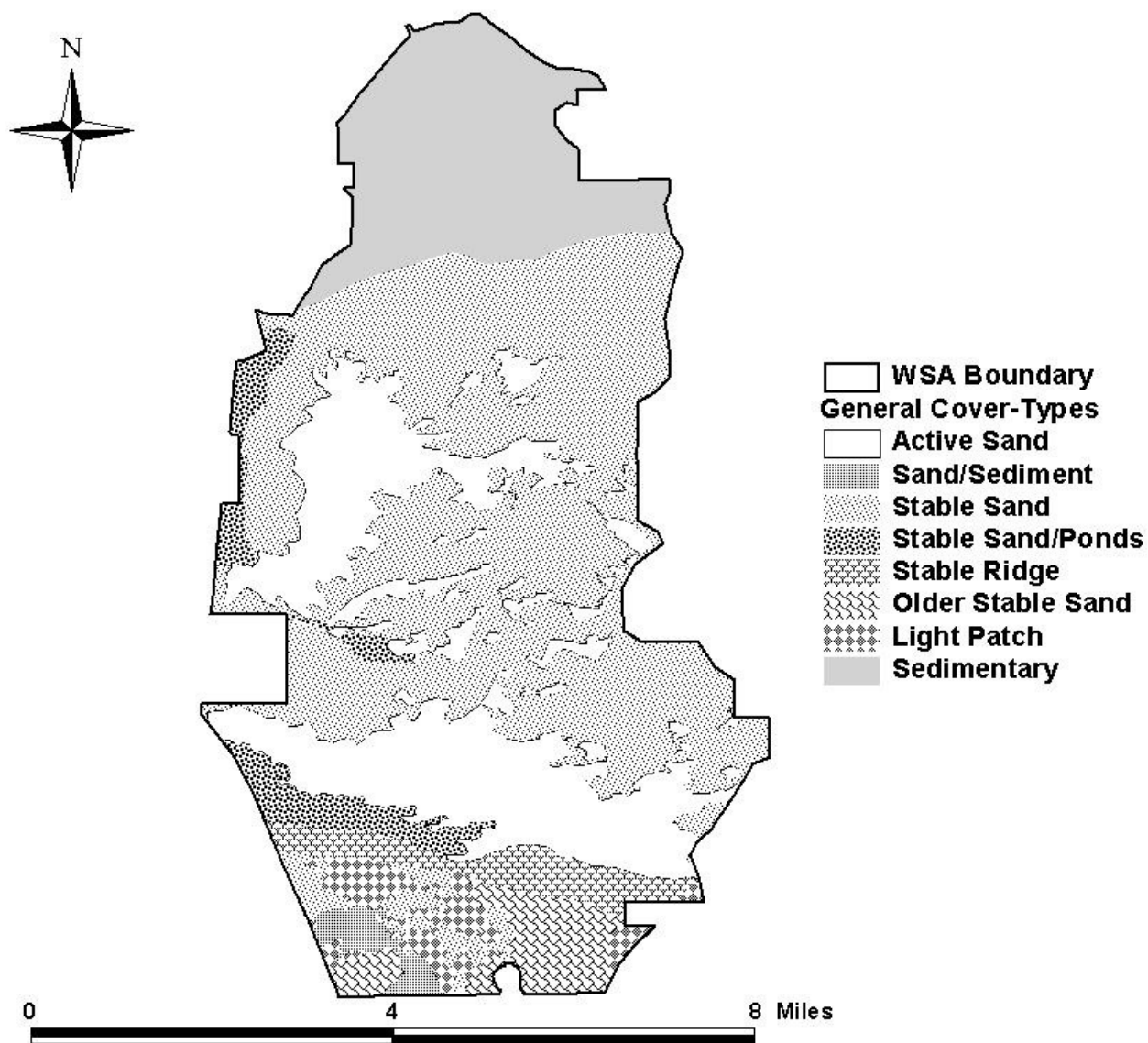


Figure 4. Sampling locations in the Sand Dunes WSA.  
(See Table 1.)

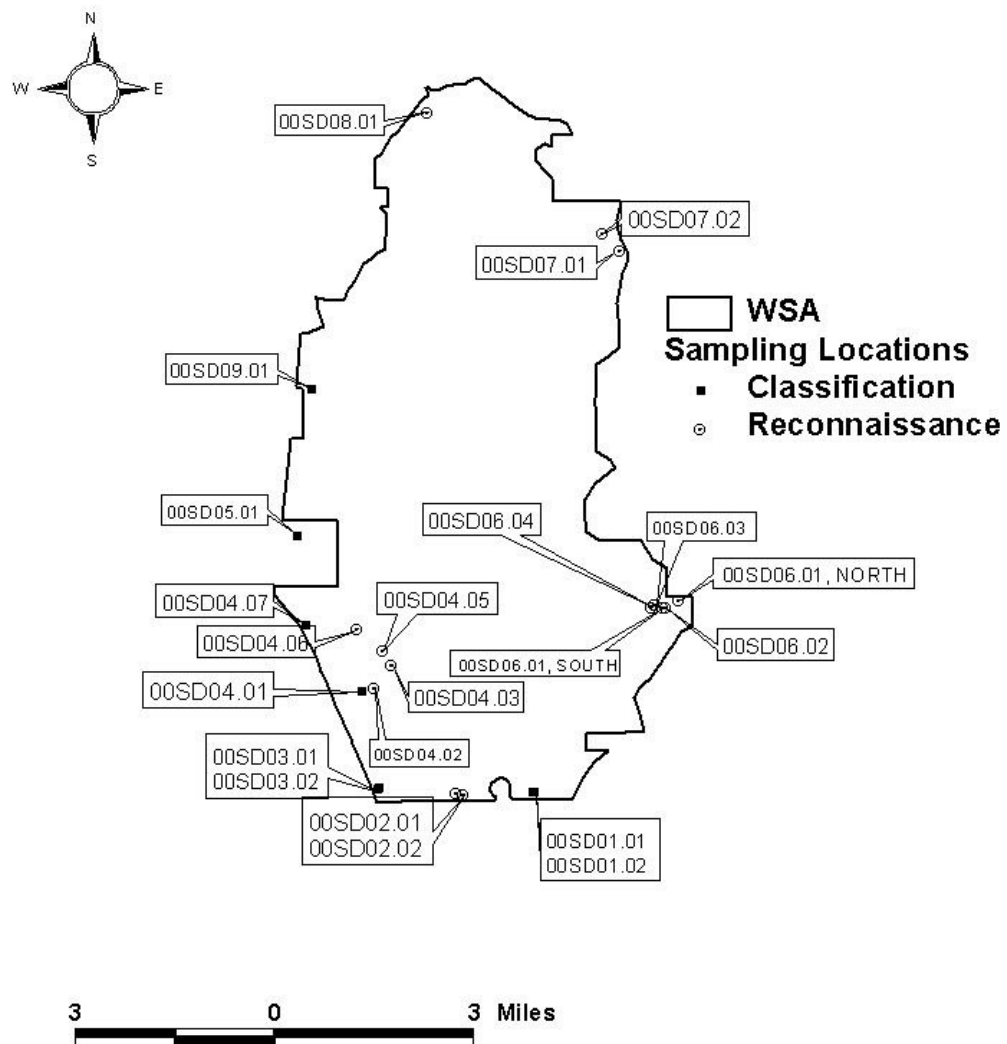


Figure 5. Layout of the modified-Whittaker nested sampling plots.

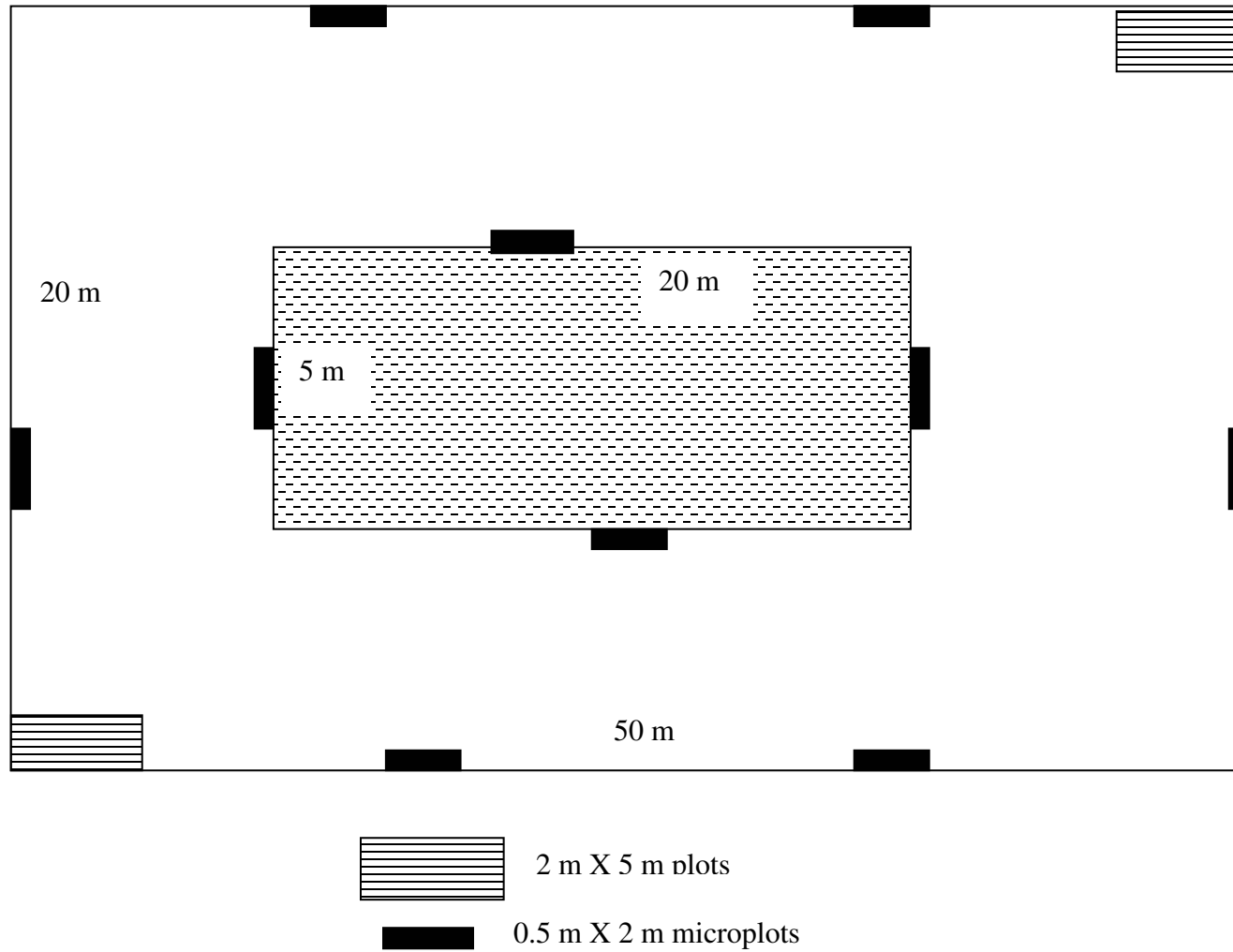


Figure 6. Wyoming GAP landcover-types in the Sand Dunes WSA.  
Note that this map shows the area in which each cover-type was mapped by GAP as the primary type. See text for explanation.

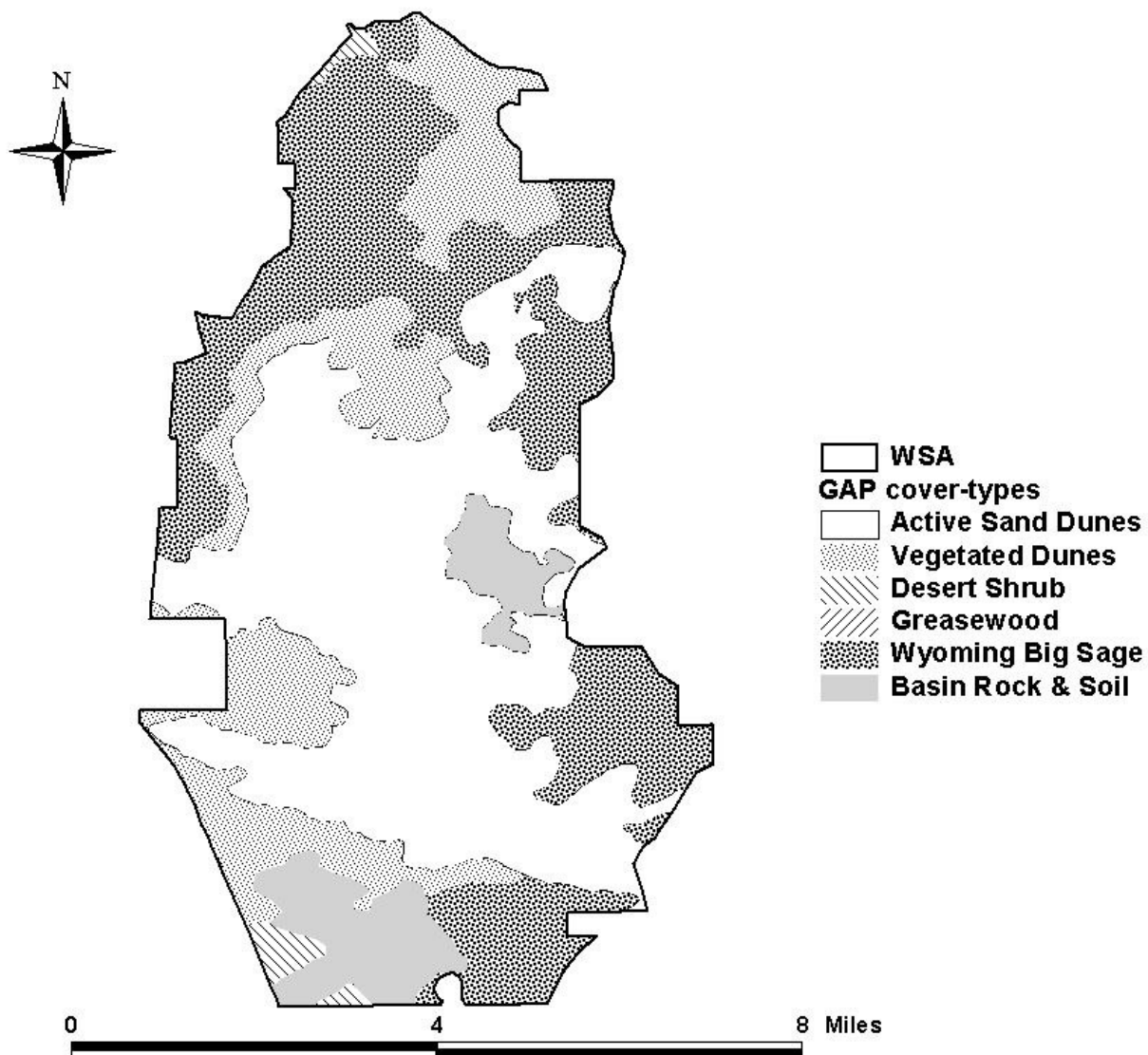


Figure 7. Dune field landtype and three landtype associations in the Sand Dunes WSA.

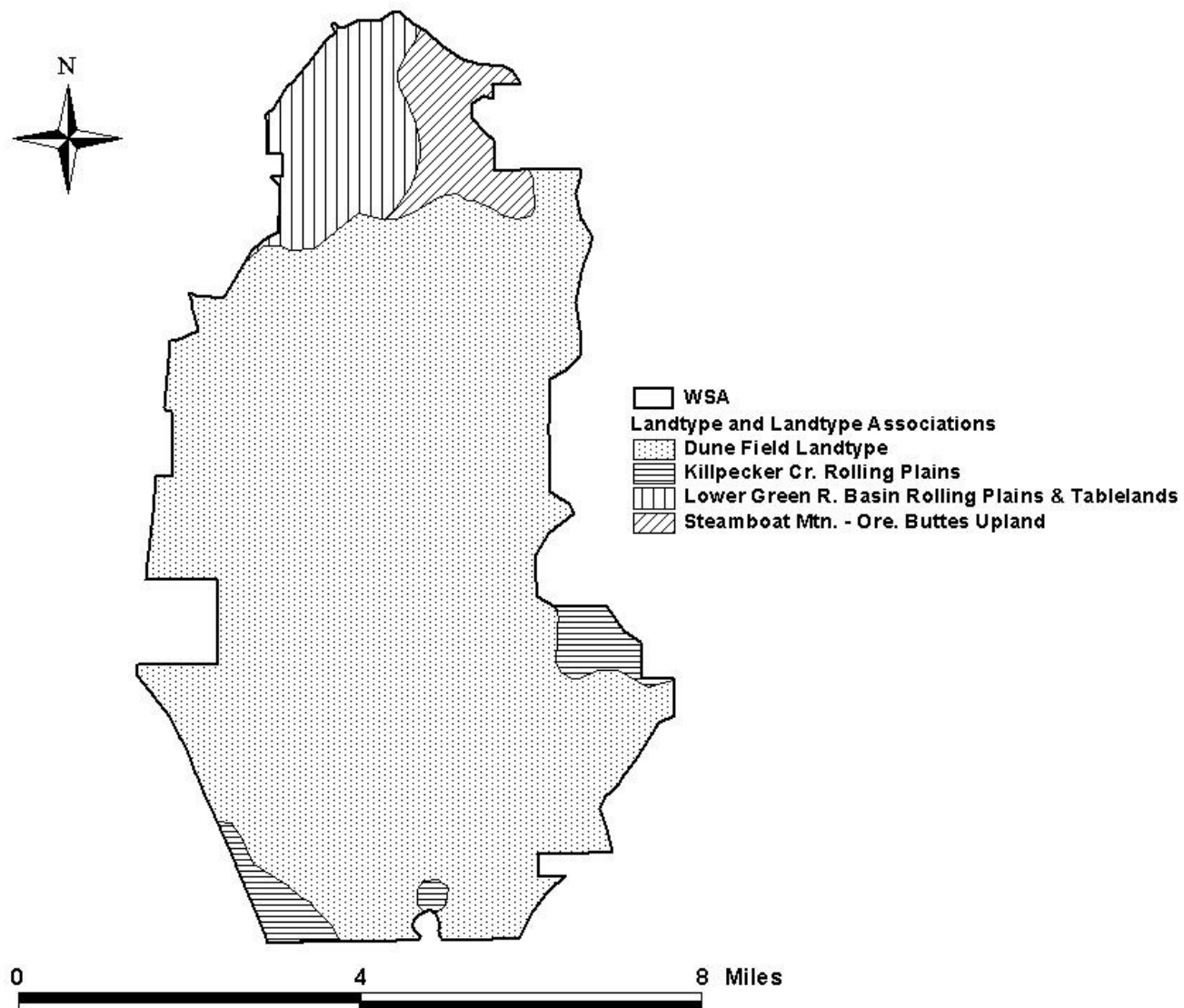




Figure 8. Categories of landtype associations in southwestern Wyoming.

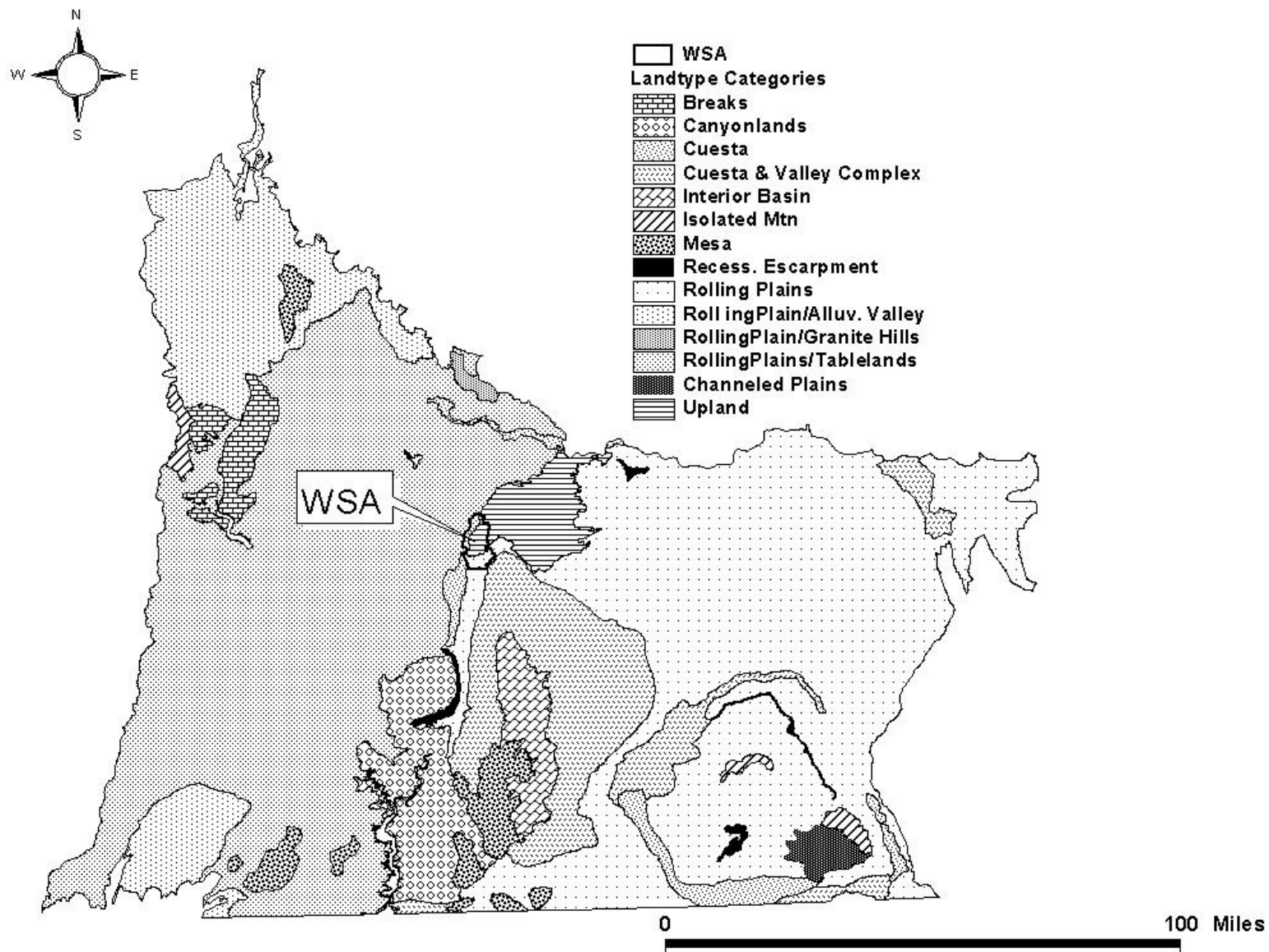
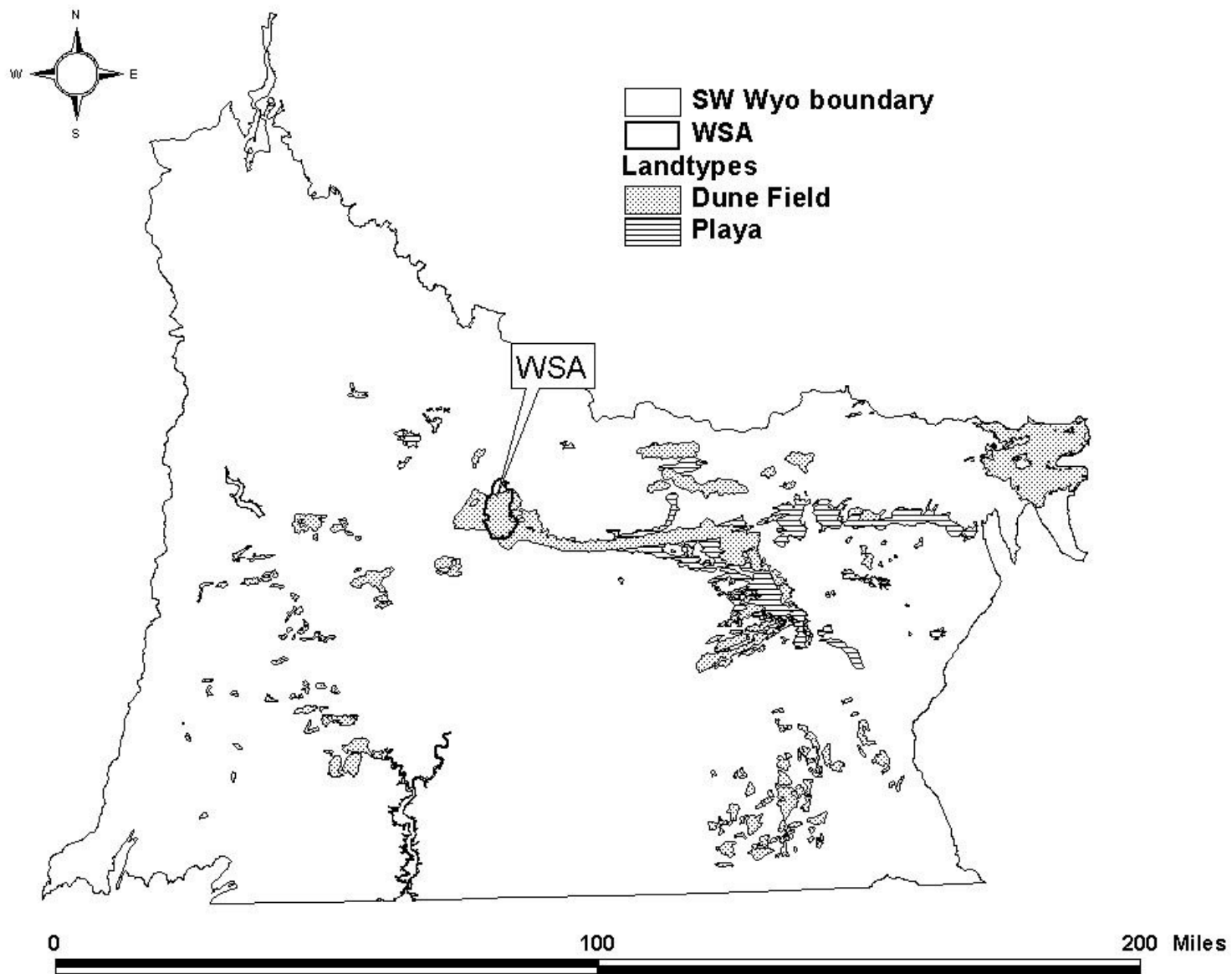


Figure 9. Dune field and playa landtypes in southwestern Wyoming.



APPENDIX 1. DESCRIPTIVE INFORMATION AND CANOPY COVER DATA FROM SAMPLING  
LOCATIONS IN THE SAND DUNES WSA.

The locations of the sampling locations are shown on Figure 4. Table 5 shows the plant alliances and plant associations from the national vegetation classification to which the vegetation at each location has been assigned.

**Plot** 00SD01.01      **Project** Sand Dunes      **Sample Type:** Classification

**GAP Cover-type Sampled:** Wyo. Big Sagebrush Steppe

**WYNDD General Cover Type Sampled:** Older Stable Sand

**NVCS Type:** *Artemisia tridentata* ssp. *tridentata* Shrubland Alliance

**Why was plot done?**

Chosen subjectively to illustrate vegetation in dark area on 1:24,000-scale true-color aerial photo.

**Vegetation Description**

*Artemisia tridentata* ssp. *wyomingensis* and *Grayia spinosa* form a patchy shrub layer 1 to 1.5 m tall. *Chrysothamnus viscidiflorus* forms a lower shrub layer. Bunchgrasses, primarily Indian ricegrass (*Achnatherum hymenoides*) and needle-and-thread (*Hesperostipa comata*), dominate the herbaceous undergrowth.

**Uncertainty on measurements**

Ricegrass and needle-and-thread are difficult to tell apart (few flowering) so values for one may include the other.

**Completeness of Spp lists**

Herbaceous species list probably incomplete because herbs are dry, so some annuals and early perennials were missed

**Notes**

Old sage grouse droppings present

Scientific and Common Names	NRCS Code	% Cover
<b>Shrub</b>		
artemisia tridentata ssp. tridentata	artrt	20.3
artemisia tridentata, big sagebrush	artr2	0.1
chrysothamnus viscidiflorus, green rabbitbrush	chvi8	8.4
grayia spinosa, spiny hopsage	grsp	4
<b>Graminoid</b>		
achnatherum hymenoides, Indian ricegrass	achy	3.4
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	ellal	0.3
hesperostipa comata, needle-and-thread	stco4	2
sporobolus cryptandrus, sand dropseed	spr	1.1
<b>Forb</b>		
arabis sp.	arab12	0.1
comandra umbellata, bastard toadflax	coum	0.1
cryptantha fendleri, sanddune catseye	crfe3	0.1
psoralidium lanceolatum, lemon scurfpea	psla3	0.2

**Plot** 00SD01.02      **Project** Sand Dunes      **Sample Type:** Classification

**GAP Cover-type Sampled:** Wyoming Big Sagebrush Steppe

**WYNDD General Cover Type Sampled:** Older Stable Sand

**NVCS Type:** *Artemisia tridentata* ssp. *tridentata* Shrubland alliance

**Why was plot done?**

Subjectively located to illustrate light-colored patch on 1:24,000-scale true-color aerial photo

**Vegetation Description**

Sparse grass vegetation, mainly of Indian ricegrass (*Achnatherum hymenoides*) and needle-and-thread (*Hesperostipa comata*), with widespread forbs that contribute little cover. Basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) (25 - 50 cm tall) and Douglas rabbitbrush (*Chrysothamnus viscidiflorus*) (< 25cm tall) are scattered.

**Uncertainty on measurements**

*Oryzopsis* and *Hesperostipa* difficult to tell apart (few flowering) so values for one probably contain the other.

**Completeness of Spp lists**

Herbs incomplete because many plants are dried up and so we missed some annuals and early perennials.

**Notes**

Scientific and Common Names	NRCS Code	% Cover
<b>Shrub</b>		
artemisia tridentata ssp. tridentata	artrt	8.1
artemisia tridentata, big sagebrush	artr2	0.1
chrysothamnus viscidiflorus, green rabbitbrush	chvi8	2
tetradymia canescens, spineless horsebrush	teca2	0.5
<b>Graminoid</b>		
achnatherum hymenoides, Indian ricegrass	achy	4.1
elymus, wildrye	elymu	0.6
hesperostipa comata, needle-and-thread	stco4	5.3
sporobolus cryptandrus, sand dropseed	sper	1.1
<b>Forb</b>		
allium, wild onion	alliu	0.1
arabis sp.	arab12	0.3
astragalus, milkvetch	astra	0.1
comandra umbellata, bastard toadflax	coum	0.9
cryptantha fendleri, sanddune catseye	crfe3	0.2
cryptantha flava, brenda's yellow catseye	crfl5	
erigonum cernuum var. cernuum	ercec	0.5
hymenopap	hymenopap	0.1
machaeranthera canescens ssp. canescens	macac3	0.1
oenothera pallida, pale eveningprimrose	oepa	0.2
opuntia polyacantha, plains pricklypear	oppo	0.1
psoralidium lanceolatum, lemon scurfpea	psla3	1.2
tiqulia nuttallii, nuttall's coldenia	tinu2	0.2

**Plot** 00SD02.01      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Basin Rock and Soil

**WYNDD General Cover Type Sampled:** Stable Sand

**NVCS Type:** *Distichlis spicata* - (*Scirpus nevadensis*) Herbaceous Vegetation association

**Why was plot done?**

Subjectively located to illustrate vegetation in light-colored patch on 1:24000-scale b/w aerial photo and on 1:40,000-scale IR NAPP aerial photo. This vegetation occupies broad, shallow dry channels between dunes.

**Vegetation Description**

Short (to 10 cm), sparse (ca. 30% cover) graminoid vegetation of *Scirpus nevadensis*, *Distichlis stricta*, and patches of *Spartina gracilis*. Scattered *Sarcobatus vermiculatus* are present, < 50 cm tall and ca. 10% cover. Vegetation is patchy; flats within this type are nearly bare of vegetation and have cracked soil surface. *Distichlis* is the most widely distributed species and contributes the most cover. *Scirpus* is second most widespread and common, and dominates some patches or co-dominates w/ *Distichlis*. *Spartina* co-dominates some patches

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded.

**Notes**

This type is in a mosaic with *Sarcobatus* - *A. tridentata* ssp. *tridentata* shrub vegetation on dunes (00SD02.02).



**Plot** 00SD02.02      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Basin Rock and Soil

**WYNDD General Cover Type Sampled:** Stable Sand

**NVCS Type:** *Artemisia tridentata* ssp. *tridentata* Shrubland alliance

**Why was plot done?**

Subjectively located to illustrate vegetation on low dunes amidst saline flats and channels, in large flat W of Killpecker Cr. This area shows up as a dark patch on the 1:24,000-scale b/w aerial photo and on the 1:40,000-scale IR NAPP aerial

**Vegetation Description**

Vegetation is mostly graminoids (*Hesperostipa comata* and *Sporbolous airoides* [?]), with short shrubs (*Chrysothamnus viscidiflorus*) contributing ca. 10% canopy cover. Higher dunes have taller, denser shrubs -- *Sarcobatus vermiculatus*, *Artemisia tridentata* ssp. *tridentata*, *Grayia spinosa* -- and very little grass cover. *Distichlis spicata* grows in the lowest areas near channels. Tall shrubs are obvious patches in this lower vegetation.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were noted.

**Notes**

No ground cover data.

**Plot** 00SD03.01      **Project** Sand Dunes      **Sample Type:** Classification

**GAP Cover-type Sampled:** Basin Rock and Soil

**WYNDD General Cover Type Sampled:** Older Stable Sand

**NVCS Type:** *Artemisia tridentata* ssp. *tridentata* Shrubland Alliance

**Why was plot done?**

Subjectively selected to illustrate vegetation on dunes, as shown on 1:24,000-scale true-color aerial photo

**Vegetation Description**

Basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) dominates a patchy shrub layer to ca. 1 m tall, with some spiny hopsage (*Grayia spinosa*). Douglas rabbitbrush (*Chrysothamnus viscidiflorus*) and horsebrush (*Tetradymia canescens*), shorter shrubs, are present throughout. Needle-and-thread (*Hesperostipa comata*) and Indian ricegrass (*Achnatherum hymenoides*) form a sparse grass undergrowth and are densest near the clumps of tall shrubs.

**Uncertainty on measurements**

Grasses -- *Oryzopsis*, *Stipa*, and even *Elymus* -- rarely in flower and difficult to tell apart, so values for one may include the others.

**Completeness of Spp lists**

Herbaceous list probably incomplete because plants are dried up and some annuals and early perennials were missed.

**Notes**

Abandoned railroad grade ca. 80 m away probably is the source of *Agropyron cristatum*.

Scientific and Common Names	NRCS Code	% Cover
<b>Shrub</b>		
artemisia tridentata ssp. tridentata	artrt	8
artemisia tridentata ssp. wyomingensis	artrw8	6.2
artemisia tridentata, big sagebrush	artr2	0.1
chrysothamnus viscidiflorus, green rabbitbrush	chvi8	10
grayia spinosa, spiny hopsage	grsp	0.3
tetradymia canescens, spineless horsebrush	teca2	1.2
<b>Graminoid</b>		
achnatherum hymenoides, Indian ricegrass	achy	2.9
agropyron cristatum, crested wheatgrass	agcr	0.1
elymus elymoides ssp. elymoides, squirreltail	elele	0.1
elymus, wildrye	elymu	1.3
hesperostipa comata, needle-and-thread	stco4	8.4
<b>Forb</b>		
arabis sp.	arab12	0.3
astragalus convallarius, timber milkvetch	asco12	0.2
cryptantha fendleri, sanddune catseye	crfe3	0.3
cryptantha flava, brenda's yellow catseye	crfl5	0.7
erigonum cernuum var. cernuum	ercec	0.5
hymenopap	hymenopap	0.1
leptodactylon pungens, granite pricklygilia	lepu	0.3
opuntia polyacantha, plains pricklypear	oppo	0.1
penstemon arenicola, sand penstemon	pear	0.1
phlox hoodii, hoods phlox	phho	0.1

**Plot** 00SD03.02      **Project** Sand Dunes      **Sample Type:** Classification

**GAP Cover-type Sampled:** Basin Rock and Soil

**WYNDD General Cover Type Sampled:** Older Stable Sand

**NVCS Type:** *Artemisia tridentata* ssp. *wyomingensis* / *Achnatherum hymenoides* Shrubland association

**Why was plot done?**

Subjectively chosen to illustrate grainy dark patch on 1:24,000-scale true-color aerial photo, and to contrast with shrubby dune ca. 20 m to west, which was sampled w/ plot 00SD03.01.

**Vegetation Description**

Open grass vegetation dominated by *Hesperostipa comata* (maybe co-dominating w/ *Achnatherum hymenoides*). Forbs and other graminoids are widespread but contribute little cover. *Chrysothamnus viscidiflorus* and fewer *Artemisia tridentata* ssp. *wyomingensis* grow scattered throughout stand.

**Uncertainty on measurements**

Few grasses are in flower so *Hesperostipa comata* and *Achnatherum hymenoides* (and *Elymus* to a lesser extent) are virtually impossible to tell apart. Hence, values for one may include the others.

**Completeness of Spp lists**

Herbaceous species list probably is incomplete because most herbs are dry so some annuals and early perennials were missed.

**Notes**

*Agropyron cristatum* probably came from abandoned railroad grade.

Scientific and Common Names	NRCS Code	% Cover
<b>Shrub</b>		
artemisia tridentata ssp. wyomingensis	artrw8	4.1
artemisia tridentata, big sagebrush	artr2	0.1
chrysothamnus viscidiflorus, green rabbitbrush	chvi8	5.3
tetradymia canescens, spineless horsebrush	teca2	0.2
<b>Graminoid</b>		
achnatherum hymenoides, Indian ricegrass	achy	3.3
agropyron cristatum, crested wheatgrass	agcr	0.1
carex duriuscula, needleleaf sedge	cadu6	0.7
elymus, wildrye	elymu	1.8
hesperostipa comata, needle-and-thread	stco4	15
<b>Forb</b>		
arabis sp.	arab12	0.1
arenaria, long	arenaria,	0.3
astragalus convallarius, timber milkvetch	asco12	0.6
astragalus kentrophytus var. jessiae	askej	0.1
cryptantha flava, brenda's yellow catseye	crfl5	0.4
eriogonum cernuum var. cernuum	ercec	0.3
hymenopap	hymenopap	0.2
leptodactylon pungens, granite pricklygilia	lepu	0.1
machaeranthera canescens ssp. canescens	macac3	0.3
opuntia polyacantha, plains pricklypear	oppo	1

**Plot** 00SD04.01      **Project** Sand Dunes      **Sample Type:** Classification

**GAP Cover-type Sampled:** Vegetated Dunes

**WYNDD General Cover Type Sampled:** Stable Ridge

**NVCS Type:** *Artemisia tridentata* ssp. *tridentata* Shrubland Alliance

**Why was plot done?**

Subjectively chosen to illustrate stabilized longitudinal dune, which shows up as grainy dark patch on 1:24,000-scale black-and-white aerial photo.

**Vegetation Description**

Patchy shrub vegetation dominated by *Artemisia tridentata* ssp. *tridentata* mostly 1 - 1.5 m tall, and by *Chrysothamnus viscidiflorus* < 0.5 m tall. *Chrysothamnus* contributes more cover than *Artemisia*. Herbaceous undergrowth is sparse and dominated by *Achnatherum hymenoides* with *Elymus* sp. *Psoralidium* is the most widespread herbaceous species and may co-dominate.

**Uncertainty on measurements**

*Achnatherum hymenoides* and *Hesperostipa comata* are very difficult to tell apart because few are flowering. So, although no *Stipa* was noted here in flower, it may be present and included in the cover value for *Achnatherum*.

**Completeness of Spp lists**

Herbaceous list probably is incomplete because the plants are dry and some annuals and early perennials were missed.

**Notes**

Flushed 3 sage grouse. Rabbit droppings, perhaps pygmy rabbit, present.

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Scientific and Common Names	NRCS Code	% Cover
<b>Shrub</b>		
artemisia tridentata ssp. tridentata	artrt	12.3
artemisia tridentata, big sagebrush	artr2	0.2
chrysothamnus viscidiflorus, green rabbitbrush	chvi8	9.9
ericameria nauseosa, rubber rabbitbrush	erna10	4.3
grayia spinosa, spiny hopsage	grsp	2.3
<b>Graminoid</b>		
achnatherum hymenoides, Indian ricegrass	achy	1.9
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	ellal	1.3
<b>Forb</b>		
chenopodium leptophyllum, narrowleaf goosefoot	chle4	0.1
psoralidium lanceolatum, lemon scurfpea	psla3	1.3

**Plot** 00SD04.02      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Vegetated Dunes

**WYNDD General Cover Type Sampled:** Stable Ridge

**NVCS Type:** *Distichlis spicata* - (*Scirpus nevadensis*) Herbaceous Vegetation association

**Why was plot done?**

Located subjectively to illustrate wetland between stabilized sand dunes.

**Vegetation Description**

Short (<25 cm) herbaceous vegetation with a few scattered shrubs. *Sarcobatus vermiculatus* grows on higher sites; *Juncus balticus*, *Glaux maritima*, *Triglochin* sp., and *Hymenoxys acaulis* var. *acaulis* are the most widespread species and probably contribute most cover. *Scirpus pungens* and *Aster pauciflorus* are next most common. *Distichlis spicata* and *Scirpus nevadensis* seem to occur on slightly higher places and around margins. *Spartina gracilis*, *Muhlenbergia richardsonis*, *Elymus* sp., and *Carex praegracilis* are present in places.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded

**Notes**



**Plot** 00SD04.03      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Vegetated Dunes

**WYNDD General Cover Type Sampled:** Stable Sand/Ponds

**NVCS Type:** *Distichlis spicata* - (*Scirpus nevadensis*) Herbaceous Vegetation association

**Why was plot done?**

Subjectively located to illustrate vegetation around depression in swales and at S foot of sandy hills to the N. This area is a grainy, dark area on the 1:24,000-scale b/w aerial photo and on the 1:40,000-scale IR NAPP photo.

**Vegetation Description**

This is a short (<15cm) meadow vegetation. *Distichlis stricta*, *Spartina gracilis*, and *Juncus balticus* are the most widespread species. The highest, driest places are *Distichlis*, *Spartina*, and *Sporobolus airoides*. Intermediate areas are usually *Juncus balticus*, *Scirpus nevadensis*, *Distichlis*, and sometimes some *Spartina*. *Muhlenbergia richardsonis*, *Triglochin* sp., and *Eleocharis* sp. may be common or absent. Lower areas are *Juncus balticus*, *Scirpus nevadensis*, maybe some *Distichlis* and *Spartina*, with *Triglochin* sp., *Aster pauciflora*, and *Hymenoxys acaulis* var. *acaulis*. The lowest areas are *Juncus balticus* - *Glaux maritima* vegetation (cf. 00SD03.02).

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded.

**Notes**

Lower, wetter spots support *Juncus balticus* - *Glaux maritima* vegetation, and stabilized longitudinal dunes support *A. tridentata* ssp. *tridentata* - *Chrysothamnus* spp. shrub vegetation.

**Plot** 00SD04.05      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Active Sand Dunes

**WYNDD General Cover Type Sampled:** Active Sand

**NVCS Type:** Unknown

**Why was plot done?**

Subjectively located to illustrate sparse vegetation on active sand.

**Vegetation Description**

Patches of *Psoralidium lanceolatum* and patches of sp. *Elymus simplex* var. *luxurians* occur in various places. The canopy cover is < 10% in each patch. These types may merge.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded.

**Notes**

This type occurs as small patches (to several thousand sq meters each) of rhizomatous vegetation in various places on the dunes.

**Plot** 00SD04.06      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Active Sand Dunes

**WYNDD General Cover Type Sampled:** Active Sand

**NVCS Type:** *Ericameria nauseosa* Shrubland Alliance

**Why was plot done?**

Subjectively located to illustrate vegetation on partially stabilized sand. This area shows up as a patch of intermediate color on the 1:24,000-scale b/w aerial photo and on the 1:40,000-scale IR NAPP photo.

**Vegetation Description**

Herbaceous vegetation ca. 20 cm tall, co-dominated by *Psoralidium lanceolatum* and *Elymus lanceolatus* var. *lanceolatus*. *Hesperostipa comata*, *Oenothera* spp, and *Lygodesmia* sp. are common. *Ericameria nauseosa* (*Chrysothamnus nauseosus*), *Chrysothamnus viscidiflorus*, and some *Chrysothamnus linifolius* grow as scattered individuals and clumps.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded.

**Notes**

This is the matrix type on partially stabilized sand south of a bedrock ridge.

**Plot** 00SD04.07      **Project** Sand Dunes      **Sample Type:** Classification

**GAP Cover-type Sampled:** Vegetated Dunes

**WYNDD General Cover Type Sampled:** Stable Sand, Ponds

**NVCS Type:** *Ericameria nauseosa* Shrubland Alliance

**Why was plot done?**

Subjectively located to illustrate variation in vegetation on stabilized sand dunes, specifically the shrub vegetation without *A. tridentata* ssp. *tridentata*. This vegetation appears on the 1:24,000-scale black and white aerial photo as a light

**Vegetation Description**

Open shrub stand of *Ericameria nauseosa* (*Chrysothamnus nauseosus*) to ca. 1 m tall. Many shrubs have dead parts in canopies. *Chrysothamnus viscidiflorus* to ca. 25 cm tall is present but contributes less cover than do the taller shrubs. *Psoralidium lanceolatum* dominates the undergrowth and is most common between the shrubs. Other forbs are present in small amounts. *Elymus lanceolatus* var. *lanceolatus*. is widespread but contributes little cover.

**Uncertainty on measurements**

*Achnatherum hymenoides* and *Hesperostipa comata* are very difficult to tell apart because so few plants are blooming, so the values for one may include the

**Completeness of Spp lists**

Herbaceous list is incomplete because the plants are dry and we certainly missed some annuals and early perennials.

**Notes**

**PLOT 00SD04.07**

**Species Cover Table**

Scientific and Common Names	NRCS Code	% Cover
<b>Shrub</b>		
chrysothamnus viscidiflorus, green rabbitbrush	chvi8	1.7
ericameria nauseosa, rubber rabbitbrush	erna10	40
<b>Graminoid</b>		
achnatherum hymenoides, Indian ricegrass	achy	0.5
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	ellal	2.3
<b>Forb</b>		
chenopodium leptophyllum, narrowleaf goosefoot	chle4	0.1
descurainia, tansymustard	descu	0.1
psoralidium lanceolatum, lemon scurfpea	psla3	9.6

**Plot** 00SD05.01      **Project** Sand Dunes      **Sample Type:** Classification

**GAP Cover-type Sampled:** Vegetated Dunes

**WYNDD General Cover Type Sampled:** Stable Sand

**NVCS Type:** *Ericameria nauseosa* Shrubland Alliance

**Why was plot done?**

Chosen subjectively to illustrate the vegetation in grainy, dark-colored patch on 1:24,000-scale black-and-white aerial photo.

**Vegetation Description**

Open shrub stand dominated by *Ericameria nauseosa* (*Chrysothamnus nauseosus*) ca. 60 cm tall and *Chrysothamnus viscidiflorus* ca. 25 cm tall. Undergrowth is sparse and consists of *Psoralidium lanceolatum* with few other species; *Elymus lanceolatus* var. *lanceolatus* is the most common of those.

**Uncertainty on measurements**

**Completeness of Spp lists**

Herbaceous list probably incomplete because herbs are dry and we missed some annuals and early perennials.

**Notes**

Sage grouse droppings present and we flushed 1 grouse.

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Scientific and Common Names	NRCS Code	% Cover
<b>Shrub</b>		
chrysothamnus viscidiflorus, green rabbitbrush	chvi8	15.3
ericameria nauseosa, rubber rabbitbrush	erna10	14.4
<b>Graminoid</b>		
achnatherum hymenoides, Indian ricegrass	achy	0.2
elymus lanceolatus ssp. lanceolatus, thickspike wheatgrass	ellal	2.1
<b>Forb</b>		
chenopodium leptophyllum, narrowleaf goosefoot	chle4	0.2
eriogonum cernuum var. cernuum	ercec	0.3
lygodesmia juncea, rush skeletonplant	lyju	0.2
machaeranthera canescens ssp. canescens	macac3	0.1
psoralidium lanceolatum, lemon scurfpea	psla3	3.2

**Plot** 00SD06.01      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Wyo. Big Sagebrush Steppe

**WYNDD General Cover Type Sampled:** Stable Sand

**NVCS Type:** *Artemisia tridentata* ssp. *wyomingensis* / *Achnatherum hymenoides* Shrubland association

**Why was plot done?**

Subjectively located to illustrate the vegetation on stabilized sand. This shows up as a grainy, dark patch on the 1:24,000-scale b/w aerial photo.

**Vegetation Description**

Low, sparse vegetation of scattered *Artemisia tridentata* ssp. *wyomingensis* with *Comandra umbellata*, *Achnatherum hymenoides*, and *Hesperostipa comata* as the most common herbaceous species.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded.

**Notes**

The aeolian sand forms a thin veneer over sandstone.



**Plot** 00SD06.02      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Wyoming Big Sagebrush Steppe

**WYNDD General Cover Type Sampled:** Active Sand

**NVCS Type:** *Artemisia tridentata* ssp. *tridentata* Shrubland Alliance

**Why was plot done?**

Subjectively located to illustrate the vegetation on stabilized sand. This appears as a dark, grainy area on the 1:24,000-scale b/w aerial photo.

**Vegetation Description**

This is moderately tall shrub vegetation of *Artemisia tridentata* ssp. *tridentata* 1-2 m tall (taller in the bottoms of draws), with a lower shrub layer of *Chrysothamnus viscidiflorus* and other species. The herbaceous undergrowth is sparse and consists of *Psoralidium lanceolatum* and *Opuntia polyacantha* with lesser amounts of *Achnatherum hymenoides*, *Hesperostipa comata*, and *Sporobolus cryptandrus*.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were noted.

**Notes**

This is the matrix vegetation on stabilized sand, covering thousands of acres. It includes patches of low *A. tridentata wyomingensis* vegetation (00SD06.04) where the bedrock is exposed (ea. ca. 1 acre?) and *Ericameria nauseosa* on more active sand along the edges of active dunes (00SD06.03).

**Plot** 00SD06.03      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Wyo. Big Sagebrush Steppe

**WYNDD General Cover Type Sampled:** Stable Sand

**NVCS Type:** *Ericameria nauseosa* Shrubland Alliance

**Why was plot done?**

Subjectively located to illustrate the vegetation on sides of longitudinal dunes. These appear as dark, grainy patches on the 1:24,000-scale b/w aerial photo.

**Vegetation Description**

*Ericameria nauseosa* (*Chrysothamnus nauseosus*) forms an open, tall shrub layer (1 - 1.5 m tall) above a herbaceous undergrowth of *Psoralidium lanceolatum*, *Elymus lanceolatus* var. *lanceolatus*, *Rumex venosus*, and a few other species. The herbs are most common in openings between the shrubs.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded.

**Notes**

This type occurs as large patches along the sides of longitudinal dunes, in a matrix of grassland vegetation (00SD06.04). Also included in the mosaic are patches of *A. tridentata wyomingensis*/*Stipa* vegetation where bedrock is exposed

**Plot** 00SD06.04      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Wyo. Big Sagebrush Steppe

**WYNDD General Cover Type Sampled:** Stable Sand

**NVCS Type:** *Artemisia tridentata* ssp. *wyomingensis* / *Achnatherum hymenoides* Shrubland association

**Why was plot done?**

Subjectively located to illustrate the vegetation on stabilized sand dunes. It appears as a dark, grainy area on the 1:24,000-scale b/w aerial photo.

**Vegetation Description**

This is open grass vegetation of *Hesperostipa comata* with *Achnatherum hymenoides* and *Elymus*, containing widespread forbs (especially *Psoraleidium lanceolatum*) and short (to 25 cm) *A. tridentata wyomingensis*. *Chrysothamnus viscidiflorus* and *Tetradymia canescens* are widespread but contribute little cover; taller *A. tridentata tridentata* (to 50 cm) and *Ericameria nauseosa* are present.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were noted.

**Notes**

This type forms small to large patches in a mosaic with taller *A. tridentata tridentata* - *C. viscidiflorus* on stabilized sand (00SD06.02), *C. nauseosus*/*Psoraleidium-Elymus* on longitudinal dunes (00SD06.03), and *A. tridentata wyomingensis*/*Stipa* on bedrock (00SD06.04)

**Plot** 00SD07.01      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Active Sand Dunes

**WYNDD General Cover Type Sampled:** Stable Sand

**NVCS Type:** *Ericameria nauseosa* Shrubland Alliance

**Why was plot done?**

Subjectively selected to illustrate the vegetation on partially stabilized sand. It appear as a grainy, dark area on the 1:24,000-scale b/w aerial photo.

**Vegetation Description**

This is a patchy shrub vegetation of *Ericameria nauseosa* of variable height (< 1 to 2 m) and cover (5% to ca. 70%) but mostly 0.75 - 1 m tall and 40-60% cover. *Chrysothamnus viscidiflorus* is present throughout w/ less cover beneath the tall *E. nauseosa*. The herbaceous undergrowth is patchy. *Psoralidium lanceolatum* dominates and *Elymus lanceolatus* var. *lanceolatus* and *Rumex venosus* are present throughout. It includes patches < 1 acres of *Psoralidium-Elymus* spp (*E. lanceolatus* var. *lanceolatus* and *Elymus* sp. w/ awns) in blowouts. The northern margin in a draw is a fringe of *A. tridentata* *tridentata* ca. 2 m tall.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded.

**Notes**

This type occupies partly-stabilized aeolian sand dunes on various aspects. It occurs in a mosaic with active sand to the S.

**Plot** 00SD07.02      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Wyoming Big Sagebrush Steppe

**WYNDD General Cover Type Sampled:** Sedimentary

**NVCS Type:** *Artemisia tridentata* ssp. *wyomingensis* / *Achnatherum hymenoides* Shrubland association

**Why was plot done?**

Subjectively located to illustrate matrix vegetation on sedimentary dip slope N of aeolian sand. This appears as a grainy, dark area on the 1:24,000-scale b/w aerial photo.

**Vegetation Description**

Grassland of *Hesperostipa comata* with *Poa secunda*. *A. tridentata* ssp. *wyomingensis* to ca. 50 cm tall are scattered throughout, and patches ca. 100 sq m of sagebrush to 1 m tall are present. Cushion plants (mainly *Haplopappus armerioides*) are common on rocky areas. Elsewhere, *Comandra umbellata* and *Phlox hoodii* probably are the most common species.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded.

**Notes**

This is the matrix vegetation on the sedimentary bedrock.

**Plot** 00SD08.01      **Project** Sand Dunes      **Sample Type:** Reconnaissance

**GAP Cover-type Sampled:** Wyoming Big Sagebrush Steppe

**WYNDD General Cover Type Sampled:** Sedimentary

**NVCS Type:** *Artemisia tridentata* - *Atriplex confertifolia* Shrubland association

**Why was plot done?**

Subjectively located to illustrate matrix vegetation at the northern end of the WSA. This appears as a light-colored area on the 1:24,000-scale b/w aerial photo.

**Vegetation Description**

*Artemisia tridentata* ssp. *wyomingensis* forms an open shrub layer < 50 cm tall, with a small amount of *Grayia spinosa* and a few *Atriplex confertifolia* and *Sarcobatus vermiculatus*. *Chrysothamnus viscidiflorus* ca. 25 cm tall is present throughout. *Elymus lanceolatus* (var. *lanceolatus*?) is the most common species in the sparse herbaceous stratum, with *Hesperostipa comata* or *Achnatherum hymenoides* (the two are indistinguishable) sub-dominant. *Phlox hoodii* is common throughout.

**Uncertainty on measurements**

**Completeness of Spp lists**

Only the common species in each stratum were recorded.

**Notes**

May be on aeolian sand veneer. This is the matrix vegetation on broad interfluves, apparently on a veneer of sand over bedrock. It includes patches of short, sparse *Atriplex gardner* - *Artemisia spinescens* dwarf-shrubland, on shale

**Plot** 00SD09.01      **Project** Sand Dunes      **Sample Type:** Classification

**GAP Cover-type Sampled:** Wyo. Big Sagebrush Steppe

**WYNDD General Cover Type Sampled:** Stable Sand

**NVCS Type:** *Ericameria nauseosa* Shrubland Alliance

**Why was plot done?**

Subjectively chosen to illustrate vegetation in dark-colored, grainy patch on 1:24,000-scale black-and-white aerial photo. This is stabilized dune.

**Vegetation Description**

Open herbaceous vegetation with scattered shrubs. *Psoraleum lanceolatum* and *Achnatherum hymenoides* are the most widespread species and contribute most cover. *Rumex venosus* is widespread but minor. Few other species are present. *Ericameria nauseosa* (to 1 m tall) and *Chrysothamnus viscidiflorus* (to 25 cm tall) are scattered throughout the stand. Many of the *E. nauseosa* are dead.

**Uncertainty on measurements**

*Oryzopsis* and *Stipa* are difficult to tell apart because few plants are blooming, so the values for one may include the other.

**Completeness of Spp lists**

Herbaceous list probably is incomplete because the herbs are dry and we missed annuals and early perennials.

**Notes**

Sage grouse droppings are present.

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Scientific and Common Names	NRCS Code	% Cover
<b>Shrub</b>		
chrysothamnus viscidiflorus, green rabbitbrush	chvi8	1.4
ericameria nauseosa, rubber rabbitbrush	erna10	14.1
<b>Graminoid</b>		
achnatherum hymenoides, Indian ricegrass	achy	5.1
hesperostipa comata, needle-and-thread	stco4	0.3
sporobolus cryptandrus, sand dropseed	spr	0.1
<b>Forb</b>		
chenopodium leptophyllum, narrowleaf goosefoot	chle4	0.1
cryptantha fendleri, sanddune catseye	crfe3	0.2
psoralidium lanceolatum, lemon scurfpea	psla3	4.6
rumex venosus, veiny dock	ruve2	0.4
tiquilia nuttallii, nuttall's coldenia	tinu2	0.3



APPENDIX 2. PHOTOGRAPHS FROM THE SAND DUNES WSA.

The photographs are arranged by NVCS vegetation type (Table 5).

Photographs of stands of the *Artemisia tridentata* ssp. *wyomingensis* / *Achnatherum hymenoides* association.

**Image 00GJ02.13**    **Plot**    00SD03.02

**Date**    08/08/20        **Location**    T23N, R104W, Sec 18, SE 1/4

**Photographer**

Amy Shelley

**Vegetation Type**

*Artemisia tridentata* ssp. *wyomingensis* / *Achnatherum hymenoides* association

**Description**

View of vegetation, with George Jones holding microplot



**Image**            **00GJ02.24**                      **Plot**                      00SD06.01  
**Date**    08/10/20            **Location**    T23N R104W, Sec 1, NW 1/4

**Photographer**  
Amy Shelley

**Vegetation Type**  
Artemisia tridentata ssp. wyomingensis / Achnatherum hymenoides association

**Description**  
View of vegetation with G. Jones recording data





**Image**            **00GJ02.29**                            **Plot**                    **00SD06.04**  
**Date**    08/10/20            **Location**    T23N, R104W, Sec 2, NE 1/4

**Photographer**  
George Jones

**Vegetation Type**  
Artemisia tridentata ssp. wyomingensis / Achnatherum hymenoides association

**Description**  
View across stand of Artemisia tridentata ssp. wyomingensis / Achnatherum hymenoides vegetation from Ericameria nauseosa stand on dune ridge, looking south to Artemisia tridentata ssp. tridentata stand on stabilized dunes in distance.



**Image**            **00GJ02.31**                            **Plot**                    00SD07.02

**Date**    08/11/20            **Location**    T24N, R1042, Sec 2, SW1/4

**Photographer**

George Jones

**Vegetation Type**

*Artemisia tridentata* ssp. *wyomingensis* / *Achnatherum hymenoides* association

**Description**

View across stand.



Photographs of stands of the *Artemisia tridentata* ssp. *tridentata* alliance.



**Image** 00GJ02.07    **Plot** 00SD01.01

**Date** 08/08/20    **Location** T23N, R1042, Sec 16, SW 1/4

**Photographer**

Amy Shelley

**Vegetation Type**

*Artemisia tridentata* ssp. *tridentata* alliance

**Description**

Taken from south end of plot, showing stand





**Image 00GJ02.08**    **Plot**    00SD01.02

**Date**    08/08/20        **Location**    T23N, R104W, Sec 16, SW 1/4

**Photographer**

Amy Shelley

**Vegetation Type**

*Artemisia tridentata* ssp. *tridentata* alliance

**Description**

View of stand with G. Jones sampling in plot.



**Image 00GJ02.12**    **Plot**    00SD03.01

**Date**    08/08/20        **Location**    T23N, R104W, Sec 18, SE 1/4

**Photographer**

Amy Shelley

**Vegetation Type**

*Artemisia tridentata* ssp. *tridentata* alliance

**Description**

View of vegetation with G. Jones sampling in plot. Sparse, low shrubs in foreground, and dense, tall shrubs in mid-ground.





**Image 00GJ02.14**   **Plot**   00SD04.01

**Date**   08/09/20      **Location**   T23N, R105W, Sec 12, SE 1/4

**Photographer**

Amy Shelley

**Vegetation Type**

*Artemisia tridentata* ssp. *tridentata* alliance

**Description**

View across stand with Steamboat Mountain and North and South Table Mtns. in the distance. G. Jones sampling in plot.



**Image 00GJ02.28**    **Plot**    00SD06.02

**Date**    08/10/20        **Location**    T23N, R104W, Sec 2, NE 1/4

**Photographer**

G.P. Jones

**Vegetation Type**

Artemisia tridentata ssp. tridentata alliance

**Description**

View of stand with Amy Shelley in plot.



Photograph of one stand of the *Artemisia tridentata* - *Atriplex confertifolia* Shrubland association.

**Image 00GJ02.32**    **Plot**    00SD08.01

**Date**    08/11/20        **Location**    T25N, R104W, Sec 27, SW 1/4

**Photographer**

Amy Shelley

**Vegetation Type**

Artemisia tridentata - Atriplex confertifolia Shrubland association

**Description**

View SE across stand, with active dunes in distance. G. Jones sampling in plot.



Photographs of stands of the *Ericameria nauseosa* Shrubland alliance.



**Image**            **00GJ02.19**                            **Plot**                    00SD04.06  
**Date**    08/09/20            **Location**    T23N, R104W, Sec 6, NW 1/4

**Photographer**

G.P. Jones

**Vegetation Type**

*Ericameria nauseosa* Shrubland alliance

**Description**

View to N, looking up and across slope, at sparse vegetation of *Psoralidium lanceolatum* with scattered *Ericameria nauseosa*. Note stand of tall, dense (*Artemisia tridentata* ssp. *tridentata*) in background.





**Image**            **00GJ02.21**                      **Plot**                      00SD04.07  
**Date**    08/09/20            **Location**    T23N, R105W, Sec 1, NE 1/4

**Photographer**  
Amy Shelley

**Vegetation Type**  
Ericameria nauseosa Shrubland alliance

**Description**  
View across stand with G. Jones sampling in plot.



**Image 00GJ02.23**    **Plot**    00SD06.03

**Date**    08/10/20        **Location**    T23N, R104W, Sec 2, NE 1/4 of

**Photographer**

G.P. Jones

**Vegetation Type**

Ericameria nauseosa Shrubland alliance

**Description**

View of shrub stand from across draw ca. 1/4 mile to E. Note active sand in distance.





**Image 00GJ02.30**    **Plot**    00SD07.01

**Date**    08/11/20        **Location**    T24N, R104W, Sec 2, NE 1/4 of

**Photographer**

G.P. Jones

**Vegetation Type**

*Ericameria nauseosa* Shrubland alliance, *Artemisia tridentata* ssp. *wyomingensis* shrub-steppe

**Description**

View of *Artemisia tridentata* ssp. *wyomingensis* shrub-steppe in foreground, with *Ericameria nauseosa* shrub stand in distance (yellow-green color), on stabilized sand.



**Image**            **00GJ02.33**                      **Plot**                      00SD09.01  
**Date**    08/11/20            **Location**    T24N, R105W, SEC 13, SE 1/4

**Photographer**  
Amy Shelley

**Vegetation Type**  
Ericameria nauseosa Shrubland alliance

**Description**  
View across stand with G. Jones sampling in plot



Photographs of stands of the *Distichlis spicata* - (*Scirpus nevadensis*) Herbaceous Vegetation association.



**Image** 00GJ02.09 **Plot** 00SD02  
**Date** 08/08/20 **Location** T23N, R104W, SEC 17, SE 1/4

**Photographer**

G.P. Jones

**Vegetation Type**

*Distichlis spicata* - (*Scirpus nevadensis*) herbaceous association

**Description**

View of low, sparse *Distichlis* vegetation in center with shrubs (*Sarcobatus vermiculatus*, *Artemisia tridentata* ssp. *tridentata*) on slightly higher spots.



**Image 00GJ02.10**    **Plot**    00SD02

**Date**    08/08/20        **Location**    T23N, R104W, SEC 17, SE 1/4

**Photographer**

G.P. Jones

**Vegetation Type**

Distichlis spicata - (Scirpus nevadensis) herbaceous association

**Description**

View of low, sparse Distichlis vegetation in center with shrubs (Sarcobatus vermiculatus, Artemisia tridentata ssp. tridentata) on slightly higher spots.





**Image**            **00GJ02.11**                      **Plot**                      **00SD02**  
**Date**    08/08/20            **Location**    T23N, R104W, SEC 17, SE 1/4

**Photographer**

G.P. Jones

**Vegetation Type**

Distichlis spicata - (Scirpus nevadensis) herbaceous association

**Description**

View of low, sparse Distichlis vegetation in center with shrubs (Sarcobatus vermiculatus, Artemisia tridentata ssp. tridentata) on slightly higher spots.





**Image**            **00GJ02.15**                      **Plot**                      00SD04.02  
**Date**    08/09/20            **Location**    T23N, R104W, SEC 7, NW 1/4

**Photographer**

G.P. Jones

**Vegetation Type**

*Distichlis spicata* - (*Scirpus nevadensis*) herbaceous association

**Description**

Looking E, with *Juncus balticus* dominating in center of photo, and *Distichlis stricta*, and some *Sarcobatus vermiculatus* behind (light color). *Artemisia tridentata* ssp. *tridentata* - *Chrysothamnus viscidiflorus* shrub vegetation on stabilized dune in distance.



**Image 00GJ02.16**   **Plot**   00SD04.03

**Date**   08/09/20      **Location**   T23N, R104W, SEC 6, SE 1/4

**Photographer**

G.P. Jones

**Vegetation Type**

*Distichlis spicata* - (*Scirpus nevadensis*) herbaceous association

**Description**

Looking SE. Dark patches are *Juncus balticus* - *Glaux maritima* in low spots. Note stabilized dunes (*Artemisia tridentata* ssp. *tridentata* and *Ericameria nauseosa* shrub vegetation) and active dunes in background.





**Image 00GJ02.20**   **Plot**   None

**Date**   08/09/20      **Location**   T23N, R104W, SEC 6, NW 1/4

**Photographer**

G.P. Jones

**Vegetation Type**

*Distichlis spicata* - (*Scirpus nevadensis*) herbaceous association?

**Description**

Ponds between dunes, with *Juncus balticus*, *Scirpus pungens*, and *Carex* spp. in narrow zones around them.



Photographs of sparse vegetation in active sand dunes.

**Image**            **00GJ02.17**                            **Plot**                    00SD04.05

**Date**    08/09/20            **Location**    T23N, R104W, SEC 6, S 1/2

**Photographer**

G.P. Jones

**Vegetation Type**

Active sand

**Description**

View looking S across patch of *Elymus simplex* var. *luxurians* in active sand.



**Image 00GJ02.18**    **Plot**    00SD04.05

**Date**    08/09/20        **Location**    T23N, R104W, SEC 6, S 1/2

**Photographer**

G.P. Jones

**Vegetation Type**

Active Sand

**Description**

View looking E at *Psoralidium lanceolatum* patch with some *Elymus simplex* var. luxurians. Note exposed rhizomes.

