Grizzly Bear Climate Change Vulnerability Assessment: Cascadia Partner Forum Decision Support Framework

Final Report

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Grizzly Bear Climate Change Vulnerability Assessment: Cascadia Partner Forum Decision Support Framework

The following climate change vulnerability assessment was developed for the Cascadia Partner Forum to support climate change adaptation efforts. The assessment includes a decision support framework to assist managers with integration into management decisions relative to grizzly bears. The Structure of this Framework was adopted from Nelson et al. (2016).

Specify conservation target and unit of analysis

Conservation Target: Grizzly Bear (*Ursus arctos*)

Unit of Analysis: Population – North Cascades Ecosystem

The grizzly bear (*Ursus arctos*) is a wide-ranging carnivore native to Washington State. Once found in large numbers across the state, grizzly bear populations have decreased dramatically as a result of trapping, hunting, predator control, and habitat loss and fragmentation (USFWS 1997, 2011; WDFW 2015). The population in the North Cascades ecosystem is very small and has been functionally extirpated (Almack et al. 1993, Gaines et al. 2000, USDI 2017). A small population of approximately 70 to 80 bears persists in the Selkirk Ecosystem, a portion of which is in northeastern Washington (Kasworm et al. 2016, 2017).

Grizzly bear populations throughout the contiguous United States were reduced to the point where the grizzly bear was federally listed as a threatened species in 1975 (USFWS 1993). Six recovery area ecosystems were designated within the lower 48 states that include approximately 2% of the historical range of the grizzly bear (USFWS 1993, 1997). The six recovery areas include the Bitterroot Ecosystem, the Cabinet-Yaak Ecosystem, the North Cascades Ecosystem (NCE), the North Continental Divide Ecosystem, the Selkirk Ecosystem, and the Yellowstone Ecosystem. The NCE was officially designated a recovery area with a recovery plan in 1997 and encompasses approximately 13,505 square miles of land under multiple jurisdictions and across the international boundary between the US and Canada. The BC portion of the NCE is approximately 3,705 square miles comprised of a large block of contiguous habitat that extends into British Columbia, Canada, but is isolated from grizzly bear populations in other parts of the two countries (USDI 2017). The US portion is approximately 9,800 square miles of which about 40 percent is in a designated wilderness area or national park. Grizzly bears require large landscapes of mixed habitats that provide an adequate combination of foraging, denning and security habitat. The NCE provides a diversity of habitat that ranges from temperate rainforests on the west side to dry ponderosa pine forests and sage-steppe on the east side, and comprises one of the most intact wildlands in the contiguous United States (USDI 2017).

In 2016 the US Fish and Wildlife Service maintained grizzly bear in the North Cascades to be “warranted but precluded” for Endangered status due to other recovery priorities (USFWS 2016). In January 2017, the North Cascades National Park and the US Fish and Wildlife Service released a draft North Cascades Ecosystem Grizzly Bear Restoration Plan / Environmental Impact Statement to determine how to restore the grizzly bear to the North Cascades Ecosystem. This draft plan/EIS provides an assessment of the potential impacts of various alternatives for grizzly bear restoration in the NCE.

The grizzly bear is also a Washington State endangered species and is considered a Priority Habitat Species (PHS) (WDFW 2008). The PHS list provides priorities for conservation and management for species that require protective measures for continued survival. Development of management recommendations for mammals is ongoing and management recommendations for grizzly bear are not yet available within the PHS. The grizzly bear is also considered a Species of Greatest Conservation Need and is included in the Washington State Wildlife Action Plan (SWAP) (WDFW 2015). Although the SWAP identifies the grizzly bear as a species with a moderate vulnerability to climate, the grizzly bear is

considered a species of conservation concern because grizzly bear populations have been functionally extirpated from most of the state and the Washington populations are important to the range-wide conservation and recovery of the species within the US.

Identify key existing and projected vulnerability stressors

According to Stein et al. (2014), key vulnerabilities represent those vulnerabilities that pose the greatest risk to achieving conservation goals. In the most likely warmer, drier climate scenario alternative, climate change projections include: increased minimum temperatures, increases in extreme events, decreased snowpack, earlier stream flow runoff, reduced peak flow, more mid-winter peak flows, and likely increases in winter, spring, and fall precipitation (in the form of rain) (Servheen and Cross 2010, Pederson et al. 2011). Grizzly bears are considered a more generalist species that have historically survived in many different climatic zones. As such grizzly bears represent one end of the climate change influence spectrum. Because grizzly bears can survive and flourish in a variety of habitats, assuming adequate resources, and are highly adaptable, climate change will not likely directly threaten their populations due to ecological threats or constraints (Servheen and Cross 2010, Roberts et al. 2014). Grizzly bears may adjust to changes in habitat that result from climate change by changing their distribution. However, this can be limited by rate of change and response or barriers to movement, such as created human development or access (roads) (Krosby et al. 2016). Although these changes can impact grizzly bears to a certain degree, the primary threat to grizzly bears is the potential threat from increases in human-bear interactions (Servheen and Cross 2010, Roberts et al. 2014).

A decrease in snowpack and an increase in temperatures may lead to additional human access and a shift in grizzly bear distribution. In turn these changes may exacerbate human-bear interactions and potential disturbance, habitat loss, conflicts, and bear mortality, resulting from collisions with vehicles, hunting (misidentification) and poaching. Additionally, there is specific concern regarding changes in denning locations and timing (later den entrance and earlier den exit) which may expose bears to negative human interactions for longer periods of time each year, with subsequent effects on human-bear conflicts and possible increases in mortality. For example, bears that enter the den later in the year may be exposed to greater potential for hunter misidentification or conflict over a carcass during late elk seasons that run into December.

Habitat Vulnerabilities

Although grizzly bears once occurred in a wide variety of habitats, from open plains to arctic tundra, their range has been reduced such that they are now usually associated with remote (low levels of human influences) mountainous terrain and forested habitats. Grizzly bears are omnivorous, taking advantage of a wide variety of food items from fish and carrion, to roots and tubers, to berries. As such, within their range they tend to be habitat generalists and are more common where food is abundant and concentrated (WDFW 2015). A substantial part of the year is spent in hibernation, so areas that provide denning habitat are also important to bears. Denning habitat is often located at mid to upper elevations. Bears may excavate dens on slopes with adequate soil depths, take advantage of natural caves, crevices, hollow trees, or locate dens under rocks or large trees (Ciarnello et al. 2005). Identified grizzly bear denning habitat occupies a variety of elevations, aspects, and slopes that result in a variety of snow cover conditions for denning bears. Grizzly bear dens have been reported at elevations of 800-3100 m, slopes of 5-70 degrees, on almost all aspects, and in a wide variety of vegetative covers. Den sites are often away from anthropogenic disturbances or at sites that are difficult for humans to access (Mace and Waller 1997, Podruzny et al 2002, Pigeon et al. 2014, Kasworm et al. 2016). This variability suggests a high degree of plasticity in den habitat selection.

Some of the habitats associated with grizzly bear have also been identified as a conservation concern in the SWAP (WDFW 2015). These habitats include:

- alpine scrub,
- forb meadow and grassland,
- Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland,
- Northern Rocky Mountain Ponderosa Pine Woodland and Savanna,
- Northern Rocky Mountain Western Larch Savanna, and
- Rocky Mountain Aspen Forest and Woodland.

Food resources and habitat selection

The effects of climate change on the availability of food resources (quantity, diversity and distribution) for grizzly bears vary according to the modeled climate scenario. Roberts et al. (2014) found varying responses of plant food items in the Canadian Rocky Mountains. Many food items persisted or increased while several other species declined. They also observed a general uphill shift in plant distribution which could lead to greater vulnerability for bears at lower elevations and potential increase in human-bear interactions. Alternatively, bears may shift their activity uphill in concert with plant distribution, potentially decreasing human-bear interactions. Grizzly bears are feeding generalists and consume a wide variety of foods. In Yellowstone documented foods include 266 species within 200 genera from four kingdoms, including 175 plant, 37 invertebrate, 34 mammal, seven fungi, seven bird, four fish, one amphibian, and one algae species (Gunther et al. 2014). Decreasing amounts of whitebark pine seeds and cutthroat trout in the Yellowstone ecosystem have resulted in an increase of bears directly preying on elk and bison calves and scavenging carcasses from winter kills or other predator kills (IGBST 2013, Costello et al. 2014). These changes in diet have come without changes in home range sizes or population density and suggest a high degree of plasticity in their diet (Bjornlie et al. 2014). Grizzly bear have also demonstrated behavioral modifications. Pigeon et al. (2016) found grizzly bears in Alberta altered some habitat selection temporal patterns during the summer relative to ambient temperature changes. The effects of climate change to grizzly bears may be more indirect (compared to other wildlife species) and depend on the how climate change influences the availability of major food resources and habitat selection (Proctor et al. 2012, Butler 2012).

Wildfire Impacts to Habitat

Fire suppression and selective timber harvest have resulted in altered forest conditions and fire regimes (Hessburg et al. 2005) that lead to fires that generally burn larger areas and at higher severities than occurred historically (Hessburg et al. 2005, 2007, 2015). Increases in large fires are driven by reductions in fuel moisture, increased temperatures and lower snowpack and increased fuel loads (McKenzie et al. 2004, Westerling et al. 2006). The predicted increases in spring and summer temperature will exacerbate the frequency and intensity of disturbances such as fire (Wotton and Flannigan 1993, McKenzie et al. 2004, Littell et al. 2009). Studies based on both empirical and process-based models using multiple global climate models and emissions scenarios have also projected that wildfires will occur more frequently and burn larger areas under projected future, warmer climates in the Pacific Northwest (McKenzie et al. 2004, Littell et al. 2010, Rogers et al. 2011). The area burned in the Western States may double under relatively modest greenhouse gas emissions scenarios (McKenzie et al. 2004). Recently burned areas are generally avoided by bears for the first few years after a fire while vegetation recovers. However, depending on fire severity, food resources can become plentiful and these areas often become highly used habitats by bears (Zager et al. 1983, Hamer and Herrero 1987, Apps et al. 2004).

Population Vulnerabilities

The grizzly bear population in the NCE is functionally extirpated and the ecosystem is isolated because of habitat fragmentation and loss of connectivity caused by human development, roads and trails, and habitat loss (WDFW 2015, USDI 2017). Within the last 10 years, only four grizzly bear detections have been confirmed in the BC portion of the NCE

(USDI 2017). The small size and isolation makes the species more vulnerable to inbreeding, wildfire, illegal harvest, and other threats (WDFW 2015). Because there are only a small number of individual grizzly bears in the NCE, population persistence is highly vulnerable and believed to be at significant risk of eventual extirpation, regardless of changes in climate. As described in the Draft Grizzly Bear Restoration Plan/EIS, "biological consensus is that grizzly bears in the NCE would have difficulty recovering on their own and need some form of human intervention to achieve reproduction and eventual recovery" (USDI 2017).

Identify Adaptive Capacity - factors that influence vulnerability

Adaptive capacity refers to the opportunities that may exist to ameliorate the sensitivity or exposure of that species or system. All this information suggests that while climate change may impact grizzly bear populations to some degree, the greater issue is that the current number of grizzly bears in the NCE is too low to allow for persistence and resiliency. The most significant issues related to climate change include barriers to bear movements that further isolate the NCE from other bear populations, and changes in the timing and duration of denning that may result in more exposure of grizzly bears to humans and increase the potential for human-bear interactions.

Grizzly bear/human interactions have been identified as the key factor that will affect grizzly bear persistence (Servheen and Cross 2010). It will be important to increase our understanding of the following to determine how to focus management efforts:

1. how and where habitat and food sources will change (and how quickly declines could occur)
2. changes in den entry and exit timing due to longer snow-free periods and reduced snowpack (Lawler et al. 2014) and changes in the availability of food sources (Servheen and Cross 2010). This would make education, proper food and garbage storage, carcass disposal measures, and human access management that much more important.

Additional strategies and actions that could be implemented to improve conditions for grizzly bears address habitat restoration, human access management, and connectivity. Application of restoration treatments to return the landscape to a more historical state and reduce likelihood of catastrophic wildfire would be beneficial in general. The influence of human access, primarily on open roads, has considerable impacts on grizzly bear habitat and population persistence and has been well documented (Archibald et al. 1987, Kasworm and Manley 1990, Mace and Waller 1996, 1998; Mace et al. 1996, 1999; Mattson et al. 1987, McLellan and Shackleton 1988, 1989, Schwartz et al. 2010, MacHutchon and Proctor 2015). The effects on grizzly bears include increased potential for conflict, poaching, collisions with vehicles, reduced connectivity and displacement of bears from important habitats due to disturbance from vehicle traffic (see Gaines et al. 2003 for review). Vulnerability to road impacts also varies depending on sex and age class, with higher mortality rates for females and younger bears (Boulanger and Stenhouse 2014). Because of these interactions, the management of human use levels through access route management is one of the most powerful tools available to balance the needs of grizzly bears with the needs and activities of humans (IGBC 1998).

A transboundary workshop focused on Rocky Mountain populations developed a list of potential priorities that could also apply to the NCE (from Servheen and Cross 2010). Priorities included:

1. Expand efforts to address human conflict, particularly in linkage areas.
2. Strengthen motorized access management.
3. Expand and create "protected" areas that span a large range and diversity of environmental gradients.
4. Create transboundary grizzly bear linkage and management plans.
5. Educate public and policy-makers about science that supports the need for recommended conservation and management actions, including causes and impacts of climate change.
6. Expand funding strategies to implement management and conservation actions.

7. Revisit annual allowable cut calculation in areas of key habitat.

Singleton et al. (2002) identified the following priorities for the North Cascades Ecosystem:

1. Develop a linkage-specific assessment from the NCE to the Coast Range bears to identify opportunities to restore habitat connectivity for bears.
2. Develop a linkage-specific assessment from the NCE across the Okanagan Valley in BC to identify opportunities to restore habitat connectivity for grizzly bears.
3. Assess and restore the permeability of Highways 2 (US) and 1 (BC) that bisects the NCE and identify species Highway Crossing areas where crossing structures could be maintained or installed.
4. Improve the general permeability of multiple-use lands through access management that restores grizzly bear habitats.
5. Reduce the potential for human-bear conflicts through the installation of bear-resistant structures at recreation sites, facilities, and residences.

Application of the Decision Framework

The following Decision Framework Matrix was designed to provide a starting point for managers to explore and transparently document the translation of available climate change information into active management strategies, objectives and actions (Nelson et al. 2016). The matrix is comprehensive, but scenarios will likely arise that do not directly fit this particular format. The structure of the matrix still provides information and flexibility to address and document those situations. Ultimately, managers can integrate this targeted climate change perspective with the myriad other factors and mandates that influence management decisions.

STEP 1: Assess Vulnerability of grizzly bear to Climate Change

Key Factors of Vulnerability	**Habitat Suitability: To what extent will climate change alter grizzly bear habitat and food distribution and subsequently human-bear interactions?**	**Denning: To what extent will climate change alter the denning period of the grizzly bear and subsequently human-bear interactions?**	**Connectivity and Landscape Context: To what extent will climate change alter the degree of connectivity of the population to neighboring populations in British Columbia and Idaho and suitable habitat?**
Climate-related Questions to Consider	Will precipitation amounts, timing and form (rain/snow) remain consistent enough to support native plant populations and assemblages?	Might climate change alter the snowpack amount and duration?	Is the grizzly bear population currently isolated, or connected to a larger network of populations and habitat?
	Will the dietary plasticity of bears allow them to thrive in a "new" plant community?		
	Might climate change impact disturbance regimes (e.g., wildfire, insects, pathogens)?	Will changes to snowpack alter human access?	If currently connected to a larger network, do you expect this connectivity to remain given changing climate conditions (e.g., is the existing habitat vulnerable to fragmentation as climate changes)?
	Are key habitat structure and composition (e.g., abundant diverse native forbs and shrubs used as food resources, such as huckleberry) expected to change as climate changes?	Will changes to snowpack alter denning period for bears?	Are features present (agriculture, urban, other non-habitats) that could become barriers to grizzly bear movement under changing climate?
	Although fish are not a large dietary component of bears in the NCE, will fish population abundance and diversity remain or become suitable to support adult and juvenile grizzly bear survival?	How will changes to denning period affect human-bear interactions?	Is the grizzly bear population likely to persist given changing climate conditions and associated extreme events?
	Could climate-driven changes in human resource use (e.g., recreation, altered grazing intensity, timber management) affect grizzly bear habitat quantity or quality?		Are climate-driven changes likely to result in changes to human-bear interactions?
	Will changes to grizzly bear habitat affect the level of human-bear interactions?		
	Is the grizzly bear population naturally more resilient to changing climate conditions?		
	Will human population areas change as a result of climate change and habitat shifts?		

Assess Vulnerabilities	**Considering your answers above, choose the most appropriate level of vulnerability of the population to climate change effects on grizzly bear habitat and food distribution and subsequently human-bear interactions:**	**Considering your answers above, choose the most appropriate level of vulnerability of the population to climate change effects on denning period of the grizzly bear and subsequently human-bear interactions:**	**Considering your answers above, choose the most appropriate level of vulnerability of the population to climate change effects on connectivity and landscape context:**
	A - Habitat likely to remain or become suitable and human-bear interactions likely to remain constant or decrease.	E – Denning period likely to remain constant or increase and human-bear interactions likely to remain or decrease.	G - Population likely to be connected to a larger network
	B - Habitat likely to become marginal (i.e., at or near thresholds for focal species) and human-bear interactions likely to remain constant or increase.	F - Denning period likely to decrease and human-bear interactions likely to increase.	H - Population likely to remain or become isolated
	C - Habitat likely to remain or become suitable and human-bear interactions likely to increase.		
	D – Habitat likely to become unsuitable and human-bear interactions likely to increase.		
	Answer: _____	**Answer: _____**	**Answer: _____**

If you answered:	Go to Box:		If you answered:	Go to Box:		If you answered:	Go to Box:		If you answered:	Go to Box:
A E G	1		B E G	2		C E G	3		D E G	4
A F G	5		B F G	6		C F G	7		D F G	8
A E H	9		B E H	10		C E H	11		D E H	12
A F H	13		B F H	14		C F H	15		D F H	16

STEP 2: Use Vulnerability Matrix to Clarify Management Goals and Select Climate Adaptation Strategies

		Habitat Remains or Becomes Suitable – Human-bear Interactions Remain or Decrease	**Habitat Becomes Marginal – Human-bear Interactions Remain or Increase**	**Habitat Remains or Becomes Suitable and Human-bear Interactions Increase**	**Habitat Becomes Unsuitable – Human-bear Interactions Increase**
Population is Connected to a Larger Network	Low Threat from Denning Period Change	Relative vulnerability to Climate Change: **Low – BOX 1**	Relative vulnerability to Climate Change: **Medium-Low – BOX 2**	Relative vulnerability to Climate Change: **Medium-Low – BOX 3**	Relative vulnerability to Climate Change: **Medium-High – BOX 4**
		Relative value for conservation: High values in both the short and long term.	Relative value for conservation: Potential value over long term, but will likely require investment to moderate climate impacts	Relative value for conservation: Potential value over long term, but will likely require investment to moderate climate impacts	Relative value for conservation: Potential value in the short term to help with population recovery, maintenance of genetic diversity and/or local adaptations; Longer-term value is lower due to decreasing habitat suitability
		Potential Goal: Protect and maintain (or improve if warranted) habitat and human access management supporting this population for long-term conservation of grizzly bear	Potential Goal: Improve the suitability of habitat and management of human access supporting this population for long-term conservation of grizzly bear	Potential Goal: Improve management of human access supporting this population for long-term conservation of grizzly bear	Potential Goal: Manage human access to support connectivity.
		Strategies: • Restore grizzly bear population to NCE • Maintain human access management • Maintain ecological connectivity • Maintain habitat resilience to wildfire • Reduce non-climate stressors	Strategies: • Restore grizzly bear population to NCE • Maintain or improve human access management • Apply strategic restoration treatments to improve/maintain/protect habitat resilience and dispersal corridors to wildfire • Consider adjusting allowable cut and harvest of non-timber forest products in key habitat areas • Maintain or improve ecological connectivity • Identify and protect corridors and associated resources • Reduce non-climate stressors	Strategies: • Restore grizzly bear population to NCE • Maintain or improve human access management • Apply strategic restoration treatments to maintain and protect habitat resilience and dispersal corridors to wildfire • Maintain or improve ecological connectivity • Identify and protect corridors and associated resources • Reduce non-climate stressors	Strategies: • Restore grizzly bear population to NCE • Improve human access management • Apply strategic restoration treatments to improve habitat resilience and dispersal corridors to wildfire • Consider adjusting allowable cut and harvest of non-timber forest products in key habitat areas • Maintain or improve ecological connectivity • Identify and protect corridors and associated resources • Consider alternative habitat corridors • Reduce non-climate stressors

	High Threat from Denning Period Change	Relative vulnerability to Climate Change: **Medium-Low – BOX 5**	Relative vulnerability to Climate Change: **Medium – BOX 6**	Relative vulnerability to Climate Change: **Medium – Box 7**	Relative vulnerability to Climate Change: **High – BOX 8**
		Relative value for conservation: High value in both the short and long term, but may require additional strategies to prevent disturbance during denning or increased human-bear interactions.	Relative value for conservation: Potential value over long term, but will require a higher level of investment to both moderate climate impacts and address increases in human-bear interactions.	Relative value for conservation: Potential value over long term, but will require a higher level of investment to address increases in human-bear interactions.	Relative value for conservation: Potential value in the short term to help with population recovery, maintenance of genetic diversity and/or local adaptations but will require investment to address increased human-bear interactions; Longer-term value is lower due to decreasing habitat suitability
		Potential Goal: Prevent increase in human-bear interactions and protect and maintain (or improve if warranted) habitat of this population for long-term conservation of Grizzly Bear	Potential Goal: Prevent increase in human-bear interactions (or decrease if already present) and improve the suitability of habitat supporting this population for long-term conservation of Grizzly Bear	Potential Goal: Address increase in human-bear interactions and protect and maintain habitat of this population for long-term conservation of Grizzly Bear	Potential Goal: Manage human-bear interactions to allow for connectivity
		Strategies: • Restore grizzly bear population to NCE • Maintain or improve human access management • Maintain ecological connectivity • Maintain habitat resilience to wildfire • Reduce non-climate stressors	Strategies: • Restore grizzly bear population to NCE • Maintain or improve human access management • Apply strategic restoration treatments to improve/maintain/protect habitat resilience and dispersal corridors to wildfire • Consider adjusting allowable cut and harvest of non-timber forest products in key habitat areas • Maintain or improve ecological connectivity • Identify and protect corridors and associated resources • Reduce non-climate stressors	Strategies: • Restore grizzly bear population to NCE • Improve human access management • Maintain ecological connectivity • Maintain habitat resilience to wildfire • Reduce non-climate stressors	Strategies: • Restore grizzly bear population to NCE • Improve human access management • Apply strategic restoration treatments to improve habitat resilience and dispersal corridors to wildfire • Consider adjusting allowable cut and harvest of non-timber forest products in key habitat areas • Maintain or improve ecological connectivity • Identify and protect corridors and associated resources • Consider alternative habitat corridors • Reduce non-climate stressors

		Habitat Remains or Becomes Suitable – Human-bear Interactions Remain or Decrease	Habitat Becomes Marginal – Human-bear Interactions Remain or Increase	Habitat Remains or Becomes Suitable and Human-bear Interactions Increase	Habitat Becomes Unsuitable – Human-bear Interactions Increase
Population Remains or Becomes Isolated	Low Threat from Denning Period Change	Relative vulnerability to Climate Change: **Medium-Low – BOX 9**	Relative vulnerability to Climate Change: **Medium – BOX 10**	Relative vulnerability to Climate Change: **Medium – BOX 11**	Relative vulnerability to Climate Change: **Medium-High – BOX 12**
		Relative value for conservation: Potential value for providing genetic diversity and/or local adaptations in both the short and long term, but will likely require investment to address fragmentation	Relative value for conservation: Potential value for providing genetic diversity and/or local adaptations, but will likely require investment to moderate climate impacts and address fragmentation	Relative value for conservation: Potential value for providing genetic diversity and/or local adaptations, but will likely require investment to moderate climate impacts and address fragmentation	Relative value for conservation: Potential value in short-term for providing genetic diversity and/or local adaptations, but will likely require investment to address fragmentation; Longer-term value is lower due to decreasing habitat suitability
		Potential Goal: Determine what level of protection/reconnection to other habitats is warranted	Potential Goal: Determine what level of protection/reconnection to other habitats is warranted	Potential Goal: Determine what level of protection/reconnection to other habitats is warranted	Potential Goal: Determine what level of protection/reconnection to other habitats is warranted
		Strategies: • Restore grizzly bear population to NCE • Maintain or improve human access management • Maintain ecological connectivity within populations • Maintain habitat resilience to wildfire • Reduce non-climate stressors • Consider augmenting genetic diversity • Recover ecological connectivity with adjacent landscapes	Strategies: • Restore grizzly bear population to NCE • Maintain or improve human access management • Maintain or improve ecological connectivity within populations • Recover ecological connectivity with adjacent landscapes • Apply strategic restoration treatments to improve/maintain/protect habitat resilience to wildfire • Identify and protect corridors and associated resources • Reduce non-climate stressors	Strategies: • Restore grizzly bear population to NCE • Improve human access management • Maintain or improve ecological connectivity within populations • Recover ecological connectivity with adjacent landscapes • Apply strategic restoration treatments to maintain and protect habitat resilience to wildfire • Identify and protect corridors and associated resources • Reduce non-climate stressors	Strategies: • Restore grizzly bear population to NCE • Improve human access management • Improve ecological connectivity within populations • Recover ecological connectivity with adjacent landscapes • Apply strategic restoration treatments to improve/maintain/protect habitat resilience to wildfire • Identify and protect corridors and associated resources • Consider alternative habitat corridors • Reduce non-climate stressors

	High Threat from Denning Period Change	Relative vulnerability to Climate Change: **Medium – BOX 13**	Relative vulnerability to Climate Change: **Medium-High – BOX 14**	Relative vulnerability to Climate Change: **Medium-High – BOX 15**	Relative vulnerability to Climate Change: **High – BOX 16**
		Relative value for conservation: Potential value, but will likely require investments to maintain level of human-bear interactions	Relative value for conservation: Lower value, and will likely require a higher-level of investment to moderate human-bear interactions and address fragmentation	Relative value for conservation: Lower value, and will likely require a higher-level of investment to moderate human-bear interactions and address connectivity	Relative value for conservation: Low value
		Potential Goal: Determine what level of protection/reconnection to other habitats is warranted and what level of human access management is warranted	Potential Goal: Determine what level of protection/reconnection to other habitats is warranted and what level of human access management is warranted. Consider managing the location for other targets/objectives	Potential Goal: Determine what level of protection/reconnection to other habitats is warranted and what level of human access management is warranted. Consider managing the location for other targets/objectives	Potential Goal: Determine what level of protection/reconnection to other habitats is warranted and what level of human access management is warranted. Consider managing the location for other targets/objectives
		Strategies: • Restore grizzly bear population to NCE • Maintain or improve human access management • Maintain ecological connectivity within populations • Maintain habitat resilience to wildfire • Reduce non-climate stressors • Consider augmenting genetic diversity • Recover ecological connectivity with adjacent landscapes	Strategies: • Restore grizzly bear population to NCE • Maintain or improve human access management • Maintain or improve ecological connectivity within populations • Recover ecological connectivity with adjacent landscapes • Apply strategic restoration treatments to improve/maintain/protect habitat resilience to wildfire • Identify and protect corridors and associated resources • Consider augmenting genetic diversity • Reduce non-climate stressors • Determine additional strategies after clarifying management goal(s)	Strategies: • Restore grizzly bear population to NCE • Improve human access management • Maintain or improve ecological connectivity within populations • Recover ecological connectivity with adjacent landscapes • Apply strategic restoration treatments to maintain or protect habitat resilience to wildfire • Identify and protect corridors and associated resources • Consider augmenting genetic diversity • Reduce non-climate stressors • Determine additional strategies after clarifying management goal(s)	Strategies: • Restore grizzly bear population to NCE • Improve human access management • Improve ecological connectivity within populations • Recover ecological connectivity with adjacent landscapes • Apply strategic restoration treatments to improve/maintain/protect habitat resilience to wildfire • Identify and protect corridors and associated resources • Consider augmenting genetic diversity • Consider alternative habitat corridors • Reduce non-climate stressors • Determine additional strategies after clarifying management goal(s)

STEP 3: Select Actions to Implement Chosen Climate Adaptation Strategies (in no particular order)

Strategy	Objective(s)	Example Actions
Restore grizzly bear population to NCE	Recover grizzly bear population	• Complete required NEPA/SEPA/ESA processes
Maintain or improve human access management	Conserve grizzly bear habitat	• identify key areas and manage motorized access to consolidate large blocks of secure habitat. • Manage motorized trail system • Consider time of use relative to critical needs (i.e. denning, rearing young) • Temporary closures of roads, trails and/or areas
Maintain or improve ecological connectivity Recover ecological connectivity with *adjacent* landscapes	Identify and protect corridors and associated resources Enhance opportunities for individuals to move within NCE or between ecosystems in US and BC	• Evaluate and identify areas • Manage motorized access to create or improve corridors • Apply strategic restoration treatments to improve/maintain/protect habitat resilience and dispersal corridors • Consider alternative habitat corridors • Establish crossing structures • Land acquisition, habitat management, etc. in landscapes adjacent to & between extant populations • conservation easements • landowner agreements
Maintain or improve habitat resilience to wildfire and pathogens	Increase Adaptive Capacity of Native habitats Restore native plant communities striving for composition, structure and function near Historical Range of Variability	• Apply strategic restoration treatments to improve/maintain/protect habitat resilience and dispersal corridors relative to wildfire or pathogens • Consider adjusting allowable cut and harvest of non-timber forest products in key habitat areas • Enhance native plant communities to promote natural resilience (i.e. Restoration, preventing encroachment, etc.) • Fuels management (coordinate with resilience strategies) • Strategic prescribed fire program • Manual fuel treatments • Continue to pursue efforts to implement a substantially increased restoration program
Augment genetic diversity		• Translocation of grizzly bears from outside NCE over the long term • Increase connectivity with populations in other areas, i.e. British Columbia, eastern Washington
Reduce non-climate stressors	Identify and remediate non-climate related threats to population and ecosystem function Reduce potential for human-bear conflicts	• Implement and monitor sanitation program - installation of bear-resistant structures • Promote use of portable bear-resistant food storage (such as hiker canisters, panniers, electric fencing) • Continue to implement education and outreach – Living with bears • Facilitate/encourage community Bear Smart programs (including residential garbage collection, etc.) • Hunter education – Bear ID (grizzly bears vs black bears) • Grazing management: coordinate with WA Wolf Working Group • Incorporate climate change considerations into management plans
Other		• Evaluate long-term funding needs to staff and appropriately fund wildlife activities

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Citations

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