LANDFIRE Biophysical Setting Model

***Biophysical Setting* 3811480 Western Great Plains Sand Prairie**

☐ *This BPS is lumped with:*
☐ *This BPS is split into multiple models:* *Please see Adjacency/Identification Concerns box for areas and system types that might resemble this system but should be mapped as another system.*

General Information

Contributors (also see the Comments field) **Date** 4/24/2007

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Vegetation Type
Upland Grassland/Herbaceous

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Dominant Species
ANHA
CALO
SCSC
BOGR2
BOHI2
HECO26
SPCR

Map Zone
38

Model Zone
☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Hawaii
☐ Northeast
☑ Northern Plains
☐ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Geographic Range

Nebraska Sandhills Prairie is found in central and western NE, south central SD covering approximately 5.5 million ha (Bleed and Flowerday, 1990).

For MZ31, this BpS is located in ECOMAP section 332 and Subsections 332Cd, 332Ca and 332Cb.

In MZ38, this BpS is located in subsections 332Ce, 332Cb and 251Ha as small outliers from the main Nebraska Sandhills region.

Biophysical Site Description

Within the last 10,000yrs, much of this area is thought to have shifted between active dune fields and more stabilized, grass-covered dunes depending on shifts in climate and changes to disturbance regimes. The area is dissected by several rivers, and includes wetlands, wet prairies, and fens which increase in frequency from east to west. The Sandhills are the primary recharge area for the Ogallala aquifer maintaining one of the most consistent groundwater levels in the world. Soil types shift from sands in the west and on uplands, to sandy loams and loams further east and in floodplains. Soils in the Sandhills are generally often undeveloped and highly permeable. Blowouts and sand draws characterize some of the wind-driven disturbances of the region. When disturbed, the fragile nature of the soils can profoundly impact vegetation composition and succession within this system. On a coarse scale, the system may be divided into riparian, sands, choppy sands, and dry valleys, each of which supports slightly different fire behavior and vegetation dynamics. Generally, dry valleys, sands, and choppy sands may be combined for modeling purposes.

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

The distribution, species richness and productivity of plant species within the sand prairie ecological system are controlled primarily by environmental conditions, in particular the temporal and spatial distribution of soil moisture and topography.

Soils in the sand prairies can be relatively undeveloped and are highly permeable. Soil texture and drainage along with a species' rooting morphology, photosynthetic physiology, and mechanisms to avoid transpiration loss are highly important in determining the composition and distribution of communities/associations within the sand prairies. Another important aspect of soils in the sand prairies is their susceptibility to wind erosion. Blowouts and sand draws are some of the unique wind-driven disturbances in the sand prairies, particularly the Nebraska Sandhills, which can profoundly impact vegetation composition and succession within this system. The unifying and controlling feature for this system is that coarse-textured soils predominate and the dominant grasses are well-adapted to this condition. Soils in the sand prairies can be relatively undeveloped and are highly permeable (NatureServe 2007).

This tallgrass system is found primarily on sandy and sandy loam soils that can be relatively undeveloped and highly permeable as compared to Western Great Plains Tallgrass Prairie (CES303.673), which occurs on deeper loams. This system is usually found in areas with a rolling topography and can occur on ridges, midslopes and/or lowland areas within a region. It often occurs on moving sand dunes, especially within the Sandhills region of NE and SD (NatureServe 2007).

It is not advised to include other sand prairies in this description unless they have a similar substrate and climate. The Nebraska Sandhills Prairie is made up of sands than can exceed 300ft in depth – not soil, but sand, so the hydrology and geomorphology of these areas – particularly the long-term aspects, would differ significantly from other sand prairies. Also, the geomorphology of the area and paleogeomorphology has led to ecological patterns unique to these areas.

Vegetation Description

Dominant vegetation includes Prairie Sandreed (Calamovilfa longifolia), Sand Bluestem (Andropogon halii), Little Bluestem (Schizachyrium scoparium), Blue Grama (Bouteloua gracilis), Hairy Grama (B. hirsuta), Needle and Thread (Stipa comata), Sand Dropseed (Sporobolus cryptandrus). Rooting morphology, photosynthetic pathway (C3 or C4) and mechanisms to avoid transpiration loss are important plant characteristics that may account for the composition, distribution, and productivity of plant communities in the Sandhills (Bragg, 1997).

Disturbance Description

Fire, grazing and drought were the primary disturbances in the Nebraska Sandhills. Disturbances were cyclic with the earliest and latest seral stages fluctuating widely on a scale of centuries in accordance with changes in climate.

Grazing: The principal large grazer of the sandhills was most likely bison (Bison bison) which, when occurring in large numbers, would have locally disturbed large areas due both to grazing impact and physical disturbances such as trampling and wallowing.

Another ubiquitous grazer of the Sandhills would have been the plains pocket gopher (Geomys bursarius). Pocket gophers graze largely below ground but their activities also result in localized areas of bare sand. Gopher diets are strongly linked to forbs thus having an effect on species composition.

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Grasshopper outbreaks can be significant in some years (i.e. summers following drought years). They presumably consume a significant amount of herbage. This was not modeled, however, due to the limited extent. It might limit fire extent in years when they are present in large numbers, however. They were not modeled, due to lack of data.

Prairie dog towns were a minor component of the Sandhills landscape occurring where soils were finer textured and in flat uplands and in valleys and the eastern Sandhills where the water table was not high. Unlike elsewhere in the Great Plains mixed and shortgrass prairie, prairie dog towns in the Sandhills are believed to have persisted for decades (20-80yrs) rather than centuries. As prairie dog towns become established in an area, short-statured ecotypes of taller grasses and forbs predominated and plant composition is likely to have shifted from mixedgrass species, such as Little Bluestem, to shortgrass species, such as Hairy Grama and Buffalo grass, and annual forbs.

Prairie dog towns were mostly located only in areas of finer textured soils primarily in the eastern areas of the sandhills or in low areas well above the water table. Where they occurred, prairie dogs grazed vegetation close to the ground; this provided a local firebreak. These towns were unlikely to persist for more than a few decades due to the dynamic characteristics of the sandhills system. Prairie dog grazing separately was therefore not modeled for this system.

Prairie dog towns probably moved with the dunes –meaning, that as a dune/valley system shifted, the dogs would probably have shifted with them, occupying the same place on the landscape. One difference between PDogs and other grazers is that they are more stable in where the grazing occurs for longer periods of time (that is, of course, making assumptions about the habits of bison grazing historically in the Sandhills). Prairie dogs are currently present on the Bessey and McKelvie units (near Halsey and Valentine, respectively), although they are not and never would be as widespread as in other grasslands north, south, and west. The impact of prairie dogs on the landscape is out of proportion to the percent of area on the landscape they occupy…a keystone species affecting the movement/area affected by at least two other significant disturbances, grazing and fire (Mary Lata, USFS, pers comm.).

Fire: The most extensive fires are likely to have occurred in years with wet springs followed by hot, dry summers when grazing pressure was low. Wet springs would have resulted in more productive and more continuous plant cover (i.e. fuel) that would have supported and expanded fires ignited under dry conditions occurring later in the season. In addition, litter accumulation over several fire-free years would also have supported widespread fire, in any conditions. The litter component, a determining factor in fire size and frequency, is correlated with seral stage. One to five or seven fire-free years produce enough litter to carry another fire. Average rainfall changes by around 10in a year from Alliance to Greeley. It takes longer for continuous litter to accumulate in the sandhills – many areas never do produce continuous litter. Post-fire shifts in species composition depend on the timing and characteristics of a fire. Maximum temperature differences of only 20 degrees C, for example, can change the response of various species to a fire (Lata 2006).

Furthermore, seasonal timing is a major factor determining fire response in systems with both C3 and C4 components. For example a spring fire during the C3 growing season will suppress those species, and often enhance later C4 growth. A late winter fire, before C3 growth begins, has the potential to enhance C3 growth, which may suppress later C4 growth.

In Sandhills prairie, most pixels would be 100% black after fire; therefore, it was modeled as replacement fire. Mixed or low fires could potentially occur on many pixels if: 1. burning under lower end conditions

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(cooler, damper, lower wind speed), and 2. more importantly, heavier grazing had disrupted fuel continuity, resulting in a "patchy" burn. Patches could be small to large, i.e. square feet to 100s of ac. However, mixed and low severity fires were not modeled for this system. Fires burn when there is some moisture in the ground, minimal wind, miscellaneous small natural fire breaks (open sand from gophers, for instance), and/or backing fires…areas that burn patchily. There is less 'top burning' in sandhills fire than in more continuous grasslands because the litter component is so much less contiguous.

Drought: Extended periods of severe drought is likely to have affected both species composition and the stability of the sandhill soil, particularly when compounded by temperature, wind and heavy grazing. These conditions may have lead to the development of blowouts making it difficult for vegetation to re-establish quickly. The occurrence of Blowout penstemon (Penstemon haydenii) suggests long periods when blowouts were common across the landscape although causes resulting in this feature have not been determined

Wind: Another important aspect of this system is its susceptibility to wind erosion. Blowouts and sand draws are some of the unique wind-driven disturbances in the sand prairies, particularly the Nebraska Sandhills, which can profoundly impact vegetation composition and succession within this system. Fire and grazing constitute the other major disturbances that can influence this system (NatureServe 2007). Wind plays a bigger role in sand-based landscapes, but the more significant events occur in conjunction with others that remove cover – drought, trampling, heavy grazing, fire, etc. Wind was therefore not modeled separately.

Heavy grazing, fire and trampling that leads to the removal of vegetation within those areas susceptible to blowouts can either instigate a blowout or perpetuate one already occurring (NatureServe 2007).

The response to disturbance in the Nebraska Sandhills should differ significantly from other sandy sites, since there is little soil structure to renew if it is physically disturbed (such as herds of bison) but, for that same reason, does not compact as other soils do in response to the same disturbance.

Adjacency or Identification Concerns

The Sandhills are dissected by riparian areas which provided fire breaks and affected the movement of bison herds.

Riparian areas include both the Loup River system draining the eastern Sandhills, and several areas of mixed wetland complexes that include areas ranging from sub-irrigated grasslands to deep, open-water lakes of up to several square miles area. The wetland areas will be included within 1495 Depressional Wetlands or within an adjacent tallgrass system.

The sandhills in MZs 39 and 40 would be quite different from the Sandhills in MZ31 in NE. The sandhills in MZ39 should probably be called midwestern sand prairie, as they have western fringed orchids - not much like the sandhills. Valentine National Wildlife Refuge in north central NE might be like the midwestern sand prairie with the orchids, however.

ECOMAP subsection 332Dg area is sometimes erroneously lumped with sandhills, but instead should be broken out as "sand plains." The sand plains area is nearly flat, with shallow groundwater and much subirrigated area and is rather tallgrass or mixedgrass. Likewise, central NE Loess Hills primarily in subsection 332Cc often is also erroneously confused with sandhills. The southeast boundary of sandhills with Loess Hills is diffuse with soil texture varying from one small divide to the next. Vegetation in the

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Loess Hills is overall similar to Sandhills, but Loess Hills is more productive historically and in potential veg and therefore should not be classified as Sandhills but rather a grass system (John Ortmann, TNC, pers comm). (Current conditions in Loess Hills grassland system is degraded by chronic improper grazing with lots of C3 exotic grasses having replaced former C4 dominants).

Note that there are Sandhills wetlands, but they are very small; some should be included within BpS 1495 Western Great Plains Depressional Wetland Systems, but some should just be lumped with an adjacent system such as tallgrass prairie.

As 1148 spreads north to 331F, where there are tallgrass, mesic sandy prairies, still having CALO and ANHI as dominants, and sandy inclusions south of the Black Hills in 331Fb and Buffalo Gap, we could use this 1148 NE model for it, or apply 1094 as more appropriate.

For the drier, coarser soiled prairies in central SD, that are sandy, these should be considered part of 1132. Loess Hills area in 332Cc should also be part of 1132.

In ECOMAP subsection 332Dg, sand plains in northwestern NE should be put into the adjacent grassland system.

In ECOMAP section 332 and 251 (MZ39) - put these sand prairies into 1420 Northern Tallgrass or 1412 N-C Interior Sand Gravel Tallgrass.

For the sand prairie of the Sheyenne Grasslands in southeast ND - put those areas into 1412.

It is likely that uplands today support more herbaceous vegetation than in pre-settlement times. There would be more of class C on the landscape today and less of classes A and B today. This is the result of the first phase of fire suppression and also of local range-management practices that leave adequate cover to prevent wind disturbance of the soil during the dormant season (winter). The Sandhills contain a significant shrub component is some topographical positions (i.e. north aspects of dunes and small protected pockets in the roughest, choppiest dunes). These areas not only provide a more favorable microclimate for woody species, but probably were somewhat fire resistant due to micro-climate and landscape position. Primary shrub species are plums (Prunus spp.) and smooth sumac (Rhus glabra). Both appear to be controlled by longer term moisture cycles, i.e., clones reduce in extent and vigor during drought cycles and rebound during wet cycles. Both species resprout vigorously after fire. Eastern redcedar also is increasingly common in the Sandhills, particularly east of the 101st meridian where surface soil moisture is more often favorable for germination and establishment of bird-vectored seeds. Although a form of eastern redcedar, perhaps intergraded with Rocky Mountain juniper, was native to very restricted areas in and around the Sandhills, modern weed trees are more likely derived from widespread windbreak plantings of selected hardy trees. Major planting began in the 1950s and continues today, introducing cedar to areas that are locally cedar free. When windbreaks begin to bear seed at about 10yrs of age, the first seedlings appear on the more favorable sites of north aspects of steep dunes. Later, as more seed producing trees infest the landscape, the increased seed rain allows some seedlings to establish in other landscape positions, continuing a progression that can be expected to lead to canopy closure over perhaps 50yrs, in the absence of control measures, or catastrophe, such as wildfire.

The Sandhills are remarkably resistant to exotic invasion. Leafy spurge is troublesome in lower, wetter areas and is showing some tendency to move into uplands. See remarks on "exotic" cedars above. In addition, Kentucky bluegrass can dominate in small patches at the base of north-facing dunes, often near

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or under shrub patches.

There might be more rhizomatous grasses now (Mary Lata, USFS, pers comm).

Although greater than 90% of the Sandhills region is privately owned, the known fragility of the soils and the cautions used by ranchers to avoid poor grazing practices have allowed for fewer significant changes in the vegetation of the Sandhills compared to other grassland systems (NatureServe 2007).

Native Uncharacteristic Conditions

See comments under "ID concerns."

Scale Description

Droughts could affect the entire region, but deep-percolation of precipitation in the coarse-grained sandy soils would have ameliorated the effects of moderate or short droughts in the uplands. The shallow water table would have protected vegetation of the lowland valleys from the effects of short droughts. During drought periods, grazing pressure would be more concentrated near water sources.

Issues/Problems

Very little data are available from presettlement times, but written accounts describe a much more sparsely vegetated landscape. However, these accounts often followed bison paths which would bias estimates of landscape cover towards more sparse vegetation. The presence of Blowout penstemon (Penstemon haydenii), a species endemic to blowouts indicates that bare sand in some form has been present in the area for some time.

Comments

For MZ38 this model was adopted from the same BpS in MZ31 by Randy Swaty (rswaty@tnc.org). Only minor editing of the description was done to fit the geographic range to MZ43 so modelership was not changed.

This model for MZ31 was adapted from the model from the RA: R4NESP Nebraska Sandhills Prairie created by Tom Bragg, Mary Lata, Dave Shadis and reviewed by John Ortmann. Model modified quantitatively and descriptively for MZ31. Co-Regional Lead for MZs 31, 39 and 40 modified model and combined classes with modelers' agreement.

Vegetation Classes

Class A **22 %**

Early Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species and Canopy Position

SPCR
Upper
SCSC
Upper
REFL
Upper
MUPU2
Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Herb 0m	Herb >1.1m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Class A (0-999yrs) represents a mix of bare sand, including blowouts and sand draws, and extensive areas of sparse vegetative cover. Once, bared, wind and shifting sand would cause a continued disturbance inhibiting

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the establishment of annual vegetation. In some years, timely rains and short (1-2 weeks) periods of relative calm winds would have allowed germination and establishment of sufficient annuals to stabilized sand and begin movement to class B. Wind was therefore modeled with a probability of .2 taking it to class B (advancing age potentially just one year).

Class B **59 %**

Mid Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

1

Indicator Species and Canopy Position

ANHA
Middle
SCSC
Mid-Upper
CALO
Upper
BOHI2
Lower

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	21 %	70 %
Height	Herb 0m	Herb >1.1m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Class B (1-10yrs) represents immediate to three-to-ten year post disturbance conditions. Vegetation consists of resprouting and seedling grass and forbs and maturing. Total bare soil is greater than before the disturbance particularly on upper slopes and dune tops. The vigor of new growth and the specific species affected depend on the season of the disturbance and on pre- and post-disturbance environmental conditions (e.g. available soil moisture).

Litter is low initially but increases until, by year three, there is enough to support fire under average burning conditions. In uplands, where soil-type is dominated by coarse-grained sands with low water-holding capacity, post-disturbance primary production initially decreases thus fire may only carry under ideal conditions. In the later years of this class, fire will carry. Replacement fire was modeled with an approximate eight year return interval, half the time bringing the class back to class A and half the time maintaining this stage.

Under these conditions, grazing is likely to be light in the first few years. In lowlands, with finer-textured soils, primary production is determined largely by moisture availability. Repeated grazing of these areas will prevent succession to class C. In the later part of this stage, there would be moderate grazing by native ungulates and insects. Grazing was modeled with an approximate overall five-to-ten year return interval.

Drought, unusually severe fire conditions, or unusual grazing pressure allows the possibility of regression to class A. (Only replacement fire was modeled as bringing this class back to A.)

Class C **19 %**

Late Development 1 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

3

Indicator Species and Canopy Position

ANHA
All
CALO
Upper
SCSC
Middle
SPCR
Mid-Upper

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	71 %	100 %
Height	Herb 0m	Herb >1.1m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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Class C (11-999yrs) Grasses are well established averaging 85-95% cover in uplands (Bragg 1998), but occurring with as low as 40% canopy cover in some locations. Canopy cover may reach 100% in wetter low areas. Litter accumulates providing continuous fuels for fires thereby increasing the probability of larger fires. This stage rarely persists more than 10yrs but, when it does, woody species such as chokecherry (Prunus virginiana), snowberry (Symphoricarpos occidentalis), and smooth sumac (Rhus glabra) may begin to become established in more protected areas. Since woody plants shade herbaceous species, some disturbance – for example fire or drought – is required to revert this class to an earlier one.

Replacement fire occurs with an approximate return interval of six years, most of the time causing a transition to class B, but sometimes causing a transition to class A.

Grazing occurs on 10% of this class each year and causes a transition back to class B.

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

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Fire Regime Group:** II

Historical Fire Size (acres)

Avg 7000
Min 1
Max 500000

Sources of Fire Regime Data

- [x] Literature
- [x] Local Data
- [x] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	10.34	2	20	0.0967	100
Mixed					
Surface					
All Fires	10			0.09672	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

Additional Disturbances Modeled

- [ ] Insects/Disease
- [x] Wind/Weather/Stress
- [x] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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