

# Tracking Ungulate-Vegetation Interaction in the Gardiner and Hebgen Basins

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# Project Goal and Objectives

- Goals

- Develop ecological baseline for monitoring sustainability of vegetation and soil

- Objectives

- Identify historic data sets that might serve as baseline
- Construct ecological reference guide for determining vegetation status and trend



# General Approach

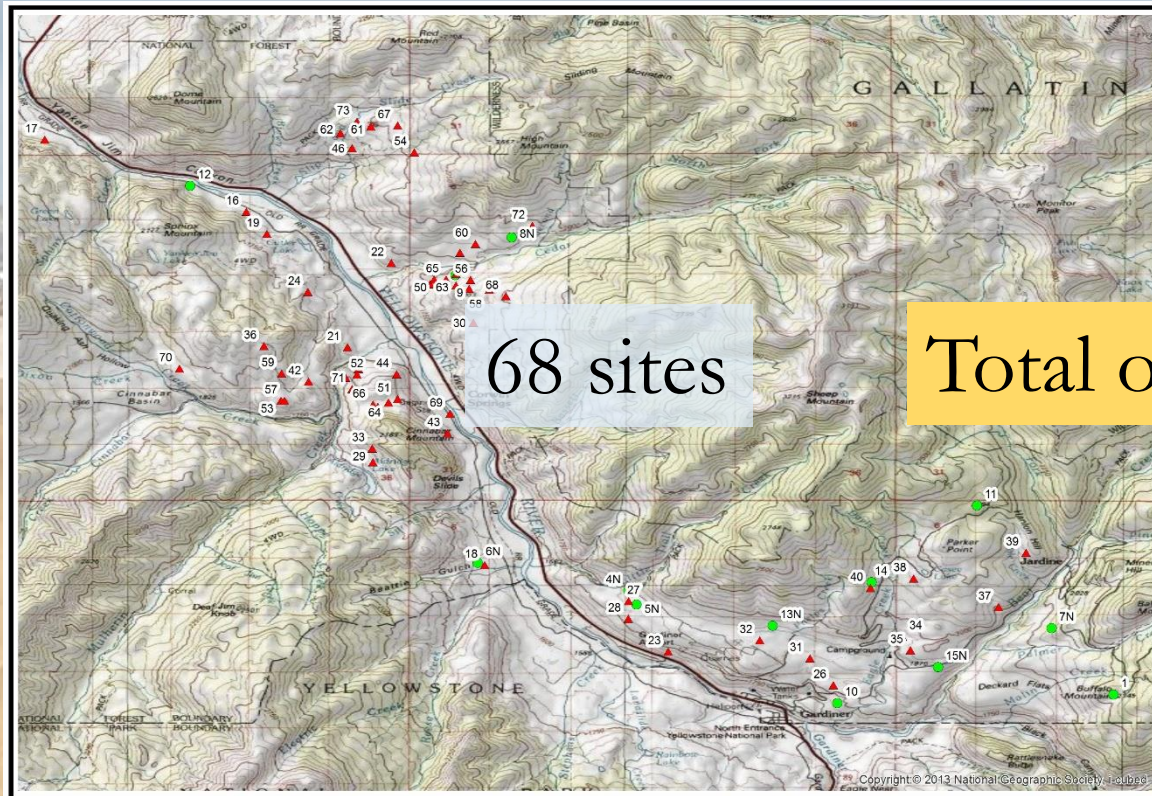
## Site Selection

- Designed to capture as much of ecological status as possible
  - All landscapes < 25% tree cover
    - Broad geologic context – soil texture
    - NE and SW aspect – high to low production potential
    - Slope – four categories to capture range of grazing use

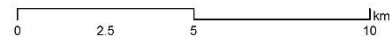
## Data Collection

- Physical
  - Field
    - Soil depth, rock content, CaCO<sub>3</sub>
  - Lab
    - Organic matter, texture
- Vegetation
  - Species canopy cover
  - Species density
  - Biomass production

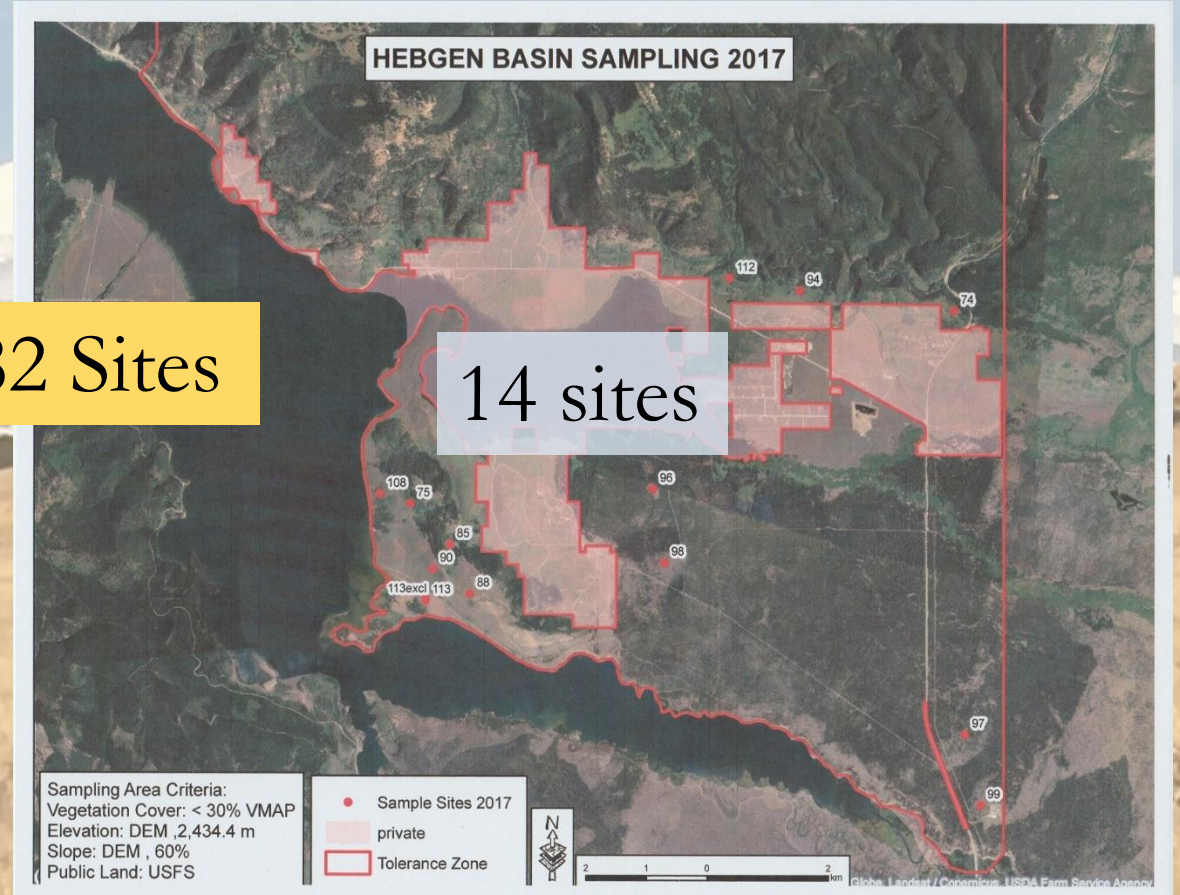
# Overview of Sample Locations



Total of 82 Sites

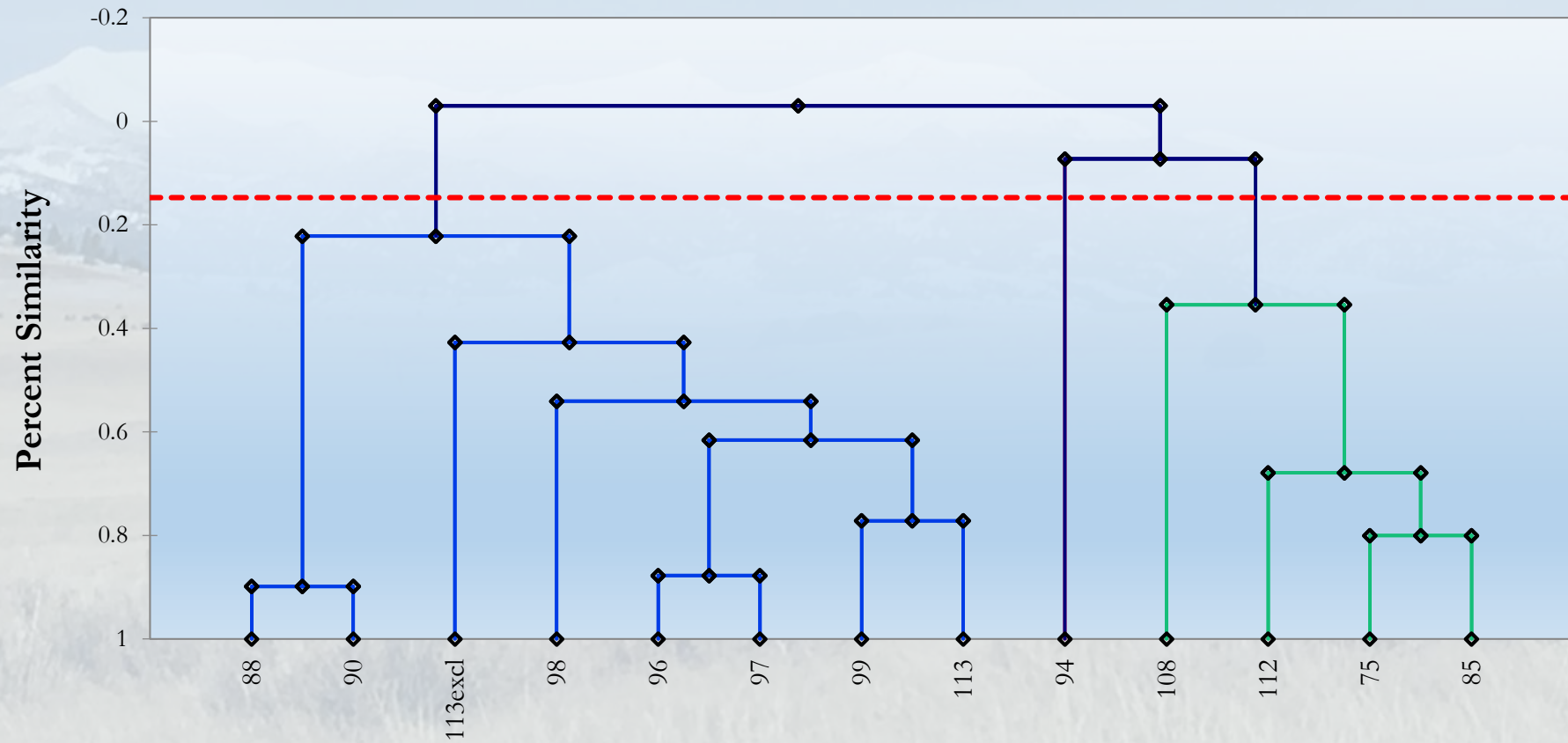


- ▲ 2015 and 2016
- 2014

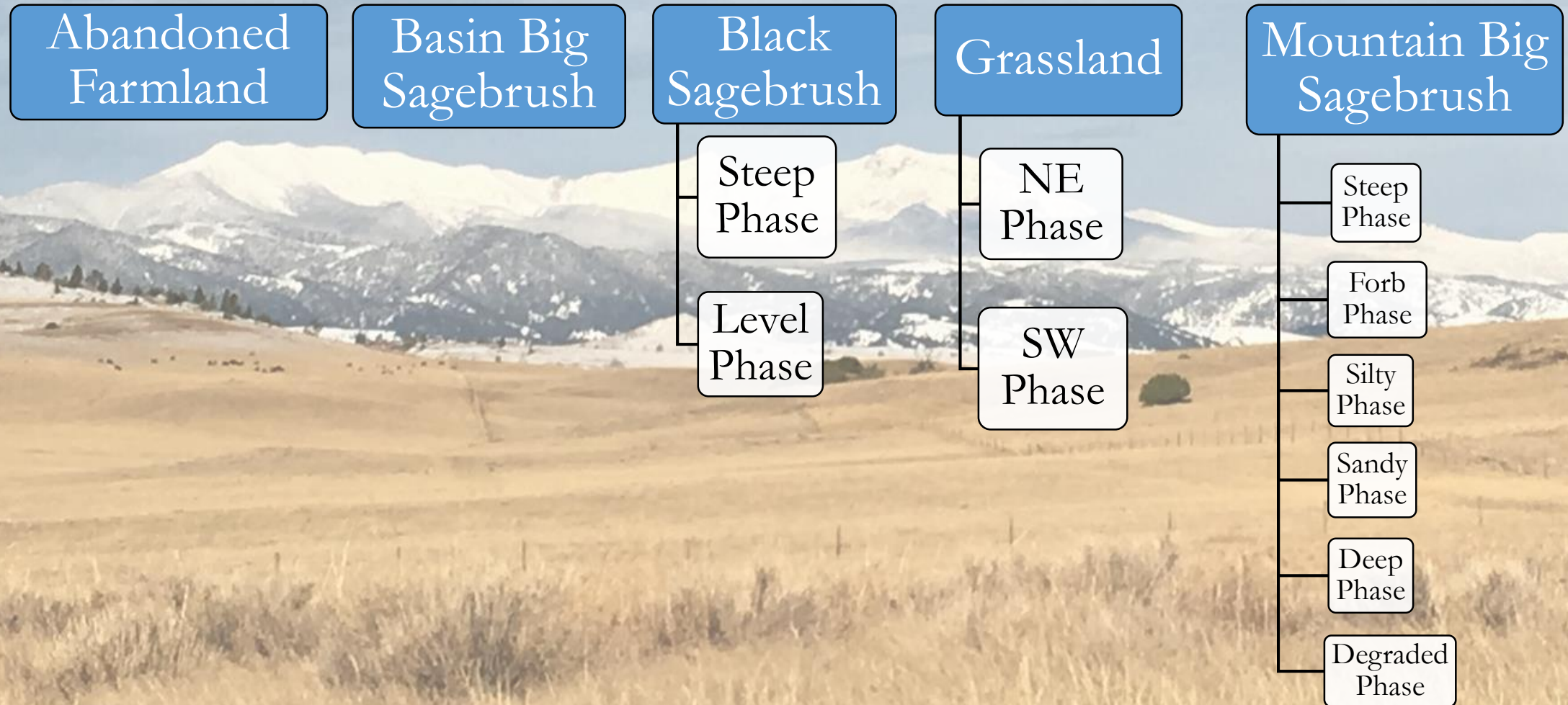


# Community Type Identification

## Hebgen Basin Cluster Analysis



# Gardiner Basin Vegetation Types



# Hebgen Basin Vegetation Types

Mountain  
Big  
Sagebrush

Antelope  
Bitterbrush

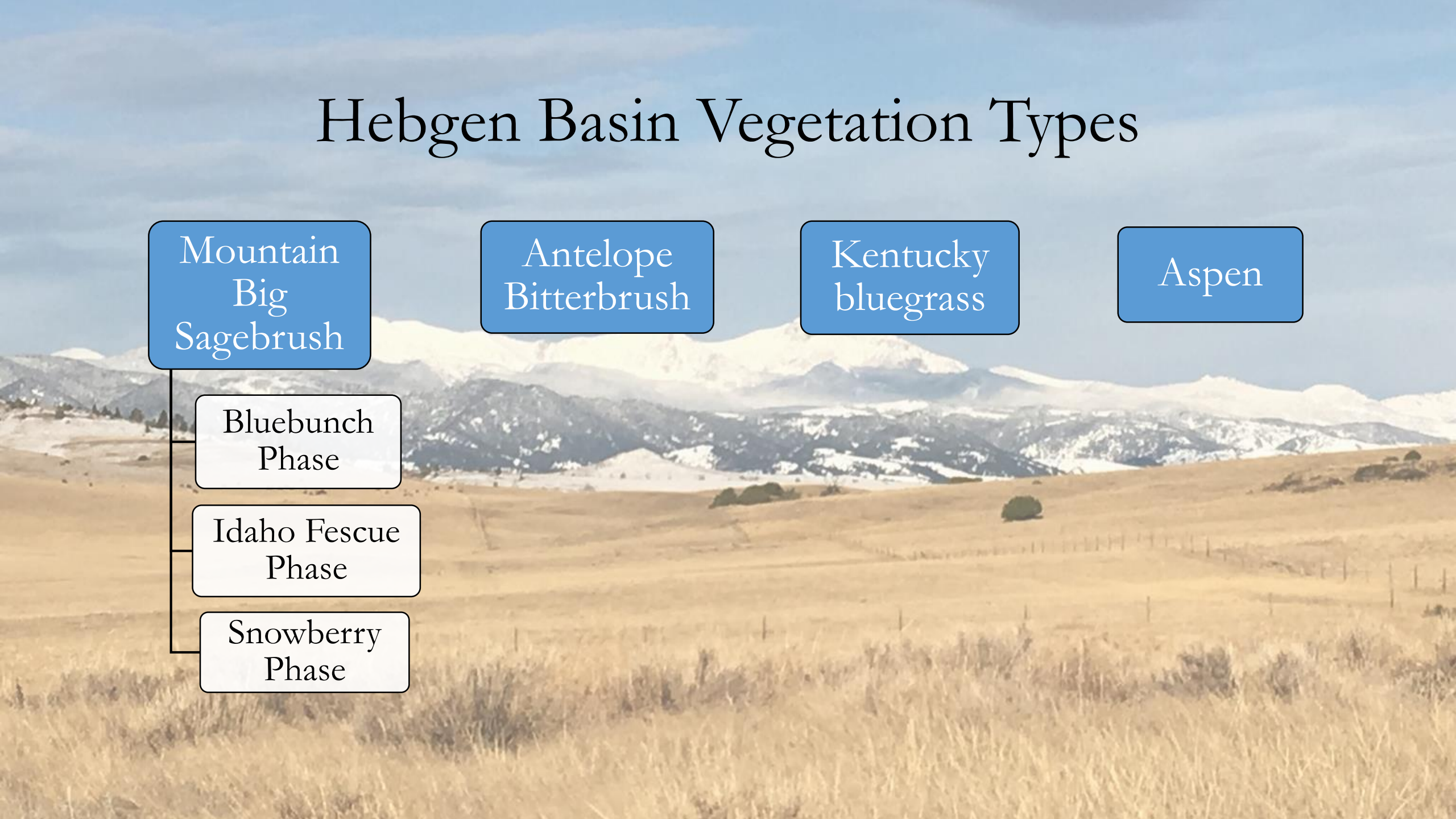
Kentucky  
bluegrass

Aspen

Bluebunch  
Phase

Idaho Fescue  
Phase

Snowberry  
Phase



6. Reference Composition for Grassland Community Type, Northeast Phase, Gardiner Basin, Gardiner, Montana.

Geology	Aspect	Slope%	Species	% Cover	Disturbance Species (%)	Biomass (kg/ha)	Grass % Biomass
unconsolidated	NE	4 - 15	<i>Shrubs:</i>				
	NE	15 – 35	Artemisia nova	3.3/ <b>np</b>			
	NE	35 - 60	Artemisia tridentata vaseyana	0.9/ <b>0.5</b>			
			<i>Grasses and Grass-likes:</i>				
			Festuca idahoensis	13/ <b>37</b>			
			Pseudoroegneria spicata	3.7/ <b>18</b>			
			Koeleria macrantha	2.4/ <b>4</b>			
			Poa cusickii	1.3/ <b>1</b>			
			Poa pratensis	0.9/ <b>0.5</b>	4.1	199	46
			Poa secunda	0.8/ <b>3</b>			
			Leucopoa kingii	0.3/ <b>np</b>			
			Carex spp	0.2/ <b>1</b>			
			<i>Forbs:</i>				
			Symphyotrichum ericoides	2.4/ <b>0.5</b>			
			Astragalus spp	1.6/ <b>1</b>			
			Phlox hoodii	1.4/ <b>3</b>			
			Antennaria microphylla	1.4/ <b>2</b>			
			Achillea millefolium	1/ <b>1</b>			
			Cymopterus spp	0.8/ <b>np</b>			
			Phlox longifolia	0.8/ <b>1</b>			
			Crepis acuminata	0.7/ <b>np</b>			
			Arenaria congesta	0.3/ <b>1</b>			
			<i>Moss-like</i>				
			Selaginella densa	1.8/ <b>np</b>			

Festuca idahoensis/Pseudoroegneria spicata. Mueggler and Stewart 1980



# Ecological Status (Mueggler and Stewart 1980)



- Shrubs at expected level
  - Mountain big sagebrush considered late seral to climax
  - Shrub is persistent under heavy grazing
- Climax and mid seral grasses less than expected level
  - Indication of prolonged heavy grazing use
- Forbs at or above expected level
  - Heath aster increases under heavy grazing

1. Reference Composition for Mountain Big Sagebrush/Bluebunch Wheatgrass Community Type, Hebgen Basin, West Yellowstone, Montana

Geology	Aspect	Slope%	Species	% Cover	Disturbance Species (%)	Biomass (kg/ha)	Grass % Biomass
Bedrock	SW	15 – 35	<i>Shrubs:</i>				
		35 - 60	<i>Artemisia tridentata vaseyana</i>	19.3/15			
			<i>Symphoricarpos albus</i>	1/np			
			<i>Grasses and Grass-like:</i>				
			<i>Pseudoroegneria spicata</i>	13.2/32			
			<i>Festuca idahoensis</i>	6.3/np			
			<i>Poa pratensis</i>	2.5/np	3.2	725	32
			<i>Carex filifolia</i>	2.1/1			
			<i>Achnatherum nelsonii</i>	0.5/np			
			<i>Koeleria macrantha</i>	0.4/5			
			<i>Poa secunda</i>	0.3/2			
			<i>Forbs:</i>				
			<i>Lupinus caudatus</i>	6.2/1			
			<i>Antennaria microphylla</i>	3/0.5			
			<i>Geranium viscosissimum</i>	1/np			
			<i>Eriogonum umbellatum</i>	0.2/0.5			
			<i>Phlox longifolia</i>	0.1/np			

*A. trid. vaseyana/Pseudoroegneria spicata*. Mueggler and Stewart 1980

# Ecological Status (Mueggler and Stewart 1980)



- Shrubs above expected level
  - Mountain big sagebrush considered late seral to climax
  - With western snowberry and Idaho fescue indicates more moisture
- Climax and mid seral grasses less than expected level
  - Indication of prolonged heavy grazing use
- Forbs at or above expected level
  - Abundant lupine affirms higher site moisture

# Evaluating New Sites

## Key to the Identification of Non-forested Vegetation Community Types in the Gardiner Basin, Gardiner, MT

1. Sagebrush canopy cover > 5% ..... 2.
  2. *Artemisia tridentata* cover < 1%, *Artemisia nova* canopy cover > 10% ..... 3.
    3. Climax grass cover > 10%, forb cover > 5%, surface rock < 3%, slopes 4 – 15% ..... **Level Black sagebrush**
    3. Climax grass cover < 2%, forb cover < 2%, surface rock > 10%, slopes 35 – 60% ..... **Steep Black sagebrush**
  2. *Artemisia tridentata vaseyana* or *tridentata* cover > 5%, *Artemisia nova* cover 2% or less. 4.
    4. *A. tri. vaseyana* cover > 5%, *A. tri. tridentata* cover < 5% ..... **Mountain big sagebrush** 5.
    4. *A. tri. tridentata* cover > 5%, *A. tri. vaseyana* cover < 5% ..... **Basin big sagebrush**
      5. *Artemisia tridentata vaseyana* cover > 5%, *Festuca idahoensis* cover > 10% ..... 6.
        6. Climax grass cover > 20%; forb cover < 10%; soil depth > 30cm..... **Sandy Loam Phase**
        6. Climax grass cover 10 - 17%; forb cover > 10%; soil depth < 30cm ..... **Forb Phase**
      5. *Artemisia tridentata vaseyana* cover 7% or less; *Festuca idahoensis* cover < 5% 7.
        7. Climax grasses < 10%, forb cover < 3%, soil depth > 50cm ..... 8.
          8. *Artemisia tridentata vaseyana* cover < 3%, spike clubmoss ..... **Degraded Phase**
        7. Climax grasses < 10%, forb cover at least 3%, soil depth < 30cm ..... 9.
          9. *Artemisia tridentata vaseyana* cover > 5%, no spike clubmoss ..... **Steep Phase**
  1. Sagebrush canopy cover < 5% ..... 10.
    10. *Artemisia nova* cover  $\leq$  3%, *Artemisia tridentata* cover  $\leq$  1%, combined cover of *Festuca idahoensis* and *Pseudoroegneria spicata* > 5%, other perennial grass cover > 5%, forb cover at least 5%, introduced or non-native grass cover < 1% ..... **Grasslands. 11**
      11. Southwest aspect, *Festuca idahoensis* cover < 10%, forb cover < 3%..... **Southwest Phase**
      11. Northeast aspect, *Festuca idahoensis* cover > 10%, forb cover > 3% ..... **Northeast Phase**
    10. *Artemisia tridentata tridentata* cover < 5%, *Artemisia tridentata vaseyana* cover < 2%, non-native or introduced grass cover > 10%, forb cover < 4% ..... **Abandoned Agriculture Lands**

# Cedar Creek

Species	Cedar Creek % Cover	Gardiner Baseline NE Grassland Phase
<i>Antennaria</i> spp.	6.5 ↑	0.3/2
<i>Artemisia tridentata</i>	1	1/0.5
<i>Carex</i> spp.	7 ↑	0.2/1
<i>Erigeron</i> spp.	1	2/0.5
<i>Festuca idahoensis</i>	18.5 ↑	13/37
<i>Koeleria macrantha</i>	4 ↑	2/4
<i>Astragalus</i>	np	2/1
<i>Lupinus</i> spp.	1	np/np
<i>Achillea millefolium</i>	np	1/1
<i>Pascopyrum smithii</i>	3	np/np
<i>Poa</i> spp.	2	3/4
<i>Pseudoroegneria spicata</i>	3 ↓	4/18
<i>Stipa viridula</i>	2	np/np

Improve??

# Evaluating New Sites

## Key to the Identification of Non-forested Vegetation Community Types in the Gardiner Basin, Gardiner, MT

1. Sagebrush canopy cover > 5% ..... 2.
  2. *Artemisia tridentata* cover < 1%, *Artemisia nova* canopy cover > 10 % ..... 3.
    3. Climax grass cover > 10%, forb cover > 5%, surface rock < 3%, slopes 4 – 15% ..... **Level Black sagebrush**
    3. Climax grass cover < 2%, forb cover < 2%, surface rock > 10%, slopes 35 – 60% ..... **Steep Black sagebrush**
  2. *Artemisia tridentata vaseyana* or *tridentata* cover > 5%, *Artemisia nova* cover 2% or less. .... 4.
    4. *A. tri. vaseyana* cover > 5%, *A. tri. tridentata* cover < 5% ..... **Mountain big sagebrush** .... 5.
    4. *A. tri. tridentata* cover > 5%, *A. tri. vaseyana* cover < 5% ..... **Basin big sagebrush**
      5. *Artemisia tridentata vaseyana* cover > 5%, *Festuca idahoensis* cover > 10% ..... 6.
        6. Climax grass cover > 20%; forb cover < 10%; soil depth > 30cm..... **Sandy Loam Phase**
        6. Climax grass cover 10 - 17%; forb cover > 10%; soil depth < 30cm ..... **Forb Phase**
      5. *Artemisia tridentata vaseyana* cover 7% or less; *Festuca idahoensis* cover < 5% ..... 7.
        7. Climax grasses < 10%, forb cover < 3%, soil depth > 50cm ..... 8.
          8. *Artemisia tridentata vaseyana* cover < 3%, spike clubmoss ..... **Degraded Phase**
        7. Climax grasses < 10%, forb cover at least 3%, soil depth < 30cm ..... 9.
          9. *Artemisia tridentata vaseyana* cover > 5%, no spike clubmoss ..... **Steep Phase**
1. Sagebrush canopy cover < 5% ..... 10.
  10. *Artemisia nova* cover ≤ 3%, *Artemisia tridentata* cover ≤ 1%, combined cover of *Festuca idahoensis* and *Pseudoroegneria spicata* > 5%, other perennial grass cover > 5%, forb cover at least 5%, introduced or non-native grass cover < 1% ..... **Grasslands. 11**
    11. Southwest aspect, *Festuca idahoensis* cover < 10%, forb cover < 3%..... **Southwest Phase**
    11. Northeast aspect, *Festuca idahoensis* cover > 10%, forb cover > 3% ..... **Northeast Phase**
  10. *Artemisia tridentata tridentata* cover < 5%, *Artemisia tridentata vaseyana* cover < 2%, non-native or introduced grass cover > 10%, forb cover < 4% ..... **Abandoned Agriculture Lands**

# Additional Metrics

## Forage Production (carrying capacity)

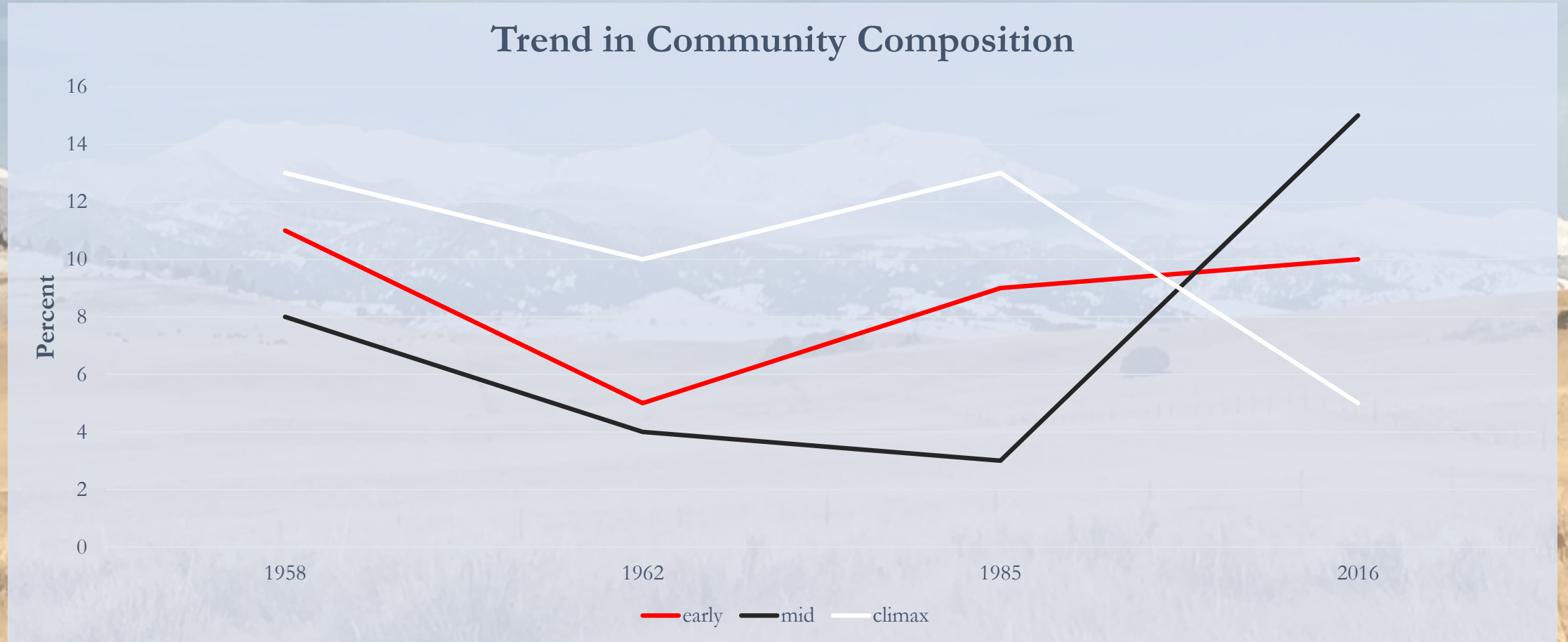
Community Type	Biomass kg/ha	Grass Production
Grassland, NE	199	92 (82)
MT Big/Steep	208	83 (74)
MT Big/Bluebunch	725	232 (208)
Bitterbrush	330	76 (68)

## Shrub Density (winter browse)

Community Type	Sagebrush Density (m <sup>2</sup> )
Abandoned Agricultural Fields	0.2 <sup>a</sup>
Basin Big Sagebrush	0.4
Black Sage, level phase	0.9 <sup>b</sup>
Black Sage, steep phase	0.7
Grassland, Idaho Fescue, loamy	0.5
Grassland, Idaho fescue/bluebunch	0.2 <sup>a</sup>
Mountain, deep loamy phase	0.4
Mountain, degraded phase	0.6
Mountain, sandy loam phase	0.6
Mountain, forb phase	0.6
Mountain, steep phase	0.4

Woody Species	Artri Psespi	Artri Fesida	Artri Symbalb	Purtri Psespi	Poapra Gervis	Poptre Potgra
A. tridentata vaseyana	0.9 <sup>a</sup>	0.5 <sup>a</sup>	0.8 <sup>a</sup>	0.03 <sup>b</sup>	0.01 <sup>b</sup>	0.2 <sup>ab</sup>
Symphoricarpos alba	0.1 <sup>a</sup>	0 <sup>a</sup>	0.b <sup>b</sup>	0 <sup>a</sup>	0.1 <sup>a</sup>	.03 <sup>a</sup>
Pinus contorta	0 <sup>a</sup>	0.01 <sup>a</sup>	0 <sup>a</sup>	0.1 <sup>b</sup>	0.01 <sup>a</sup>	0.02 <sup>a</sup>
Populus tremuloides	0 <sup>a</sup>	0 <sup>a</sup>	0.1 <sup>a</sup>	0 <sup>a</sup>	0.2 <sup>a</sup>	0.4 <sup>b</sup>
Purshia tridentata	0 <sup>a</sup>	0 <sup>a</sup>	0.4 <sup>b</sup>	0.04 <sup>c</sup>	0 <sup>a</sup>	0 <sup>a</sup>

# Comparison with Historical Data





# Data collection protocol designed to facilitate re-sampling at these locations

Site ID	Latitude	Longitude	elevation	geology	aspect	Slope Class	Community Type	location	Sample Year
16	45.16042	-110.843	1541	unconsolidated	flat	0-4%	Mountain big sagebrush, deep phase		2015
17	45.17882	-110.895	1602	bedrock controlled	sw	35-60%	Grassland, Idaho fescue/bluebunch		2015
18	45.07004	-110.782	1610	unconsolidated	ne	4 - 15%	Basin big sagebrush	beadie gulch	2015
19	45.15473	-110.838	1615	unconsolidated	ne	15-35%	Mountain big sagebrush, degraded phase		2015
20	45.12023	-110.815	1655	bedrock controlled	sw	15-35%	Mountain big sagebrush, steep phase	universal church	2015
21	45.12573	-110.817	1662	unconsolidated	ne	15-35%	Mountain big sagebrush, degraded phase	universal church	2015
22	45.14732	-110.806	1668	bedrock controlled	ne	35-60%	Mountain big sagebrush, degraded phase	oto ranch	2015
23	45.04797	-110.735	1690	unconsolidated	sw	35-60%	Grassland, Idaho fescue/bluebunch	travertine road	2015
24	45.13993	-110.827	1703	unconsolidated	ne	35-60%	Mountain big sagebrush, deep phase	universal church	2015
25	45.11792	-110.818	1739	bedrock controlled	ne	35-60%	Black sagebrush, steep phase	hideway road	2015
26	45.03937	-110.693	1779	bedrock controlled	ne	4-15%	Mountain big sagebrush, deep phase	travertine road	2015
27	45.06086	-110.746	1794	bedrock controlled	sw	4-15%	Basin big sagebrush	travertine road	2015
28	45.05637	-110.746	1794	bedrock controlled	ne	15-35%	Black sagebrush, steep phase	travertine road	2015
29	45.09635	-110.811	1819	bedrock controlled	ne	15-35%	Black sagebrush, steep phase		2015
30	45.1321	-110.785	1839	bedrock controlled	ne	35-60%	Black sagebrush, steep phase		2015
31	45.04624	-110.699	1845	bedrock controlled	ne	4-15%	Basin big sagebrush	travertine road	2015
32	45.05086	-110.712	1878	bedrock controlled	flat	0-4%	Mountain big sagebrush, degraded phase	travertine road	2015
33	45.0999	-110.811	1923	bedrock controlled	ne	35-60%	Black sagebrush, steep phase		2015
34	45.05184	-110.676	1938	unconsolidated	sw	4-15%	Mountain big sagebrush, sandy loam	eagle creek	2015
35	45.04833	-110.674	1955	unconsolidated	sw	15-35%	Mountain big sagebrush, sandy loam	eagle creek	2015
36	45.1261	-110.839	1983	bedrock controlled	ne	15-35%	Mountain big sagebrush, sandy loam	hideway road	2015
37	45.0593	-110.651	2057	bedrock controlled	sw	35-60%	Mountain big sagebrush, steep phase	bear creek	2015
38	45.06661	-110.673	2137	bedrock controlled	ne	15-35%	Mountain big sagebrush, sandy loam	eagle creek	2015
39	45.07324	-110.644	2153	bedrock controlled	ne	15-35%	Mountain big sagebrush, deep phase	eagle creek	2015
40	45.0642	-110.684	2144	bedrock controlled	sw	15-35%	Abandoned agricultural fields	eagle creek	2015
41	45.14991	-110.789	1768	unconsolidated	sw	15-35%	Abandoned agricultural fields	oto ranch	2015
42	45.117	-110.827	1811	bedrock controlled	sw	35-60%	Mountain big sagebrush, sandy loam	hideway road	2015
43	45.10375	-110.792	1632	bedrock controlled	sw	35-60%	Grassland, Idaho fescue/bluebunch	old Yellowstone trail	2016
44	45.11886	-110.805	1720	bedrock controlled	sw	35-60%	Grassland, Idaho fescue/bluebunch	cinabar mountain	2016
45	45.17848	-110.803	2057	unconsolidated	sw	35-60%	Mountain big sagebrush, steep phase	slip & slide	2016
46	45.17664	-110.816	1857	unconsolidated	sw	35-60%	Grassland, Idaho fescue./bluebunch	slip & slide	2016

# Tracking Ungulate – Vegetation Interactions

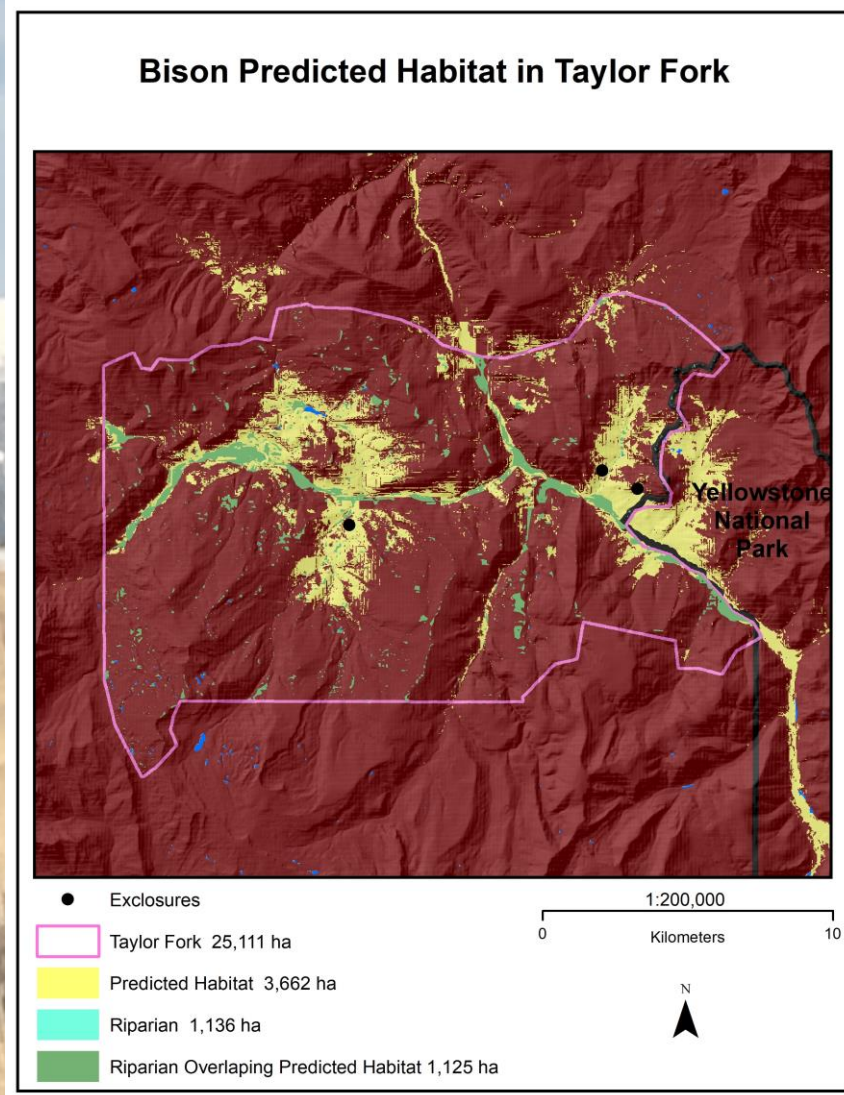
- Regular monitoring of established sites is critical; the vegetation/soil complexes in both areas stand at a threshold
  - Few of the inventoried sites were at potential listed by either Forest Service publications or Montana Natural Heritage listings
  - Antelope Bitterbrush community type is an example
    - Poorly developed, infertile soils + flat topography (primary foraging area)
    - Grass production < 100lbs/ac and dominant vegetation indicates declining ecological condition; community type is at its limit
- Additional measures like shrub density and canopy intercept can be used to explain apparent changes discovered through cover monitoring
  - Long history of heavy grazing use means these ecological baseline reference conditions are at the lower threshold, no where to go but up.

# Acknowledgements



- Custer-Gallatin NF for funding, logistical and data support
  - Jodi Canfield
  - Walt Allen
  - Tom Keck
- A herd of underpaid and overworked MSU undergraduate and graduate students

# Taylor Fork Habitat



# Bison Habitat

