Appendix A: Why Herb Species Composition is an Important Element of Wildlife Habitat

— Wildlife Forage —

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ABSTRACT

A central upshot of this report is that a natural or relatively-natural herbaceous species composition is crucial to maintaining suitable foraging habitat for native ungulates, sensitive species, management and ecological indicator species (MIS), migratory birds, and other wildlife — in addition to maintaining suitable cover — and it assumes a relatively-natural mix of succession age classes is maintained[1]. There are several reasons why it is crucial to define suitable herbaceous species composition for wildlife as a relatively-natural herbaceous species composition:

1. Plant species composition dictates the vegetation structure that is produced during the growing season, and vegetation structure is highly important to wildlife (specifics of this are addressed elsewhere).

2.a. Known forage preferences and dietary needs of the many dozens of species of mammals and birds in the project area —with respect to leafy forage, seeds, and flowers — encompass a very large number and variety of grass, forb, and sedge species.

2.b. While forage preferences and diets of elk and mule deer are fairly well understood, preferred herbaceous forage species (for leafy forage, seeds, and flowers) of many mammal and bird species are not very well understood.

3.a. There is limited understanding of the invertebrate prey species of many bird, bat, shrew, reptile, and amphibian species, and less understanding of the seasonal needs for particular invertebrate species.

3.b. There is limited understanding, at best, of the occurrence of individual invertebrate species in the project area, seasonality, dependence of individual invertebrate species on or preferences for specific herbaceous species, and other habitat relationships.

4.a. While the vertebrate-prey preferences of many predatory mammal and bird species are well understood, they are not fully known for all predatory mammal and bird species.

4.b. Dietary needs and forage preferences and other habitat needs of many small mammal, bird, reptile, and amphibian (prey) species are not fully understood (see 2.b and 3.b, above).

5. There are far too many species of birds, mammals, reptiles, amphibians, and invertebrates that depend on the leaves, seeds, and flowers of specific herbaceous species to attempt to determine and manage for compositions of individual grass, sedge, and forb taxa for particular wildlife species or groups of species.

6. Even if sufficient information were to be available on specific forage/prey needs of all mammal, bird, reptile, and amphibian species in the project area, it would be virtually impossible to determine a composition of herbaceous plant species that balances these needs, by plant community type, and to attempt to manage for this.

7. Even if it were possible to determine a composition of herbaceous plant species that balances the herbaceous needs of all vertebrate and invertebrate species, by plant community type, it is almost certain that a relatively-natural herbaceous species composition by plant community type would be identified. This is because the wildlife community that developed in this part of the Rocky Mountains did so under the habitat conditions — including plant species composition — that existed here.

These likely are some of the very reasons the architects of the 2012 Planning Rule came to the conclusion that "…native species evolved and adapted within the limits established by natural landforms, vegetation, and disturbance patterns prior to extensive human alteration. Maintaining or restoring ecological conditions similar to those under which native species have evolved therefore offers the best assurance against losses of biological diversity and maintains habitats for the vast majority of species in an area, subject to factors outside of the Agency's control, such as climate change…" (USDA 2012:21212). Also, "The Department's intent in

[1] The assumption of a relatively-natural mix of is important because the mix of succession age classes defines the distribution, size, and juxtaposition of plant communities across the landscape, and plant species composition is typically addressed within plant communities.

providing the requirements in this section [e.g., coarse-filter/fine-filter approach] is to provide for diversity of plant and animal communities, and provide ecological conditions to keep common native species common, contribute to the recovery of threatened and endangered species, conserve candidate and proposed species, and maintain viable populations of species of conservation concern within the plan area" (USFS 2012:21212).

Given direction in the 2012 Planning Rule, the large number and variety of herbaceous species needed by vertebrate wildlife and their prey, and the many unknowns, the watershed/erosion-control potential ratings outlined in Exhibit 01 of R4 AMENDMENT 2209.21-2005-1 make a poor indicator of wildlife habitat quality with respect to herbaceous species composition. It being a poor indicator of wildlife habitat quality is further outlined in the "Applicability of R4 Watershed Species" section.

The purpose of the information in the remainder of this report is to present lists of herbaceous species eaten by or used for nectar by a few representative species and groups of vertebrate and invertebrate species, and to briefly summarize the importance of approximating a relatively-natural plant species composition for several other groups of wildlife species.

ROCKY MOUNTAIN ELK AND MULE DEER

Grasses and Sedges

There is considerable overlap in the graminoid species consistently selected by native ungulates and the graminoid species identified by NRCS (2008) and Youngblood et al. (1985) as being representative of or consistently found in mountain big sagebrush, mountain shrubland, grassland, silver sagebrush, and meadow plant communities that are in relatively-natural condition (i.e., potential natural plant community, historic climax plant community). Given this large overlap, the plant species compositions generally described in NRCS (2008) for historic climax plant communities would provide suitable conditions for native ungulates. Furthermore, early-successional plant communities resulting from fire or mechanical treatments would produce similar plant species compositions, except at higher abundances/canopy cover.

In graminoid-dominated plant communities and understories, a substantive composition of bluebunch wheatgrass, Idaho fescue, needlegrasses (spp.), blue wildrye, blue wildrye, mountain brome, bluejoint reedgrass, elk sedge, riparian sedges, and other native graminoids — as exists in a natural species composition — would contribute substantively toward meeting seasonal needs of elk (Table 1) and, to a lesser extent, mule deer (Tables 5.a and 6). Bluebunch wheatgrass and Idaho fescue as a herbaceous forage favored by elk and mule deer is well documented (Tables 1, 2, and 3; see also Anderson and Scherzinger 1975, Dietz and Nagy 1976, Miller et al. 1981, Dragt and Havstad 1989). Elk use a wide range of grass species (Table 2a only shows a relatively small portion of species) and, while elk show preference for some grass species throughout the year, they show preference for some species only seasonally. Mule deer also use a wide range of grass species (Tables 5.a), but the composition of grass in mule deer diets is lower than it is for elk. A larger variety of grasses appear to be used by mule deer during summer months, but grasses comprise a larger component of their diet during spring and fall. In northeastern Oregon, Miller et al. (1981) found Sandberg's bluegrass — the earliest to initiate growth — to be the most grazed grass species by deer and elk in March, with bluebunch wheatgrass, Idaho fescue, Kentucky bluegrass, and timothy also being favored at this time; this is consistent with Tables 1 and 2. These grasses comprised a large part of the diet through mid-May and forbs comprised nearly half of deer and elk diets at this time. Sandberg's bluegrass may be the species found on wind-blown ridges used by mule deer and elk on the district during winter and early spring.

Elk and mule deer show preference for several nonnative species, including orchardgrass, timothy, Kentucky bluegrass, smooth brome, and cheatgrass. So long as naturalized non-native plant species fill roles or functions of native species and so long as they are species that do no tend to dominate communities, they would be considered satisfactory from the standpoint of elk and mule deer. There area at least two reasons why Kentucky bluegrass, smooth brome, and cheatgrass are not satisfactory, despite elk and mule deer showing preference for

Table 1. Relative seasonal values of graminoids eaten by Rocky Mountain elk, compiled by Cook (2002:286-288). Of the 79 grass and sedge species and genera listed by Cook, the following are some of the commonly found species and genera in major plant communities on the Greys River Ranger District, as indicated in the left column. The right-hand column indicates the number of references listed by Cook; see his paper for literature cited.

Plant Community[A]	**Species**	**Consumption Ranking**[B] **by Season**				**No. of Refs.**
		Spring	**Summer**	**Fall**	**Winter**	
	Natives	[C]				
sb,ms,a,g,ss,m	Bluebunch wheatgrass	+	+	+	++	20
sb,ms,a,g,ss,m	Slender wheatgrass		–	+	++	1
sb,ms,g,ss,m	Idaho fescue	++	+	++	+	22
sb,ms,g	Spike fescue		+			2
sb,ms,a,g[D]	Needlegrass spp.	++	+	+	++	5
sb,ms,g,m	Nelsons / Columbia needlegrass[E]		–		++	2
sb,ms,g	Needle-and-thread	+	–	+	+	3
?	Canada wildrye		+			1
sb,ms,g,ss,m	Blue wildrye	+	++	++	–	4
sb,ms,a,g,m	Prairie junegrass	+	+	++	+	10
ss,m	Alpine timothy	+	+			3
sb,ms,g	Sandberg's bluegrass	+	–	+	+	5
sb,g	Indian ricegrass			++	+	2
c	Pinegrass	+	+	–	+	4
f,a,ss	Mountain brome	+	++	+	++	6
f,a,m	Showy (purple) oniongrass		+			2
ss,m	Tufted hairgrass		0			2
ss,m,wm	Bluejoint reedgrass	–	+	–	++	4
m,ss,wm[C]	Sedge spp.	–	+	+	+	16
sb,ms,g,m	Elk sedge	+	+	++	++	11
wm	Baltic rush		++			1
	Nonnatives					
sb,ms,g,m	Intermediate wheatgrass		–		+	2
sb,ms,a,g,ss,m	Smooth brome	+	+	+	++	3
sb,ms,g	Cheatgrass	–			+	4
sb,ms,a,g,m	Orchardgrass	+	+			3
sb,ms,a,g,ss,m	Timothy	++	–	++	+	6
sb,ms,a,g,ss,m	Bluegrass spp.[F]	++	+	++	+	13
m	Bulbous bluegrass				+	1
sb,ms,a,g,ss,m	Kentucky bluegrass	+	++	++	++	3

[A] Species that are representative of or common in particular plant communities, as identified in NRCS (2008) for big sagebrush (bs), mountain shrubland (ms), grassland (g), silver sagebrush (ss) and meadow (m) communities; Youngblood et al. (1985; e.g., Appendix B) and Padgett et al. (1989; e.g., Appendix B) for silver sagebrush and meadow communities; and Gregory (1983) and O'Brien et al. (2003) for forbland (f) and aspen (a) communities. Conifer communities (c).

[B] Based on average amounts reported, with – = light, + = moderate, and ++ = high use.

[C] Blanks mean that information was not presented in the source document for this cell, which could potentially mean no more than a trace during the respective season.

[D] One or more species from the identified taxa are representative species.

[E] Also known as subalpine needlegrass.

[F] Appears to include native and nonnative species of bluegrass.

them. First, they tend to dominate plant communities at the exclusion of other plant species, which greatly reduces the ability of plant communities to provide a wide range of grass and forb species. Plant species richness is one of the most important attributes of plant communities for ungulate foraging, including providing for seasonal needs (Tables 1, 2, 4, and 5). Second, some species like Kentucky bluegrass and orchard grass are grazed down fairly quickly in many areas upon the initiation of cattle grazing that they effectively become unavailable as forage for native ungulates.

Table 2. Relative seasonal values of grasses eaten by mule deer, compiled by Kufeld et al. (1973). Of the 67 species and 17 genera of grasses and sedges listed by Kufeld et al. (1973:Table 4) (a total of 84 rows of information), the following are some of the commonly found species and genera in forbland, big sagebrush, meadow, and aspen communities on the Greys River Ranger District. The right-hand column indicates the number of references listed by Kufeld et al. (1973). Table 4 of their paper lists the actual literature references, and the table also identifies the number of references for each season. Increaser species are also included for comparison.

Plant Communities	**Grass/Sedge Species**	**Consumption Ranking[B] by Season**				**No. of Refs.**
		Spring	**Summer**	**Fall**	**Winter**	
	Representative Species					
sb,ms,a,m	Bluebunch wheatgrass	–	t	t –	+	8
sb,ms,m	Idaho fescue	+			+	5
sb,ms,m	Letterman needlegrass		t –			2
sb,ms,m	Columbia needlegrass		t –	+		1
sb,ms,m	Spikefescue		t		t –	2
sb,ms,a,m	Slender wheatgrass					*
f,sb,ms,a	Mountain brome					*
sb,ms,a,m	Prairie junegrass	+	t +	t	t	7
ss,m	Foxtail barley		t			1
f,sb,ms	Sandberg's bluegrass	++	t	t +	+	4
	Spike trisetum		t			1
m	Tufted hairgrass		t			1
sb,ms,g,ss,m	Wheatgrass spp. (old Agropyron)	+	t	++	+	9
sb,ms,a,g,ss,m	Bluegrass spp.	t +	t	t	t –	13
m,wm	Carex spp.	t –	t +	t +	t –	15
	Nonnative Species					
sb,ms,a,ss,m	Kentucky bluegrass	t	–			6
sb,ms,a,ss,m	Smooth brome		+			1
sb,ms,a,ss,m	Timothy	+	t	t	+	4
sb,ms,a,m	Orchardgrass	+	+			2
sb,ms	Cheatgrass	+	t	+	+	13

[B] Based on average amounts reported, with t = trace, – = light, + = moderate, and ++ heavy use relative to other species eaten. Two symbols means a range from the first to the second.

* No data provided in Kufeld et al. (1973). This may be a result of the species not being present on any of the study areas or of very low availability, or it could mean that the species was present, but just not selected.

Table 3. Relative values of several grasses as forage for mule deer, from Peek (1996:185). Peek's valuation of these grass species as forage for cattle is also included below. Only plant species occurring on the Greys River Ranger District are included, and those that are representative of certain plant species are indicated in the left column.

Rep. Species[A]? (by community)	**Species / Genera**	**Rating for Mule Deer**	**Rating for Cattle**
	Representative Species		
sb,ms,a,g,ss,m	Bluebunch wheatgrass	Good	Excellent
sb,ms,g,ss,m	Idaho fescue	Excellent	Excellent
sb,ms,g	Needleandthread	Moderate	Fair-Good
f,a,ss,m	Mountain brome	Good	Excellent
ss,m	Tufted hairgrass	Fair-good	Excellent
	Nonnatives		
sb,ms,a,g,ss,m	Kentucky bluegrass	Light use	Good
sb,ms,a,g,m	Orchardgrass	Moderate	Excellent
sb,ms,a,g,ss,m	Timothy	Good-Excellent	Excellent
sb,ms,g	Cheatgrass	Moderate	Good

[A] Species that are representative of or common in particular plant communities; see previous tables for codes.

Forbs

Probably the most important attribute of ungulate foraging habitat with respect to forbs is plant species composition, both in terms of high species richness and abundance of forage species. There is no set small group of forb species that contribute proportionally more than other forbs in general (e.g., Tables 4 and 5 for elk and mule deer). For mule deer, Kufeld et al. (1973:4) noted that "Relatively few individual forb species were reported heavily eaten in a large number of references, although many forbs were frequently reported to be consumed in moderate quantities. In studies reporting forbs, a large variety of species were usually involved.

Table 4. Relative seasonal values of forbs eaten by Rocky Mountain elk, compiled by Cook (2002:286-288). Of the 145 forb species and genera listed by Cook, the following are some of the commonly found species and genera in major communities on the Greys River Ranger District. The right-hand column indicates the number of references listed by Cook; see his paper for literature cited.

Plant Community[A]	**Species**	**Seasons**				**No. of Refs.**
		Spring	**Summer**	**Fall**	**Winter**	
	Representative Species					
f,sb,ms,a,m	Sticky geranium	+	++	+	[B]	10
f,sb,ms,a,m	Mountain bluebells		++	++		1
f,a,m	Cow parsnip	–	–			2
f,a,m,wm	California false hellebore		–			1
f,a,m	Goldenrod spp.	–				1
f,sb,ms,a	Groundsel spp.	+	–		+	5
f,sb,ms,a	Arrowleaf groundsel		++	++		2
—	(Columbian groundsel[C])		++			
wm	Avens spp.		+			1
wm	Elephanthead pedicularis		+			1
wm	Jacob's ladder		+	-		1
	Closely-Related Species					
f,a,m	Yampa[D]		+			1
f,sb,ms,a,m	Larkspur spp.[E]		+			1
f,sb,ms,a,m	Lupine spp.[F]	+	–	+		14
f,sb,ms,a,m	Velvet Lupine[F]		++			1
	Increaser Species					
m,ss	Canada thistle (nonnative)	–				1
f,sb,a,m,ss	Northwest cinquefoil		–			1
f,sb,a,m,ss	(Cinquefoil ssp.)	–	–	+		8
f,sb,ms,a	Wyethia spp.		++	++		3

[A] Species that are representative of or common in particular plant communities, as identified in Gregory (1983) and O'Brien et al. (2003) for forbland (f) and aspen (a) communities; NRCS (2008) for big sagebrush (bs), mountain shrubland (ms), grassland (g), silver sagebrush (ss), and riparian and other meadow (m) communities; and Youngblood et al. (1985; e.g., Appendix B) and Padgett et al. (1989; e.g., Appendix B) for wet meadow communities (wm).

[B] Blanks mean that information does not exist.

[C] Columbian groundsel does not exist on Greys River RD, but is provided as another example of groundsels, of which 13 occur on the district.

[D] Fernleaf ligusticum — also in the carrot family — is representative of forbland communities on the Greys River RD. Additionally, yampa also is common in forbland communities on the district.

[E] Tall larkspur is representative of forbland communities on the Greys River RD.

[F] Silvery lupine is representative of forbland communities on the Greys River RD. Additionally, velvet lupine also is common in big sagebrush communities, meadows, and forest openings on the district.

Table 5. Relative seasonal values of forbs eaten by mule deer, compiled by Kufeld et al. (1973). Of the 394 species and 120 genera listed by Kufeld et al. (1973:Table 3) (a total of 514 rows of information), the following are some of the commonly found species and genera in forbland, big sagebrush, meadow, and aspen communities on the Greys River Ranger District. The right-hand column indicates the number of references listed by Kufeld et al. (1973). Table 4 of their paper lists the actual literature references, and the table also identifies the number of references for each season. Increaser species are also included for comparison.

Plant Communities	**Forb Species**	**Consumption Ranking[B] by Season**				**No. of Refs.**
		Spring	**Summer**	**Fall**	**Winter**	
	Representative Species					
f,sb,ms,a	Sticky geranium	+	+			4
f,a	Ferneaf ligusticum					*
f,sb,ms,a	Tall larkspur		t –	t		2
f,sb,ms,a	Silvery lupine	–	+	++	t –	5
f,sb,ms,a	Needleleaf gianthyssop		+			3
f,a	Blue stickseed					*
f,a	Western valerian		t			1
f,a	Edible valerian					*
f,a,m	Meadowrue	t	+	t		8
f,sb,ms,a	Thickleaf groundsel		+	t		2
f,a	Peregrine fleabane		t	t		2
f,a	Leafbract aster	t	+		t	2
f,a	Thickstem aster					*
f,a	Engelmann aster		+	+		1
f,sb,a	Single-flower sunflower		+		t	3
f,sb,a	Arrowleaf balsamroot	t +	t +	+	+	33
f,a,m	Elkslip marsh marigold		t –	t		2
f,sb,ms,a,m	Western yarrow	t –	t –	t –	t –	27
f,a	Mountain bluebells		t	t		1
f,a	Canada goldenrod					*
f,a	Cow parsnip					*
f,m	California false hellebore					*
f	Long-leaf arnica					*
f,sb,ms,g	Sulphur buckwheat	t ++	t –	t +	t –	6
sb,ms,g	Hood's phlox	t +		t +	–	11
sb,ms	Pale agoseris			+	t	4
sb,ms	Tapertip hawksbeard	–	t		–	4
sb,ms	Slender locoweed		+			1
f,a	Rocky Mountain goldenrod					*
f,sb,ms,a	Arrowleaf groundsel		t	t		1
f,sb,ms,a	Wyoming Indian paintbrush		++	+	–	2
f,sb,ms,a	Wasatch penstemon	t			t	1
f,sb,ms,a,ss,m	Wild strawberry (Virginia)	t	t –	t +	–	6
a	Woodland strawberry		+			1
f,a	Wild licorice (Glycyrrhiza)	–	++	+	–	5
	Prairie smoke (Geum)	–	t –		t	8
f,sb,ms,g	American bistort (Polygonum)		t –			2
f,sb,ms,g	Yellow salsify	t –	+	+	t –	12
f,sb,ms,g	Blue-eyed Mary (Collinsia)				t	1
f,sb,ms,g	Narrow-leaved collomia	t	–			2

Table 5. Continued.

Plant Communities	Forb Species	Consumption Ranking[B] by Season				No. of Refs.
		Spring	Summer	Fall	Winter	
	Increaser Species					
f,sb,ms	Mule ears	–	++	–	–	5
f,sb,ms,a,ss,m	Northwestern cinquefoil			t	t	4
f,sb	Cutleaf balsamroot					*
f,sb	Cudweed sagewort	t –	t	t –	t –	18
m,ss	Canada thistle (nonnative)	t			t	1
roadsides	Yellow sweetclover (nonnative)	+	++	t ++	t +	6
sb,ms,a,ss,m	Common dandelion (nonnative)	t +	+	t –	t	14
	Common Genera					
f,sb,ms,a,g,m	Lomatium	t ++	–	t	t	8
f,sb,ms,a,g	Lupine spp.	+	–	+	+	35
f,sb,ms,a,g	Daisy spp. (Erigeron)	t +	t –	t –	t –	16
f,sb,ms,a,g	Aster spp.	t +	+	+	+	19
f,sb,ms,a	Goldenrod spp.	t	t +		t –	6
f,sb,ms	Arnica spp.		+			3
f,sb,ms,a	Paintbrush spp.	t	+	t –	t	8
f,sb,ms,g	Milkvetch spp.	t	+	t –	t	12
f,sb,ms	Locoweed	–	t –	t	–	5
f,sb,ms	Pussytoes spp.	+	t	–	t –	14
f,sb,ms,g	Agoseris spp.	–	t –	t	t	9
f,sb,ms,a	Penstemon	t +	t –	t –	t +	25
f,sb,ms,a,ss,m	Thistle (native/nonnative)	t	t +	+	t +	21
f,sb,ms,g	Buckwheat	t –	t +	t –	t +	43
sb,ms	Phlox	t –	t –	t +	t +	25
f,sb,ms	Gilia	t		t –	–	3
f,sb,ms,a,ss,m	Clover	–	t ++	t +	t	15
f,sb,ms,a	Voilet		t –			3

[B] Based on average amounts reported, with t = trace, – = light, + = moderate, and ++ heavy use relative to other species eaten. Two symbols means a range from the first to the second.

* No data provided in Kufeld et al. (1973). This may be a result of the species not being present on any of the study areas or of very low availability, or it could mean that the species was present, but just not selected.

Given the importance of species richness to native ungulates and the naturally high herbaceous-species richness in native forb, shrub-forb, and aspen-forb communities, suitable conditions for native ungulates in forb communities and understories consist of the richness and relative abundance of each species that occurred naturally; see the "Key Habitat Elements" subsection of "Native Wildlife Communities as a Whole," above.

Kufeld et al. (1973) found the composition of forbs in the diets of mule deer rising from an average of 15% in winter to 25% in spring, and rising again to an average of 46% in the summer, and down to an average of 30% during fall. Dietz and Nagy (1976) identified "a great many species of forbs" as being moderately used by mule deer during spring, and .

Elk forage on forbs to a much lesser degree than mule deer, but show a similar pattern. Elk eat few if any forbs during winter and gradually increase their consumption of forbs later in the spring through summer when forbs are succulent (Cook et al. 2002).

MOOSE

Little information exists on the use of forbs by moose, but Table 6 identifies some of the local forbs that were reported used in studies in other parts of the western United States. Moose forage on forbs when they are succulent on the district, and may be an important part of the diet at this time.

Table 6. Graminoids and forbs consumed by moose throughout North America, compiled by Renecker and Schwartz (1997:417-418), but limited to those that occur on the Greys River Ranger District.			
Plant Community[A]	**Species / Genera**	**Locations of Studies**	**No. of Refs.**
sb,ms,a,g,m	Wheatgrass spp.	WY, MT	1
sb,ms,g,f,m	Brome spp.	WY	1
sb,ms,a,g,m	Bluegrass spp.	WY	2
all	Grass spp.	NF, IR, BC, AK, MB	11
wm,m	Sedge spp.	AB, NF, IR, BC, AK, MB, NWT, SK	8
f,sb,ms,a,m	Western yarrow	ON, AB	1
f,sb,ms,a	Sticky geranium	MT	1
f,sb,ms,a	Lupine spp.[F]	MT	1
	Fleabane	AB	1
	Willow-herb spp.	WY	1
c	Fireweed	AK,BC	3
sb,ms	Elk thistle	MT	1
	Increaser Species		
f,sb,ms,a,m	Western coneflower	MT	1
ss,m,w	Canada thistle	AB	1

[A] Species that are representative of or common in particular plant communities. Plant communities include mountain big sagebrush (sb), mountain shrubland (ms), forbland (f), silver sagebrush (ss), meadow (m), aspen (a), and wet meadow (wm).

BIGHORN SHEEP

The historical distribution of bighorn sheep in western Wyoming was much larger than it is today, they had much larger seasonal movements, and they historically used a much larger range of habitat types. Their current distribution in western Wyoming is restricted (Krausman and Shackleton 2000, WAFWA 2007). Even though the bighorn sheep distribution in western Wyoming was considerably larger than it is today, bighorn sheep habitat in western North America is naturally fragmented within a much larger landscape (Beecham et al 2007).

Although diets vary among populations and winter diets are dominated by grasses, Krausman and Shackleton (2000) and Beechman et al. (2007) assessed that the diet of bighorn sheep in the Rocky Mountains is dominated by forbs when they are succulent and palatable, followed by grasses, and lastly browse. Shrubs, including sagebrush and bitterbrush, may be used in fall and winter. For bighorn sheep in the Teton Range, Courtemanch (2014:20) assessed that "Bighorn sheep diets were comprised of shrubs, grasses, and sedges during the spring and early summer, and shifted to forbs and grasses later in the summer… Forbs comprised nearly 60% of the August diet. Summer diets were diverse, including 40 plant genera identified from fecal samples… However, only 5 genera were present above 5% in the diet: Bromus (8%), Poa (22%), Carex (20%), Astragalus (8%), and Geranium (6%). Bighorn sheep exhibited significant selection for Bromus, Poa, Carex, and Astragalus throughout the summer…" Two noteworthy items regarding this quoted material: (1) forbs comprised 60% of the August diet, (2) diets consisted of 40 plant species, and (3) nearly all forage species comprise small percentages of their diet. In combination, high plant species diversity appears to be important.

Historically, bighorn sheep wintered on lower-elevation winter ranges, but migration to these low-elevation ranges is much more restricted today, which means they need to now find sufficient winter forage at high elevations.

SAGE GROUSE

Suitability of a big sagebrush site for pre-laying sage grouse hens and sage grouse chicks increases as more of the following species are present and as the canopy cover of individual species increases:

Hawksbeard	Clover	Curlyleaf gumweed
Mountain dandelion	Broomrape	Western salsify
Common dandelion	Long-leaf phlox	Western yarrow
Milkvetch	Parsley	Prickly lettuce
Microseris	Everlasting	Fleabane

This list is based on the following information:

- In a study in southeastern Oregon, pre-laying hens consistently selected for hawksbeard, mountain dandelion, long-leaf phlox, milkvetch, clover, desert parsley, and everlasting (Barnett and Crawford 1994), and these are all well represented on the Greys River Ranger District.
- The Upper Snake River Sage-Grouse Working Group (2008) identified the following forb species as commonly identified as important forb species used by sage grouse in early spring (only those occurring on the Greys River Ranger District are listed): common dandelion, curlycup gumweed, western salsify, western yarrow, prickly lettuce, fleabane, sweetclover, milkvetch, and fringed sagewort, although they noted that most native forb species are eaten by sage grouse when the plants are young and succulent. This group of species may be more representative of Wyoming big sagebrush habitat than mountain big sagebrush habitat.
- Forbs eaten by sage grouse chicks in a study in southeastern Oregon, in order of preference, included hawksbeard, milkvetch, common dandelion, mountain dandelion, broomrape, microseris, and clover (Drut et al. 1994). All of these genera are well represented on the Greys River Ranger District. Sage grouse chicks in the southeast Oregon study foraged on a total of 34 genera of forbs.

MIGRATORY BIRDS AND GROUSE

Many migratory bird species and three species of grouse depend on a relatively natural herbaceous species composition to provide the "right foods" in the "right seasons." There are four main groups of food that have their foundations in herbaceous vegetation and that are highly dependent on herbaceous species composition:

- ***Seeds*** — A large number and wide variety of bird species feed on seeds of grasses, sedges, and forbs, and this includes birds that typically inhabit riparian areas (e.g., mallards, black-headed grosbeaks, white-crowned sparrows, Lincoln's sparrows, savannah sparrows) and rangelands (e.g., Brewer's sparrows, vesper sparrows), as well as species that spend most of their time in forests (e.g., Pine grosbeaks, Cassin's finches). (See "Food Habits" sections for individual species of sparrows, finches, grosbeaks, blackbirds, and ducks in The American Ornithologist's Union's *Birds of North America* reports; the list of herbaceous plant taxa is long.) In part, use of different seed sizes by different bird species stems from different beak sizes. Herbaceous species richness and relative abundance of seedstalks and flowers of particular species is important at least to some degree because different granivorous bird species have different preferences and species richness and relative abundance of seedstalks and flowers can influence the availability of seeds under different situations.

  While the most practical way to provide for the foraging needs of birds with respect to seeds is to restore and maintain a relatively-natural composition of herbaceous species, this likely is not as important as it is for invertebrates.
- ***Flowers*** — Hummingbirds are the only group of bird species dependent on nectar for food, although a few other species will opportunistically feed on nectar (e.g., northern oriole). They use a fairly limited number of forb species as nectar sources.
- ***Leafy Material*** — a small number of bird species eat leaves in meadows (e.g., Canada geese, mallards, sage grouse) and mountain big sagebrush communities (sage grouse). Canada geese and mallards likely will eat most any grass species that is available, sage grouse have distinct preferences for several forb species (see "Sage Grouse" section).

- ***Invertebrate Prey*** — The only practical way to provide for the full range of foraging needs of birds (as well as for bats, small mammals, reptiles, and amphibians) with respect to invertebrates is to restore and maintain a relatively-natural composition of herbaceous species for at least three reasons. First, there is a large number of bird species having known different preferences for invertebrate taxa. Second, there is limited understanding of the prey species of many bird species, the seasonal importance of different invertebrate species, the distribution and abundance of these invertebrate species in the central Rocky Mountains, and the habitat needs of the species inhabiting riparian and rangeland habitat. The most practical approach to provide for a wide range of habitat needs of wildlife species native to an area, when little is known of their species composition or their habitat needs, is to approximate the conditions under which the wildlife community formed (Principle A.2).

  Third, even if sufficient information was available on specific habitat needs of prey species, it would be impractical to attempt to manage for specific habitat needs of individual invertebrate species eaten by a select group of migratory birds, especially given other management objectives and priorities.

  Also critical to providing for a suitable invertebrate prey base is retaining a sufficient amount of herbaceous vegetation to provide for the cover, microclimate, shading, egg-laying-substrate (specific locations on plants), pupation sites, and litter/mulch needs of invertebrates.

- ***Vertebrate Prey (small mammals, birds, reptiles, and amphibians)*** — Approximating a natural composition of herbaceous species and herbaceous retention levels is important to sustaining the range of vertebrate species in riparian areas and rangelands that seasonally provide for the foraging needs of predatory bird species for at least two reasons. First, there is a range of predatory bird species that have known different preferences for vertebrate taxa, and some of these are seasonal. Second, it would be impractical to attempt to manage for specific habitat needs of individual small mammal, bird, amphibian, and reptile species eaten by predatory bird species, especially given the other wide range of habitat needs of migratory birds and other wildlife species, as well as management objectives for other resource areas, recreational use, and commercial uses.

  Likely more important than a relatively-natural composition of herbaceous species is approximating natural vegetation structure, especially for species like meadow voles, montane voles, and long-tailed voles, which provide the bulk of the biomass of small mammal prey in moist meadow complexes. Also critical to providing for a suitable invertebrate prey base is retaining a sufficient amount of herbaceous vegetation to provide for the cover, microclimate, shading, egg-laying-substrate (specific locations on plants), pupation sites, and litter/mulch needs of invertebrates.

BATS

As noted in the Conservation Plan for Bats in Wyoming (Hester and Grenier 2005:11), “In general, nocturnal flying insects are the most common prey, including moths (Lepidoptera), beetles (Coleoptera), flies (Diptera), midges (Chironomidae), mosquitoes (Culicidae), termites (Isoptera), and ants (Formicidae). Some bat species also take non-flying insects, which they glean off of foliage or the ground (Kurta 2000; Hinman and Snow 2003). Although some bats may specialize to some extent, most are opportunistic foragers, concentrating on whatever insects of the correct size are within their habitat and the limits of their morphology and echolocation abilities (Brigham and others 1992).” Although many bat species are opportunistic, flying insects must be of the “correct size,” as noted above.

Given unknowns about prey species preferences of many bats and about the occurrence, distribution, and habitat relationships of prey species, the most practical approach to maintaining a suitable prey base for bats is to approximate the conditions under which native insect communities developed, which is consistent with a key premise of the 2012 Planning Rule. An important part of this for insects is approximating a relatively natural composition of herbaceous plant species.

SMALL MAMMALS

Herbaceous species composition is important, at least at a broad level, for small mammals. Herbaceous species composition is a key driver of vegetation structure, which is important to many small mammals species. Also, even though the main utility of herbaceous vegetation to microtine voles appears to be hiding and escape cover, Batzli (1985) provided evidence that low amounts of preferred forage, and the subsequent effects on nutrition may play an important role in the population size of voles. Fagerstone and Ramey (1996) cited two studies indicating that sagebrush voles are restricted to areas where bluebunch wheatgrass occurs with big sagebrush.

Several species of shrews exist within the Greys River and Kemmerer Ranger Districts, and they feed on invertebrates. As part of a large group of wildlife species that feed on invertebrates (many species of migratory birds, grouse, bats, small mammals, reptiles, and amphibians), the types and distribution of invertebrates available to shrews depend on habitat conditions, and an important habitat condition that affects invertebrates is herbaceous species composition.

INVERTEBRATES — GENERAL

Although invertebrates are treated as one group of wildlife with other groups including amphibians, small mammals, and migratory birds, the number and variety of species represented in the invertebrate grouping far exceeds that of any other grouping. It encompasses thousands of species across numerous classes, orders, families, and genera in riparian areas and rangelands across the central Rocky Mountains. In general, invertebrates include insects, spiders, mites, terrestrial worms, nematodes, centipedes, millipedes, and mollusks. Major orders include dragonflies and damselflies (*Odanata*); grasshoppers, crickets, and katydids (*Orthopera*); stick insects (*Phasmida*); stoneflies (*Plecoptera*); true bugs, cicadas, and kin (*Hemiptera*); beetles (*Coleoptera*); flies (*Diptera*); caddisflies (*Trichoptera*); butterflies and moths (*Lepidoptera*); ants, bees, and wasps (*Hymenoptera*); spiders (*Aranea*); ticks and mites (*Acari*); centipedes (*Chilopoda*); and millipedes (*Diplopoda*). While invertebrate species likely comprise more than 95% of the animal species in riparian areas and rangelands, habitat relationships of these species are much less understood than those of vertebrate species.

Invertebrates are of fundamental importance to a wide range of ecological functions (e.g., pollination, decomposition and soil aeration, herbivory, a major food source) in riparian and rangeland systems. Most insects are either primary or secondary consumers and, therefore, are critical links in food webs (Krebs 1978, Brewer 1979, Ricklefs 1979, Evans 1984). Food-web and energy-pyramid illustrations demonstrate the pivotal role that invertebrates play in sustaining wildlife communities. Pollinators (e.g., moths, butterflies, bees, and some fly and beetle species) play a crucial role in sustaining healthy meadow plant communities (Samways 2005, National Research Council 2009), especially where forbs are a naturally predominant component of plant communities. Healthy and diverse invertebrate communities are central to sustaining numerous species of birds, bats, small mammals (e.g., shrews), reptiles, and amphibians.

In areas where plant species richness was naturally high, plant species composition is paramount to restoring and sustaining invertebrate communities. Given the large proportion of herbaceous communities and shrub-herbaceous communities that have reduced plant species richness, it is especially important for remaining plant communities in good health (e.g., at potential natural community, potential functioning condition, approximation of natural community) to remain as such. Allowing plant species composition to recover also is important.

Many invertebrate species depend on particular parts of plants (e.g., flowers, seedheads, stalks, leaves, roots), and some even need the correct plant parts at certain positions or heights relative to the ground or top of canopies; as one example, some butterfly species only lay their eggs on leaves of certain plant taxa near the canopy surface (Scott 1986, Samways 2005, National Research Council 2007, New 2009). Some larva attach themselves to particular plant parts of certain plant taxa. Providing for the egg-laying and pupation sites of the full range of invertebrate species, along with providing for the forage needs of these invertebrates, relies

heavily upon a relatively-natural composition of herbaceous plant species, relatively-tall herbaceous vegetation, and high percent canopy cover.

A relatively natural species composition of invertebrates is central to maintaining ecosystem functioning conducted by invertebrates and to providing for the seasonal invertebrate-forage needs of more than 100 species of birds, bats, small mammals, reptiles, and amphibians (Wyo. Partners in Flight 2003). And key to this is maintaining (or, restoring and then maintaining) a relatively natural plant species composition in the major vegetation types (Samways 2005, New 2009). Samways (2005:103-104) stressed that "insect diversity conservation depends heavily on plant diversity conservation." Specialization in insects may be a contributing factor to this as well as related findings of Hughes et al. (2000) and Siemann et al. (1998) that higher plant species composition facilitates higher insect diversity.

BUTTERFLIES, MOTHS, AND BEES

While many insect species are generalists, there are also many species that are specialists, with some species of insects depending on one or small number of plant species or species within a small number of genera, and some populations within a given insect species may have different host plant species (Evans 1984:328-331, Scott 1993; and see Tables 7 and 8). There are many examples of this in butterfly, moth, and bee species, although the plant hosts of many butterflies, moths, and bees remain unknown (Scott 1986, Debinski and Pritchard 2002, Poole 2009, Cane In Press).

The information on host plants and on forage-plant species favored by pollinators provided in this section represents a very small fraction of plant-invertebrate relationships and needs. The main point of presenting this information is to illustrate the major importance of plant species richness and relative abundance / canopy cover of individual plant species. As discussed in the main body of the report, "functional plant species composition" is of utmost importance. If herbaceous species composition is measured prior to the livestock grazing season and is ascertained to be "suitable" for pollinators and other invertebrates, but then is grazed to the point that functional plant species composition (e.g., in this case, the abundance of flowers of each particular species that remains, and the amount of forage of particular plant species that remains) is considerably lower than what was measured, pollinators and other invertebrates that depend on the needed plant parts of particular plant taxa — that are no longer available or available at too low of frequency — the pollinator species or other invertebrate species would likely decline in abundance.

Table 7. Plant associations, location of egg-laying, and timing of flights of 15 butterfly subfamilies (representing 138 species), based on information in Scott (1993), Debinski and Pritchard (2002), Pool (2009).

Butterfly Subfamily		No. Spp. in GYA	Timing of Flights	Host Plants (and nectar plants where info. was available)	Loc. of Eggs On/Near Host Plant
Common Name	**Scientific Name**				
Parnassians	Parnassiinae	2	Jn-Au	Herb: Stonecrops	on HP
Swallowtails	Papilioninae	6	Ap-Jy, My-Jy, My-Au, Jn-Jy	Herb: carrot family (e.g., cow parsnip, angelica) Woody: Ceonothus, cherry, cottonwood, birches, willows, aspen	leaves & flowers; near HP
Whites	Pierinae	11	Ap-My, My-Jn, My-Jy, My-Au, Au-Se	Herb: Mustard family, Rocky Mtn. bee plant, alpine bladderpod, common tansy Woody: Conifers	leaves, flower buds, flowers; near top of plants
Sulphers	Coliadinae	8	My-Se, My-Oc, Jn-Au, Jy-Au, Jn-Oc	Herb: Pea family (e.g., vetches, locoweeds, clovers, lupines) Woody: Huckleberry, alpine false-wintergreen	leaves; near top of plants
Blues	Polyommatinae	12	Ap-Jn, Ap-Jy, Ap-Oc (3x), My-Au	Herb: buckwheats, asters/sunflowers, herb. primrose, Pea family (e.g., locoweeds, vetches, lupines, clovers, legumes), alpine rock jasmine, saxifrages. Woody: roses, heaths	flowers, flower buds, seed pods, near HP
Hairstreaks	Theclinae	14	Ap-Jn, My-Jn, My-Au, Jn-Jy, Jn-Au	Herb: lupines, buckwheats Woody: bitterbrush, mtn. mahogany, cherry, serviceberry, huckleberry, bearberry, willows, juniper, lodgepole pine Nectar: buckwheats, ceonothus, Rocky Mtn. bee plant, pussytoes, lupines, roses	flowers, leaves, twigs/stems, litter at HP base, near HP
Coppers	Lyaeninae	10	My-Au, Jn-Jy, Jn-Au, Jy-Au	Herb: pondweeds, buckwheats (incl. mtn. knotweed, sorrels, docks) Nectar: buckwheats (as above), rabbitbrush, shrubby cinquefoil, milkweed	leaves, litter at HP base, near HP
Fritillaries–Greater	Heliconinae	10	My-Au, Jn-Au, Jn-Se	Herb: violets	litter at base of HP, on HP
Lesser	" "	8	My-Jn, My-Jy, Jn-Jy, Jn-Au	Herb: violets, bistorts, buckwheats Woody: heath family, willows	near HP, on HP
True Brushfoots	Nymphalinae	10	Ap-Se (2x), My-Jn, My-Au, Jn-Jy, Jn-Au, Jy-Au	Herb: thistles, asters/sunflowers, fleabanes, groundsels, figwort family (e.g., paintbrushes, elephanthead), penstemon, valarians, plantains, honeysuckles, broomrapes Woody: common rabbitbrush	leaves and flowers
Tortoiseshells, Anglewings, Ladies		12	Ap-Se, June, Jn-Jy, Jn-Se	Herb: nettles, thistles, mallows Woody: gooseberries, currents, alders, willows, cottonwoods, birches, ceonothus	leaves and twigs
Admirals	Limenitidinae	2	Jn-Au, Jn-Se	Woody: willows, cottonwood, aspen, rose family (e.g., chokecherry, serviceberry)	leaves
Satyrs	Satyrinae	15	Ap-Se, My-Au, My-Se, Jn-Jy, Jn-Au, Jy-Au, Jy-Se	Herb: grasses (e.g., needle-and-thread, reed canary grass, blue gramma, Kentucky bluegrass), sedges Woody: willows	leaves, stems, rocks near HP
Milkweed Butterfy	Danainae	1	variable	Milkweeds	leaves
Dusky Wings		3	Ap-Jy, Ap-Au	Herb: legumes (e.g., lupines, vetches) Woody: willows, aspen	leaves
Skippers		14*	Ap-Se, My-Jy, My-Au, My-Se, Jn-Jy, Ju-Au, Jy-Oc	Herb: grasses (e.g., Idaho fescue, timothy, wheat-grasses, bluegrasses, wildrye), sedges, horkelias, cinquefoils, mallows (incl. hollyhock), and amaranthaceae and chenopodiaceae families	stalks, seed-heads, leaves, near HP
Total No. Species		138			

Table 8. Plant associations of several bee genera, based on input from Jim Cane, Agricultural Research Service, Logan, Utah (Cane 2011). J. Cane was asked what types of bees are associated with the following forb species.	
Forb Species	**Bee Associations**
Sticky geranium	Few sweat bees, Andrena
Fernleaf ligusticum	Unknown
Single-flowered sunflower	Likely large number of bees
Tobacco root	Unknown
Silvery lupine	Moderate to large numbers of Osmia and bumblebees; few Eucera
Fendler meadow rue	Low number of bees
Tall larkspur	Long-tongued bumblebees, possibly Eucera
Showy goldeneye	Moderate to large number of bees, generalists and those liking composites
Mountain bluebells	Bumblebees
Western sweetroot	Unknown
Blue stickseed	Moderate to large number of Osmia, bumblebees, and Andrena
Thickleaf groundsel	Rarely identified with bees
Needleleaf gianthyssop	Bumblebees
Canada goldenrod	Many kinds of bees in good numbers
Leafbract aster	Small generalist bees
Thickstem aster	Small generalist bees
Arrowleaf balsamroot	Select bee species in the Osmia, Halictus, Eucera, Andrena families
Long-leaf arnica	Small number of Osmia, Andrena, and bumblebees
Elkslip marsh marigold	Likely no bees (and likely few insects)
Cow parsnip	Few if any bees (mostly flies)
California false hellebore	Few if any bees (mostly flies)
Western yarrow	Small to moderate number of small bees; not very attractive
Common Genera	
Groundsels	Varies; S. serra abundantly visited
Goldenrods	Many kinds of bees in good numbers
Milkvetches	Abundant Osmia, bumblebees, Eucera
Hawksbeards	Small number of species in the Osmia, Halictus, Eucera, and Andrena families
Fleabanes	Depends on speciesl small generalist bees
Parsley/wild carrots	Small number of species in the Andrena family; abundance of these bees
Lupines	Small number of species in the Osmia, Eucera, and Andrena families
Penstemons	Small number of species in the Osmia (Pseudomasaris on many)
Indian paintbrushes	Bombus use some paintbrush species (red paintbrushes used by hummingbirds)
Cinquefoils	Attracts some bees
Buttercups	Few bees

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