**APPENDIX H** 

CLIMATE CHANGE VULNERABILITY INDEX DOCUMENTATION

# Middle Rockies Grizzly Bear NSCCVI

Release 2.1 7 April 2011; Bruce Yo With input fror Funding for Re	Change Vulnerability Index oung, Elizabeth Byers, Kelly Gravuer, Kim Hall, m: Jay Cordeiro, Kristin Szabo elease 2.0 generously provided by the Duke Er = Required field	Geoff Hammerson, Alan Redder NatureServe
Geographic Area Assessed:	Middle Rockies Ecoregion	]*
Assessor:	Sarah Bresnan	]
Species Scientific Name:	Ursus arctos	* English Name: Grizzly Bear
Major Taxonomic Group:	Mammal	]*
Relation of Species' Range	to Assessment Area: Southern edge of	range * G-Rank: G4
Check if species is an obligate of ca	aves or groundwater aquatic systems:	(Must be marked with an "X" for accurate scoring of these species.)
Assessment Notes (to document spec	cial methods and data sources)	
S-Rank - NatureServe Explorer U.S. &	& Canada State/Province Status: Montana (S2S	S3)
Section A: Exposure to Local Climat	te Change (Calculate for species' range within	assessment area)
Tomporaturo *		Hamon AET-PET Moisture Metric *
remperature		
Severity         S           >5.5° F (3.1° C) warmer         5.1-5.5° F (2.8-3.1° C) warmer           4.5-5.0° F (2.5-2.7° C) warmer         3.9-4.4° F (2.2-2.4° C) warmer           3.9° F (2.2° C) warmer         Total:	Cope (percent of range)           18.002         69.4715           69.4715         12.5265           0         0           100         (Must sum to 100)	Severity         Scope (percent of range) $< -0.119$ $8.2668$ $-0.097 - 0.119$ $61.8974$ $-0.074 - 0.096$ $27.5892$ $-0.051 - 0.073$ $2.2466$ $-0.028 - 0.050$ 0 $> -0.028$ 0 $Total:$ 100
Severity         S           >5.5° F (3.1° C) warmer         5.1-5.5° F (2.8-3.1° C) warmer           4.5-5.0° F (2.5-2.7° C) warmer         3.9-4.4° F (2.2-2.4° C) warmer           3.9° F (2.2° C) warmer         Total:	Scope (percent of range)         18.002         69.4715         12.5265         0         0         0         0         0         0         0         0         100         (Must sum to 100)	Severity       Scope (percent of range) $-0.097 - 0.119$ $61.8974$ $-0.074 - 0.096$ $27.5892$ $-0.51 - 0.073$ $2.2466$ $-0.028 - 0.050$ $0$ $-0.028$ $0$ Total:       100         (Must sum to 100)
Severity         S           >5.5° F (3.1° C) warmer         5.1-5.5° F (2.8-3.1° C) warmer           4.5-5.0° F (2.5-2.7° C) warmer         3.9-4.4° F (2.2-2.4° C) warmer           3.9-4.4° F (2.2-2.4° C) warmer         -           3.9° F (2.2° C) warmer         -           Section B: Indirect Exposure to Clin	iscope (percent of range)         18.002         69.4715         12.5265         0         0         100         (Must sum to 100)	Severity         Scope (percent of range)           -0.097         -0.119         8.2668           -0.097         -0.119         61.8974           -0.074         -0.092         27.5892           -0.051         -0.073         2.2466           -0.028         -0         0           >-0.028         0         7otal:           100         (Must sum to 100)
Severity         S           >5.5° F (3.1° C) warmer         5.1°.5.0° F (2.8°.3.1° C) warmer           4.5°.5.0° F (2.8°.3.1° C) warmer         3.9°.4.4° F (2.2°.2.4° C) warmer           3.9° F (2.2° C) warmer         3.9° F (2.2° C) warmer           3.9° F (2.2° C) warmer         Total:   Section B: Indirect Exposure to Clin           Mark an "X" in all boxes that apply.   Effect o           Greative         Somewhat	Scope (percent of range) 18.002 69.4715 12.5265 0 0 0 100 (Must sum to 100) mate Change (Evaluate for specific geographic n Vulnerability	Severity         Scope (percent of range)           -0.097 - 0.119         8.2668           -0.097 - 0.119         61.8974           -0.051 - 0.073         2.2466           -0.028 - 0.050         0           >-0.028         0           Total:         100           Must sum to 100)         Factors that influence vulnerability (* at least three required)

## Middle Rockies Grizzly Bear NSCCVI

### Section C: Sensitivity

Mark an "X" in all boxes that apply.

	Effect on Vulnerability								
Greatly		Somewhat		Somewhat					
increase	Increase	increase	Neutral	decrease	Decrease	Unknown			
			Х	Х					
				Х					
		Х	Х						
				Х					
		Х	Х						
			Х						
		Х							
				Х					
			Х						
			Х						
						Х			
			Х						
			Х						
						Х			
			Х						
		Х							

#### Factors that influence vulnerability (\* at least 10 required)

1) Dispersal and movements

- 2) Predicted sensitivity to temperature and moisture changes
- a) Predicted sensitivity to changes in temperature
  - i) historical thermal niche
    - ii) physiological thermal niche
- b) Predicted sensitivity to changes in precipitation, hydrology, or moisture regime i) historical hydrological niche
  - ii) physiological hydrological niche
- c) Dependence on a specific disturbance regime likely to be impacted by climate change
- d) Dependence on ice, ice-edge, or snow-cover habitats
- 3) Restriction to uncommon geological features or derivatives
- 4) Reliance on interspecific interactions
- a) Dependence on other species to generate habitat
- b) Dietary versatility (animals only)
- c) Pollinator versatility (plants only)
- d) Dependence on other species for propagule dispersal
- e) Forms part of an interspecific interaction not covered by 4a-d
- 5) Genetic factors
- a) Measured genetic variation
- b) Occurrence of bottlenecks in recent evolutionary history (use only if 5a is "unknown")
- 6) Phenological response to changing seasonal temperature and precipitation dynamics

Section D: Documented or Modeled Response to Climate Change (Optional; May apply across the range of a species)

Mark an "X" in all boxes that apply.

	Effect on Vulnerability									
Greatly		Somewhat		Somewhat						
increase	Increase	increase	Neutral	decrease	Decrease	Unknown				
			Х							
						Х				
						Х				
						Х				

#### (Optional)

1) **Documented response** to recent climate change

2) Modeled future (2050) change in population or range size

- 3) Overlap of modeled future (2050) range with current range
- 4) Occurrence of protected areas in modeled future (2050) distribution

# Middle Rockies Grizzly Bear NSCCVI





Results of a Monte Carlo simulation (1000 runs) of the data entered in the Index.

# Middle Rockies Greater Sage-Grouse NSCCVI

Release	tureServe 2.1 7 April 201 Wit Fu	Climate 11; Bruce You th input from: nding for Rel	Change ung, Elizabet : Jay Cordeir lease 2.0 ger	<b>Vulnera</b> th Byers, K ro, Kristin S nerously pr	Ibility Inc Sily Gravuer, Zabo Divided by the	<b>lex</b> Kim Hall, Geoff F Duke Energy Co	lammerson, Ala rporation.	n Redder	NatureServe	
		*=	= Required fie	eld						
Geog	graphic Area As	ssessed:	Midd	dle Rockies	Ecoregion	*				
	As	ssessor:		Sarah Bre	snan					
S	pecies Scientifi	c Name:	Centr	rocercus ur	ophasianus	*	Eng	lish Name:	Greater Sage-Grouse	
M	lajor Taxonomio	c Group:		Bird		*		C Banks 0204	7	
R	elation of Spec	ies' Range te	o Assessme	ent Area:	East/wes	t edge of range	*	S-Rank: 0304		
Check if s	pecies is an ob	ligate of cav	ves or groun	ndwater ac	uatic system	IS:	(Must be n	narked with an "X" for	accurate scoring of these sp	ecies.)
Assessme	ent Notes (to do	cument speci	ial methods a	and data so	urces)					
Section A	: Exposure to L	ocal Climate	e Change ((	Calculate fo	r species' rai	nge within assess	ment area)		-,	
Temperate	ure *					Hamon	AET:PET Mois	sture Metric *		
5.1-5. 4.5-5.	Severity >5.5° F (3.1° C) 5° F (2.8-3.1° C) 0° F (2.5-2.7° C) 4° F (2.2-2.4° C)	warmer warmer warmer warmer	cope (percent 24.7544 57.5526 17.693	t of range)		Severit	<ul> <li>-0.119</li> <li>-0.0970.119</li> </ul>	Scope (percent of ra 13.919 42.1471 26.2474	nge)	
3.9-4.	< 3.9° F (2.2° Č)	warmer Total:	о 0 100 <i>(М</i>	fust sum to 10	0)		-0.0740.096 -0.0510.073 -0.0280.050 >-0.028 <i>Total</i> :	7.5723 0.000143 0.014057 100 (Must sur	n to 100)	
3.9-4.	< 3.9° F (2.2° C)	warmer Total:	0 0 100 (M	Aust sum to 10	0)		-0.0740.096 -0.0510.073 -0.0280.050 >-0.028 <i>Total</i> :	7.5723 0.000143 0.014057 100 (Must sur	n to 100)	
3.9-4. Section B	< 3.9° F (2.2° C)	warmer Total:	100 (M	lust sum to 10	0) for specific ge	eographical area	-0.0740.094 -0.0510.073 -0.0280.050 >-0.028 <i>Total:</i> <i>under consider</i>	30.3474 7.5723 0.000143 0.014057 100 (Must sur	n to 100)	
3.9-4. Section B	< 3.9° F (2.2° Č)	warmer Total:	ate Change	lust sum to 10 (Evaluate illity	0) for specific gu	eographical area	-0.074 - 0.092 -0.051 - 0.073 -0.028 - 0.050 >-0.026 -0.026 Total: under consider	3.3474 7.5723 0.000143 0.014057 100 (Must sur ation)	n to 100) nerability (* at least three	required)
Section B	< 3.9° F (2.2° Č)	warmer	ate Change	fust sum to 10 (Evaluate illity ecrease	0) for specific gu	eographical area	-0.0740.09 -0.0510.073 -0.0280.050 >-0.028 <i>Total:</i> under consider	30.3474 7.5723 0.000143 0.014057 100 (Must sur ation)	n to 100) nerability (* at least three	required)
Section B Mark an "X" in Greatly increase	< 3.9° F (2.2° Č)	sure to Clima oply. Effect on mewhat ncrease	ate Change	lust sum to 10 (Evaluate bility omewhat ecrease	o) for specific ge Decrease U	eographical area	-0.0740.09 -0.0510.073 -0.028 - 0.050 >-0.026 <i>Total:</i> <i>under consider</i> <u>Factors 1</u> 1) Exposu	30.3474 7.5723 0.000143 0.014057 100 (Must sur ation) hat influence vul	n to 100) nerability (* at least three	required)
Section B Mark an "X" in Greatly increase	< 3.9° F (2.2° Č)	sure to Clima oply. Effect on mewhat hcrease	ate Change	lust sum to 10 (Evaluate illity pomewhat ecrease	o) for specific g Decrease U	eographical area	-0.0740.095 -0.051 -0.073 -0.028 -0.050 >-0.028 <i>Total:</i> <i>under consider</i> <u>Factors 1</u> 1) Exposu 2) Distribu a) Natur	ation)	n to 100) <u>nerability (* at least three</u> s	required)
Section B Mark an "X" in Greatly increase	< 3.9° F (2.2° Č)	sure to Clima oply. Effect on mewhat hcrease N	ate Change	lust sum to 10 (Evaluate illity pomewhat ecrease	o) for specific g Decrease U	eographical area	-0.0740.095 -0.051 -0.073 -0.0280.050 >-0.028 <i>Total:</i> <i>under consider</i> <b>Factors 1</b> 1) Exposu 2) Distribu a) Natur b) Anthr	ation) hat influence vul hat influence vul re to sea level rise al barriers pogenic barriers	n to 100) <u>nerability (</u> * at least three s	required)

### Middle Rockies Greater Sage-Grouse NSCCVI

#### Section C: Sensitivity

Mark an "X" in all boxes that apply.

		Effect	on Vulne	rability		
Greatly		Somewhat		Somewhat		
increase	Increase	increase	Neutral	decrease	Decrease	Unknown
			Х			
				Х		
			Х			
				X		
			Х			
		Х				
			Х			
			~	X		
	х	Х				
			X			
			~			х
			X			
			X			
			~			
						X
		x				~
	X	X				

#### Factors that influence vulnerability (\* at least 10 required)

1) Dispersal and movements

- 2) Predicted sensitivity to temperature and moisture changes
- a) Predicted sensitivity to changes in temperature
- i) historical thermal niche
  - ii) physiological thermal niche
- b) Predicted sensitivity to changes in precipitation, hydrology, or moisture regime i) historical hydrological niche
  - ii) physiological hydrological niche
- c) Dependence on a **specific disturbance regime** likely to be impacted by climate change
- d) Dependence on ice, ice-edge, or snow-cover habitats
- 3) Restriction to uncommon geological features or derivatives
- 4) Reliance on interspecific interactions
- a) Dependence on other species to generate habitat
- b) Dietary versatility (animals only)
- c) Pollinator versatility (plants only)
- d) Dependence on other species for propagule dispersal
- e) Forms part of an interspecific interaction not covered by 4a-d
- 5) Genetic factors
- a) Measured genetic variation
- b) Occurrence of bottlenecks in recent evolutionary history (use only if 5a is "unknown")
- 6) Phenological response to changing seasonal temperature and precipitation dynamics

Section D: Documented or Modeled Response to Climate Change (Optional; May apply across the range of a species)

Mark an "X" in all boxes that apply.

Effect on Vulnerability									
Greatly		Somewhat		Somewhat					
increase	Increase	increase	Neutral	decrease	Decrease	Unknown			
						Х			
						Х			
						Х			
						Х			

(Optional)

1) Documented response to recent climate change

- 2) Modeled future (2050) change in population or range size
- 3) Overlap of modeled future (2050) range with current range
- 4) Occurrence of protected areas in modeled future (2050) distribution

## Middle Rockies Greater Sage-Grouse NSCCVI





Results of a Monte Carlo simulation (1000 runs) of the data entered in the Index.

# Middle Rockies Golden Eagle NSCCVI

The NatureServe Climate Change Vulnerability Index Release 2.1 7 April 2011; Bruce Young, Elizabeth Byers, Kelly Gravuer, Kim I With input from: Jay Cordeiro, Kristin Szabo Funding for Release 2.0 generously provided by the Duk	Hall, Geoff Hammerson, Alan Redder NatureServe
* = Required field	
Geographic Area Assessed: Middle Rockies Ecoregion	*
Assessor: Sarah Bresnan	
Species Scientific Name: Aquila chrysaetos	* English Name: Golden Eagle
Major Taxonomic Group: Bird	
Relation of Species' Range to Assessment Area: Entire	range * S-Rank: G5
Check if species is an obligate of caves or groundwater aquatic systems:	(Must be marked with an "X" for accurate scoring of these species.)
Assessment Notes (to document special methods and data sources)	
Section A: Exposure to Local Climate Change (Calculate for species' range v         Temperature *         Severity       Scope (percent of range)	vithin assessment area) Hamon AET:PET Moisture Metric * Severity <u>Scope (percent of range)</u>
>5.5° F (3.1° C) warmer 20.5 5.1-5.5° F (2.8-3.1° C) warmer 59.7 4.5-5.0° F (2.5-2.7° C) warmer 19.8 3.9-4.4° F (2.2-2.4° C) warmer 0 < 3.9° F (2.2° C) warmer 0 Total: 100 (Must sum to 100)	< -0.119 12.7224 -0.097 - 0.119 43.7861 -0.074 - 0.096 32.2697 -0.051 - 0.073 10.9624 -0.028 - 0.050 0.2594 >-0.028 0 Total: 100 (Must sum to 100)
Section B: Indirect Exposure to Climate Change (Evaluate for specific geogra	aphical area under consideration)
Mark an "X" in all boxes that apply.	
Effect on Vulnerability Greatly Somewhat Somewhat	Factors that influence vulnerability (* at least three required)
increase Increase increase Neutral decrease Decrease Unkn	1) Exposure to sea level rise     2) Distribution relative to barriers     Alternative to barriers

## Middle Rockies Golden Eagle NSCCVI

### Section C: Sensitivity

Mark an "X" in all boxes that apply.

		Effect	on Vulne	rability		
Greatly		Somewhat		Somewhat		
increase	Increase	increase	Neutral	decrease	Decrease	Unknown
					Х	
				Х		
			Х			
				Х		
			Х			
		Х				
						Х
				Х		
			Х			
			Х			
						Х
			Х			
			Х			
						Х
			Х			
			Х			

#### Factors that influence vulnerability (\* at least 10 required)

1) Dispersal and movements

- 2) Predicted sensitivity to temperature and moisture changes
- a) Predicted sensitivity to changes in temperature
  - i) historical thermal niche
    - ii) physiological thermal niche
- b) Predicted sensitivity to changes in precipitation, hydrology, or moisture regime i) historical hydrological niche
  - ii) physiological hydrological niche
- c) Dependence on a specific disturbance regime likely to be impacted by climate change
- d) Dependence on ice, ice-edge, or snow-cover habitats
- 3) Restriction to uncommon geological features or derivatives
- 4) Reliance on interspecific interactions
- a) Dependence on other species to generate habitat
- b) Dietary versatility (animals only)
- c) Pollinator versatility (plants only)
- d) Dependence on other species for propagule dispersal
- e) Forms part of an interspecific interaction not covered by 4a-d
- 5) Genetic factors
- a) Measured genetic variation
- b) Occurrence of **bottlenecks** in recent evolutionary history (use only if 5a is "unknown")
- 6) Phenological response to changing seasonal temperature and precipitation dynamics

Section D: Documented or Modeled Response to Climate Change (Optional; May apply across the range of a species)

Mark an "X" in all boxes that apply.

Effect on Vulnerability									
Greatly		Somewhat		Somewhat					
increase	Increase	increase	Neutral	decrease	Decrease	Unknown			
						Х			
						Х			
						Х			
						Х			

#### (Optional)

1) **Documented response** to recent climate change

2) Modeled future (2050) change in population or range size

- 3) Overlap of modeled future (2050) range with current range
- 4) Occurrence of protected areas in modeled future (2050) distribution

# Middle Rockies Golden Eagle NSCCVI

## **Climate Change Vulnerability Index** for Aquila chrysaetos in Middle Rockies Ecoregion Confidence in Species Not Vulnerable/Increase Likely **Information** Very High Notes: Species range may shift and perhaps leave the assessment area. \* Histogram below **Definitions of Index Values** Extremely Vulnerable (EV): Abundance and/or range extent within geographical area assessed extremely likely to substantially decrease or disappear by 2050. Highly Vulnerable (HV): Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050. Moderately Vulnerable (MV): Abundance and/or range extent within geographical area assessed likely to decrease by 2050. Not Vulnerable/Presumed Stable (PS): Available evidence does not suggest that abundance and/or range extent within the geographical area assessed will change (increase/decrease) substantially by 2050. Actual range boundaries may change. Not Vulnerable/Increase Likely (IL): Available evidence suggests that abundance and/or range extent within geographical area assessed is likely to increase by 2050. Insufficient Evidence (IE): Available information about a species' vulnerability is inadequate to calculate an Index score.



Results of a Monte Carlo simulation (1000 runs) of the data entered in the Index.

# Middle Rockies Mule Deer NSCCVI

With inp Funding	te Change Vulner ce Young, Elizabeth Byers, i ut from: Jay Cordeiro, Kristin for Release 2.0 generously * = Required field	<b>ability Index</b> Kelly Gravuer, Kim Hall, Geofl Szabo orovided by the Duke Energy	Hammerson, Alan Redder Corporation.	NatureServe	
Geographic Area Assess	ed: Middle Rocki	es Ecoregion *			
	Sorah [	Program			
Assess	Saran E	breshan			
Species Scientific Nar	ne: Odocoileus	s hemionus *	English Name:	Mule Deer	
Major Taxonomic Gro	u <b>p:</b> Man	nmal *	G-Pank: G5	_	
Relation of Species' R	ange to Assessment Area	: Entire range	* <b>S-Rank:</b> S5		
Check if species is an obligate	of caves or groundwater a	aquatic systems:	(Must be marked with an "X" for	accurate scoring of these species.)	
Assessment Notes (to documer	t special methods and data	sources)		- · ·	
S-Rank - NatureServe Explorer L	J.S. & Canada State/Provinc	e Status: Montana (S5), Idah	o (S5), Wyoming (S5), South Dakota (S	5)	
Section A: Exposure to Local C	Climate Change (Calculate	for species' range within asse	ssment area)		
T			en AFT-DFT Meisture Metrie *		
Temperature "		Ham			
			on ALT.PLT MOISture Metho		
Severity	Scope (percent of range	e) Seve	erity Scope (percent of r	ange)	
<b>Severity</b> >5.5° F (3.1° C) warm 5.1-5.5° F (2.8-3.1° C) warm	Scope (percent of range ner 4.2661984 er 47.753053	e) Seve	erity Scope (percent of r <-0.119 0.349484 -0.097 - 0.119 43.70727	ange)	
<b>Severity</b> >5.5° F (3.1° C) warm 5.1-5.5° F (2.8-3.1° C) warm 4.5-5.0° F (2.5-2.7° C) warm	Scope (percent of range ner 4.2661984 47.753053 her 47.980749	e) Seve	Scope         (percent of r           < -0.119	ange)	
<b>Severity</b> >5.5° F (3.1° C) warm 5.1-5.5° F (2.8-3.1° C) warm 4.5-5.0° F (2.5-2.7° C) warm 3.9-4.4° F (2.2-2.4° C) warm < 3.9° F (2.2° C) warm	Scope (percent of range er 4.2661984 er 47.753053 er 47.980749 er 0 er 0	e) Seve	Scope         (percent of r           < -0.119	ange)	
<b>Severity</b> >5.5° F (3.1° C) warm 5.1-5.5° F (2.8-3.1° C) warm 4.5-5.0° F (2.5-2.7° C) warm 3.9-4.4° F (2.2-2.4° C) warm < 3.9° F (2.2° C) warm To	Scope (percent of range ner 4.2661984 er 47.753053 her 47.980749 er 0 tal: 100 (Must sum to	e) Seve	Scope         (percent of r           < -0.119	ange)	
<b>Severity</b> >5.5° F (3.1° C) warm 5.1-5.5° F (2.8-3.1° C) warm 4.5-5.0° F (2.5-2.7° C) warm 3.9-4.4° F (2.2-2.4° C) warm < 3.9° F (2.2° C) warm To	Scope (percent of range er 4.2661984 47.753053 er 47.980749 er 0 tal: 100 (Must sum to	e) Seve	Scope         (percent of r           < -0.119	ange) ım to 100)	
<b>Severity</b> >5.5° F (3.1° C) warm 5.1-5.5° F (2.8-3.1° C) warm 4.5-5.0° F (2.5-2.7° C) warm 3.9-4.4° F (2.2-2.4° C) warm < 3.9° F (2.2° C) warm To	Scope (percent of range er 4.2661984 er 47.753053 her 0 her 0 tal: 100 (Must sum to	e) Seve	Scope         (percent of r           < -0.119	ange) ım to 100)	
Severity >5.5° F (3.1° C) warm 5.1-5.5° F (2.8-3.1° C) warm 4.5-5.0° F (2.5-2.7° C) warm 3.9-4.4° F (2.2-2.4° C) warm < 3.9° F (2.2° C) warm To Section B: Indirect Exposure to	Scope (percent of range ther 4.2661984 47.753053 ther 47.980749 ter 0 tal: 100 (Must sum to Climate Change (Evaluat	e for specific geographical are	Scope         (percent of r           < -0.119	ange) Im to 100)	
Severity >5.5° F (3.1° C) warm 5.1-5.5° F (2.8-3.1° C) warm 4.5-5.0° F (2.5-2.7° C) warm 3.9-4.4° F (2.2-2.4° C) warm < 3.9° F (2.2° C) warm To Section B: Indirect Exposure to lark an "X" in all boyes that apply	Scope (percent of range er 4.2661984 47.753053 er 47.980749 er 0 tal: 100 (Must sum to	e) Seve	Scope         (percent of r           < -0.119	ange) ım to 100)	
Severity >5.5° F (3.1° C) warm 5.1-5.5° F (2.8-3.1° C) warm 4.5-5.0° F (2.5-2.7° C) warm 3.9-4.4° F (2.2-2.4° C) warm < 3.9° F (2.2° C) warm To Section B: Indirect Exposure to fark an "X" in all boxes that apply.	Scope (percent of range 4.2661984 47.753053 her 47.980749 her 0 tal: 100 (Must sum to b Climate Change (Evaluat	e) Seve	Scope (percent of r           < -0.119	ange) Im to 100)	
Severity           >5.5° F (3.1° C) warm           5.1-5.5° F (2.8-3.1° C) warm           4.5-5.0° F (2.5-2.7° C) warm           3.9-4.4° F (2.2-2.4° C) warm           < 3.9° F (2.2° C) warm	Scope (percent of range ter 4.2661984 ter 47.753053 ter 0 tal: 100 (Must sum to collimate Change (Evaluate tect on Vulnerability tet Somewhat	e) Seve	Scope (percent of r           < -0.119	ange) um to 100) Inerability (* at least three required)	
Severity           >5.5° F (3.1° C) warm           5.1-5.5° F (2.8-3.1° C) warm           4.5-5.0° F (2.5-2.7° C) warm           3.9-4.4° F (2.2-2.4° C) warm           < 3.9° F (2.2° C) warm	Scope (percent of range ter 4.2661984 ter 47.753053 ter 0 ter 0 tal: 100 (Must sum to c Climate Change (Evaluate ter on Vulnerability ter Neutral decrease	e) Seve	Scope (percent of r           < -0.119	ange) Imerability (* at least three required)	
Severity           >5.5° F (3.1° C) warm           5.1-5.5° F (2.8-3.1° C) warm           4.5-5.0° F (2.5-2.7° C) warm           3.9-4.4° F (2.2-2.4° C) warm           < 3.9° F (2.2° C) warm	Scope (percent of range er 4.2661984 47.753053 her 0 her 0 tal: 100 (Must sum to Climate Change (Evaluat ect on Vulnerability hat Neutral decrease X	e) Seve	Scope (percent of r           < -0.119	ange) um to 100) Inerability (* at least three required)	
Severity           >5.5° F (3.1° C) warm           5.1-5.5° F (2.8-3.1° C) warm           4.5-5.0° F (2.5-2.7° C) warm           3.9-4.4° F (2.2-2.4° C) warm           < 3.9° F (2.2° C) warm	Scope (percent of range ter 4.2661984 47.753053 47.980749 ter 0 tal: 100 (Must sum to Climate Change (Evaluat Control Vulnerability ter Neutral decrease X X	e) Seve	Scope (percent of r           < -0.119	ange) Imerability (* at least three required)	
Severity           >5.5° F (3.1° C) warm           5.1-5.5° F (2.8-3.1° C) warm           4.5-5.0° F (2.5-2.7° C) warm           3.9-4.4° F (2.2-2.4° C) warm           < 3.9° F (2.2° C) warm	Scope (percent of range ter 4.2661984 47.753053 ter 0 ter 0 tal: 100 (Must sum to Climate Change (Evaluat ter Neutral decrease X X X X	e) Seve	Scope         (percent of r           < -0.119	ange) Imerability (* at least three required)	

## Middle Rockies Mule Deer NSCCVI

### Section C: Sensitivity

Mark an "X" in all boxes that apply.

	Effect on Vulnerability										
Greatly		Somewhat		Somewhat							
increase	Increase	increase	Neutral	decrease	Decrease	Unknown					
				Х	Х						
				Х							
			Х								
				X							
			х	~		-					
			X			-					
			X								
			~	Y							
			v								
			×								
			^			v					
			X			Χ.					
			X								
			X								
						Х					
			Х								
						Х					

#### Factors that influence vulnerability (\* at least 10 required)

1) Dispersal and movements

- 2) Predicted sensitivity to temperature and moisture changes
- a) Predicted sensitivity to changes in temperature
  - i) historical thermal niche
    - ii) physiological thermal niche
- b) Predicted sensitivity to changes in precipitation, hydrology, or moisture regime i) historical hydrological niche
  - ii) physiological hydrological niche
- c) Dependence on a specific disturbance regime likely to be impacted by climate change
- b) Dependence on ice, ice-edge, or snow-cover habitats
- B) Restriction to uncommon geological features or derivatives
- 4) Reliance on interspecific interactions
- a) Dependence on other species to generate habitat
- b) Dietary versatility (animals only)
- c) Pollinator versatility (plants only)
- d) Dependence on other species for propagule dispersal
- e) Forms part of an interspecific interaction not covered by 4a-d
- 5) Genetic factors
- a) Measured genetic variation
- b) Occurrence of bottlenecks in recent evolutionary history (use only if 5a is "unknown")
- 6) Phenological response to changing seasonal temperature and precipitation dynamics

Section D: Documented or Modeled Response to Climate Change (Optional; May apply across the range of a species)

Mark an "X" in all boxes that apply.

Effect on Vulnerability									
Greatly		Somewhat		Somewhat					
increase	Increase	increase	Neutral	decrease	Decrease	Unknown			
						Х			
						Х			
						Х			
						Х			

#### (Optional)

1) **Documented response** to recent climate change

2) Modeled future (2050) change in population or range size

- 3) Overlap of modeled future (2050) range with current range
- 4) Occurrence of protected areas in modeled future (2050) distribution

# Middle Rockies Mule Deer NSCCVI

# **Climate Change Vulnerability Index** for Odocoileus hemionus in Middle Rockies Ecoregion Confidence in Species Not Vulnerable/Increase Likely **Information** Very High Notes: Species range may shift and perhaps leave the assessment area. \* Histogram below **Definitions of Index Values** Extremely Vulnerable (EV): Abundance and/or range extent within geographical area assessed extremely likely to substantially decrease or disappear by 2050. Highly Vulnerable (HV): Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050. Moderately Vulnerable (MV): Abundance and/or range extent within geographical area assessed likely to decrease by 2050. Not Vulnerable/Presumed Stable (PS): Available evidence does not suggest that abundance and/or range extent within the geographical area assessed will change (increase/decrease) substantially by 2050. Actual range boundaries may change. Not Vulnerable/Increase Likely (IL): Available evidence suggests that abundance and/or range extent within geographical area assessed is likely to increase by 2050. Insufficient Evidence (IE): Available information about a species' vulnerability is inadequate to calculate an Index score.



Results of a Monte Carlo simulation (1000 runs) of the data entered in the Index.

# Middle Rockies Elk NSCCVI

The NatureServe Climate Release 2.1 7 April 2011; Bruce Yo With input from Funding for Re	Change Vulnerability Index oung, Elizabeth Byers, Kelly Gravuer, Kim H. n: Jay Cordeiro, Kristin Szabo elease 2.0 generously provided by the Duke	all, Geoff Hammerson, Alan Redder Energy Corporation.
*:	= Required field	
Geographic Area Assessed:	Middle Rockies Ecoregion	*
Assessor:	Sarah Bresnan	
Species Scientific Name:	Cervus canadensis	* English Name: Elk
Major Taxonomic Group:	Mammal	*
Relation of Species' Range	to Assessment Area: Entire ra	nge * S-Rank: S5
Check if species is an obligate of ca	ives or groundwater aquatic systems:	(Must be marked with an "X" for accurate scoring of these species.)
	cial methods and data sources)	
Assessment Notes (to document spec S-Rank - NatureServe Explorer U.S. &	Canada State/Province Status: Montana (S	S5), Idaho (S5), Wyoming (S5), South Dakota (S5)
Assessment Notes (to document spec S-Rank - NatureServe Explorer U.S. & Section A: Exposure to Local Climat	Canada State/Province Status: Montana (	55), Idaho (S5), Wyoming (S5), South Dakota (S5)
Assessment Notes (to document spec S-Rank - NatureServe Explorer U.S. & Section A: Exposure to Local Climat Temperature *	Canada State/Province Status: Montana (: Canada State/Province Status: Montana (: Canada State/Province Status: Montana (:	S5), Idaho (S5), Wyoming (S5), South Dakota (S5) hin assessment area) Hamon AET:PET Moisture Metric *
Assessment Notes (to document spec S-Rank - NatureServe Explorer U.S. & Section A: Exposure to Local Climat Temperature * Severity >5.5° F (3.1° C) warmer 5.1-5.5° F (2.8-3.1° C) warmer 4.5-5.0° F (2.5-2.7° C) warmer 3.9-4.4° F (2.2-2.4° C) warmer < 3.9° F (2.2° C) warmer Total:	Canada State/Province Status: Montana ( te Change (Calculate for species' range wi cope (percent of range) 16.63 51.94 31.43 0 100 (Must sum to 100)	35), Idaho (S5), Wyoming (S5), South Dakota (S5)         hin assessment area)         Hamon AET:PET Moisture Metric *         Scope (percent of range)         < -0.119
Assessment Notes (to document spec S-Rank - NatureServe Explorer U.S. & Section A: Exposure to Local Climat Temperature * Severity S >5.5° F (3.1° C) warmer 4.5-5.0° F (2.8-3.1° C) warmer 3.9-4.4° F (2.2-2.4° C) warmer 3.9° F (2.2° C) warmer Total: Section B: Indirect Exposure to Clim	Canada State/Province Status: Montana (: te Change (Calculate for species' range wi 16.63 51.94 31.43 0 100 (Must sum to 100) tate Change (Evaluate for specific geografi	35), Idaho (S5), Wyoming (S5), South Dakota (S5)         hin assessment area)         Hamon AET:PET Moisture Metric *         Scope (percent of range)         < -0.119
Assessment Notes (to document spec S-Rank - NatureServe Explorer U.S. & Section A: Exposure to Local Climat Temperature * Severity >5.5° F (3.1° C) warmer 4.5-5.0° F (2.5-2.7° C) warmer 3.9-4.4° F (2.2-2.4° C) warmer < 3.9° F (2.2° C) warmer Total: Section B: Indirect Exposure to Clim Mark an "X" in all boxes that apply.	Canada State/Province Status: Montana ( te Change (Calculate for species' range wi cope (percent of range) 16.63 51.94 31.43 0 0 (Must sum to 100) tate Change (Evaluate for specific geograp	35), Idaho (S5), Wyoming (S5), South Dakota (S5)         thin assessment area)         Hamon AET:PET Moisture Metric *         Scope (percent of range)         < -0.119
Assessment Notes (to document spec S-Rank - NatureServe Explorer U.S. & Section A: Exposure to Local Climat Temperature * Severity Severity Sev	Canada State/Province Status: Montana ( te Change (Calculate for species' range wi cope (percent of range) 16.63 51.94 31.43 0 100 (Must sum to 100) tate Change (Evaluate for specific geographics) Nulnerability	35), Idaho (S5), Wyoming (S5), South Dakota (S5)         thin assessment area)         Hamon AET:PET Moisture Metric *         Scope (percent of range)         <-0.119

## Middle Rockies Elk NSCCVI

### Section C: Sensitivity

Mark an "X" in all boxes that apply.

Greatly		Somewhat		Somewhat		
increase	Increase	increase	Neutral	decrease	Decrease	Unknown
					Х	
				X		
			Y	X		
				~		
				X		
			X			
			Х			
			Х			
		Х				
			Х			
			Х			
			~			X
			×			~
			<u>~</u>			
			^			
						Х
			Х			
						Х

#### Factors that influence vulnerability (\* at least 10 required)

1) Dispersal and movements

- 2) Predicted sensitivity to temperature and moisture changes
- a) Predicted sensitivity to changes in temperature
  - i) historical thermal niche
    - ii) physiological thermal niche
- b) Predicted sensitivity to changes in precipitation, hydrology, or moisture regime i) historical hydrological niche
  - ii) physiological hydrological niche
- c) Dependence on a specific disturbance regime likely to be impacted by climate change
- d) Dependence on ice, ice-edge, or snow-cover habitats
- 3) Restriction to uncommon geological features or derivatives
- 4) Reliance on interspecific interactions
- a) Dependence on other species to generate habitat
- b) Dietary versatility (animals only)
- c) Pollinator versatility (plants only)
- d) Dependence on other species for propagule dispersal
- e) Forms part of an interspecific interaction not covered by 4a-d
- 5) Genetic factors
- a) Measured genetic variation
- b) Occurrence of bottlenecks in recent evolutionary history (use only if 5a is "unknown")
- 6) Phenological response to changing seasonal temperature and precipitation dynamics

## Middle Rockies Elk NSCCVI

Section D: Documented or Modeled Response to Climate Change (Optional; May apply across the range of a species)

Mark an "X" in all boxes that apply.

Effect on Vulnerability									
Greatly		Somewhat		Somewhat					
increase	Increase	increase	Neutral	decrease	Decrease	Unknown			
						Х			
						Х			
						Х			
						Х			

(Optional)

1) Documented response to recent climate change

- 2) Modeled future (2050) change in population or range size
- 3) Overlap of modeled future (2050) range with current range
- 4) Occurrence of protected areas in modeled future (2050) distribution



Moderately Vulnerable (MV): Abundance and/or range extent within geographical area assessed likely to decrease by 2050.

Not Vulnerable/Presumed Stable (PS): Available evidence does not suggest that abundance and/or range extent within the geographical area assessed will change (increase/decrease) substantially by 2050. Actual range boundaries may change.

Not Vulnerable/Increase Likely (IL): Available evidence suggests that abundance and/or range extent within geographical area assessed is likely to increase by 2050.

Insufficient Evidence (IE): Available information about a species' vulnerability is inadequate to calculate an Index score.



Results of a Monte Carlo simulation (1000 runs) of the data entered in the Index.