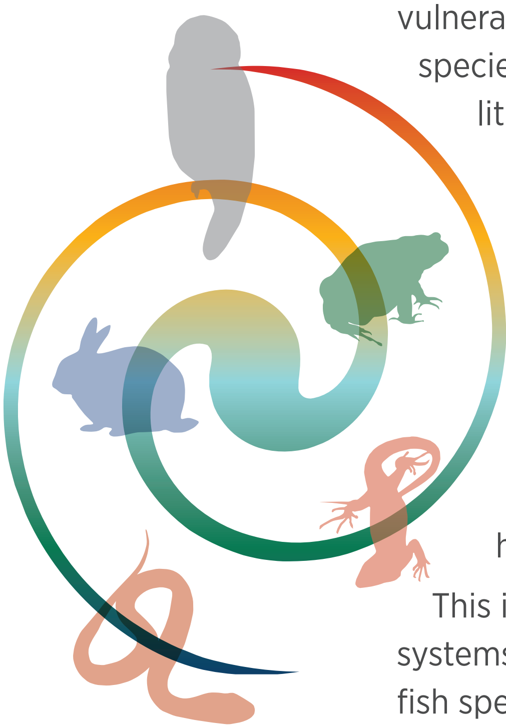
How Will Climate Change Affect Shrub-Steppe Ecological Systems and Species in Washington?

Washington Department of FISH and WILDLIFE

Introduction



This summary represents an initial evaluation of climate change vulnerability for shrub-steppe systems and closely associated species based on expert input and information in the scientific literature. In this context, climate change vulnerability is a function of the sensitivity of a particular resource to climate changes and its exposure to those changes. The aim of this document is to summarize the climatic factors shrub-steppe systems and species are sensitive to, the projected changes for those factors, and potential impacts to systems and species. This document also provides an overview of management actions that could be implemented to help reduce vulnerabilities and impacts.

This initial evaluation focused on the terrestrial ecological systems within the shrub-steppe, and did not include the fish species that use aquatic and riparian systems in the same geography.

Exposure: How much of a change in climate a system or species is likely to experience

Sensitivity: Whether and how a system or species is likely to be affected by a given change in climate

Vulnerability

V = E+S / 2

This assessment also included confidence rankings. Confidence reflects the sureness experts had in a given ranking and was based on the extent and quality of reference material and information.

Fact sheet developed by EcoAdapt.

Shrub-steppe System Description[1]

Shrub-steppe systems occur throughout most of eastern Washington, and generally have an understory layer of native bunchgrasses and other perennial grasses and/or forbs as well as some cover of shrubs. Current non-climate stressors include agricultural conversion, wind power and residential development, soil disturbance, invasive annual plants, increased fire and fire frequency, and overgrazing. This summary covers the following shrub-steppe ecological systems:

Columbia Plateau Low Sagebrush Steppe

This large patch system is very rare (<1% of Washington State), occurring on isolated ridges adjacent to Douglas-fir and ponderosa pine forests. The ecological integrity of the system is in decline, primarily due to disturbances from intense grazing, which reduces cover of moss and lichens and increases areas of bare ground, and invasive plants (i.e., cheatgrass). Closely associated species include the American badger, ferruginous hawk, greater sage-grouse, sage thrasher, sharp-tailed grouse, northern leopard frog, Woodhouse's toad, ring-necked snake, and short-horned lizard.

Inter-mountain Basins Big Sagebrush Steppe

This large patch system occurs at lower elevations (below 3,000 feet), and is mostly degraded due to grazing, invasive plants, and altered fire regimes, which affect native grass and shrub cover and composition. Historically this system was more expansive across eastern Washington, but much of it has been converted to cropland and residential and wind farm development. Closely associated species include the American badger, pygmy rabbit, burrowing owl, ferruginous hawk, greater sage-grouse, sage thrasher, sagebrush sparrow, sharp-tailed grouse, northern leopard frog, Woodhouse's toad, ring-necked snake, sagebrush lizard, sharptail snake, short-horned lizard, and striped whipsnake.

Inter-mountain Basins Montane Sagebrush Steppe

This widespread system occurs at higher elevations (above 3,000 feet), including montane to subalpine elevations in forested landscapes, and is a compositionally diverse system of shrubs (primarily Artemisia tridentata spp. vaseyana), grasses, and forbs. Livestock practices, invasive species, soil disturbances, and habitat fragmentation degrade this system by decreasing native bunch grasses, increasing invasive species, and affecting shrub abundance and cover. Generally associated species include the American badger and golden eagle.

Inter-mountain Basins Semi-Desert Shrub-Steppe

This system occurs in the hottest and driest parts of the southeastern Columbia Plateau, and is the rarest of all shrub-steppe systems (<0.1% of Washington State). Most of this system occurs on privately owned lands, and consists of an open to moderately dense mix of shrubs and dwarf shrubs with an understory of bunchgrasses. Persistent grazing, invasive plants, wildfire, soil disturbances, and habitat fragmentation have degraded the ecological integrity of this system, leading to a loss of habitat diversity. Closely associated species include the ferruginous hawk.

Many shrub-steppe systems are already imperiled due to land use conversion, invasive plants, overgrazing, and altered fire regimes. Climate change is likely to exacerbate the impacts of these non-climate stressors on shrub-steppe systems, potentially leading to increased habitat degradation and loss of habitat diversity.

[1] Information in this section comes from: (1) Washington Department of Fish and Wildlife. 2015. Washington's State Wildlife Action Plan: 2015 Update. Washington Department of Fish and Wildlife, Olympia, Washington, USA; and (2) Rocchio, F.J. and R.C. Crawford. 2015. Ecological Systems of Washington State: A Guide to Identification. Washington State Department of Natural Resources. Report 2015-04. 397 pp.

Key Climate Sensitivities and Impacts:
Shrub-Steppe Systems[2]

Overall, shrub-steppe systems exhibit sensitivity to changes in precipitation and soil moisture, temperature, drought, and altered wildfire regimes. Changes in precipitation (type, timing, amount) can lead to shifts in species composition and/or vegetation structure. Increased soil moisture could increase shrub density. More frequent fire could result in conversion to annual grasslands, particularly for Inter-mountain Basins Big Sagebrush Steppe. Increased drought and increased fire frequency can both reduce shrub cover and elevate herbaceous diversity and cover. However, increased fire frequency also favors invasive species establishment and dominance (e.g., cheatgrass), which exacerbates fire risk. Sensitivity rankings for shrub-steppe systems include:

Sensitivity of shrub-steppe systems to climatic factors was assessed by evaluating whether each system occurs in a relatively narrow climatic zone and/or whether it experiences large changes in structure or composition in response to relatively small changes in a given climate or climate-driven factor (e.g., temperature, drought).

Columbia Plateau Low Sagebrush Steppe[3]	Mod Sensitivity	Low Confidence
Inter-Mountain Basins Big Sagebrush Steppe	Mod Sensitivity	Mod Confidence
Inter-Mountain Basins Montane Sagebrush Steppe	Mod-High Sensitivity	Mod Confidence
Inter-Mountain Basins Semi-Desert Shrub-Steppe	High Sensitivity	High Confidence

Key Climate Sensitivities and Impacts:
Shrub-Steppe Closely Associated Species

Increased temperatures and moisture stress, altered fire regimes, and increased invasive weeds that reduce the extent, quality, and connectivity of shrub-steppe habitats will likely have adverse impacts on closely associated species. **For example:**

- Reductions in **sagebrush habitat** will likely negatively impact **pygmy rabbits**, **greater sage-grouse**, **sage thrashers**, **sagebrush sparrow**, **sagebrush lizards**, and **short-horned lizards**, which are dependent on these habitats for forage, nesting, and reproduction.
- Reductions in **shrub-steppe**, **grassland**, and **associated riparian habitats** could adversely impact the **sharp-tailed grouse**, **ring-necked snake**, and **Woodhouse's toad**, and may lead to altered prey availability for the **American badger**.

In shrub-steppe systems, habitat and prey specialization drives overall species sensitivity to climate change.

[2] Information on system and species sensitivity, exposure, and overall vulnerability can be found in the WDFW Climate Vulnerability spreadsheet.

[3] Columbia Plateau Low Sagebrush Steppe received a low confidence ranking due to uncertainty about fire risk and impacts (fires were historically uncommon in this system) and whether drought or increased precipitation poses a greater risk. Inter-mountain Basins Montane Sagebrush Steppe also received a low confidence ranking due to uncertainty about fire risk and impacts, in particular how changes in fire frequency may impact the system. Inter-mountain Basins Semi-Desert Shrub-Steppe received a low confidence ranking due to uncertainty about changes in soil moisture and impacts on the system. For those systems with lower confidence evaluations, managers may want to target monitoring or data collection efforts that help increase understanding of potential impacts of climate. Higher confidence evaluations can provide greater clarity as to what management actions may be most effective in reducing vulnerabilities and increasing resilience of these systems.

- Loss of **wetland and pond** breeding habitat and reductions in herbaceous **riparian vegetation** used as non-breeding habitat could significantly affect **northern leopard frogs**.
- Altered habitat availability (i.e., **coniferous and hardwood forest edges**) and prey base (e.g., molluscs and soft-bodied invertebrates) may negatively impact the s**harp-tailed snake**.

Other possible climate impacts on shrub-steppe associated species include:

- Increased temperatures and changes in precipitation may lead to range contractions for the **burrowing owl**.
- Warmer temperatures may benefit the **ferruginous hawk** if grasslands expand however, more frequent or severe droughts that lead to declines in prey may adversely affect this species.
- **Striped whipsnakes** are highly dependent on side-blotched lizards for prey, and may also exhibit similar dependencies on sagebrush lizards; any changes in prey availability due to climate may adversely impact this species.

Sensitivity of shrub-steppe species to climatic factors was assessed by considering:

- **Physiology.** Physiological ability to tolerate changes higher or lower than the current range of variability
- **Phenology.** Dependency on the timing of ecological events (e.g., the availability of prey or forage species relative to migration timing)
- **Ecological Relationships.** Dependencies on and/or linkages to specific habitats, prey or forage species, pollination, or competition, among others

Sensitivity rankings for closely associated shrub-steppe species include:

Mammals

Species	Sensitivity	Confidence
American Badger *(Taxidea taxus)*	Mod Sensitivity	Mod Confidence
Pygmy Rabbit *(Brachylagus idahoensis)*	High Sensitivity	High Confidence

Birds

Species	Sensitivity	Confidence
Burrowing Owl *(Athene cunicularia)*	Low Sensitivity	Mod Confidence
Ferruginous Hawk *(Buteo regalis)*	Low Sensitivity	Mod Confidence
Greater Sage-grouse *(Centrocercus urophasianus)*	High Sensitivity	Mod Confidence
Sage Thrasher *(Oreoscoptes montanus)*	Mod-High Sensitivity	Mod Confidence
Sagebrush Sparrow *(Artemisiospiza nevadensis)*	Mod-High Sensitivity	Low Confidence
Sharp-tailed Grouse *(Tympanuchus phasianellus)*	Mod Sensitivity	Mod Confidence

Amphibians & Reptiles

Species	Sensitivity	Confidence
Northern Leopard Frog *(Rana pipiens)*	Mod-High Sensitivity	Mod Confidence
Ring-necked Snake *(Diadophis punctatus)*	Low-Mod Sensitivity	Low Confidence
Sagebrush Lizard *(Sceloporus graciosus)*	Mod-High Sensitivity	Low Confidence
Sharp-tailed Snake *(Contia tenuis)*	Mod Sensitivity	Low Confidence
Short-horned Lizard *(Phrynosoma douglasii)*	Mod Sensitivity	Low Confidence
Striped Whipsnake *(Masticophis taeniatus)*	Low-Mod Sensitivity	Low Confidence
Woodhouse's Toad *(Bufo woodhousii)*	Mod-High Sensitivity	Mod Confidence

Vulnerability assessment methodology developed by EcoAdapt.

Projected Future
Climate Exposure[4]

Under projected future climate conditions, shrub-steppe habitats and species will likely be exposed to increased wildfire risk (frequency and intensity), warmer temperatures, increased drought risk, and precipitation and soil moisture changes by the end of the century. Precipitation and soil moisture projections for the state are highly variable, with some areas projected to get drier and others wetter. There is greater certainty regarding seasonal precipitation patterns, with summers projected to get drier and fall, winter, and springs projected to get wetter in the Columbia Plateau. Air temperature is projected to increase in all seasons, with summers experiencing the most rapid warming (Figure 1). Increases in air temperature are projected to increase drought risk, particularly in summer, even with potential increases in winter precipitation. Increased wildfire frequency, intensity, severity, and total area burned are also projected for the region due to warmer temperatures. Inter-mountain basins big sagebrush steppe is projected to decline by the end of the century, with 4% of the current range projected to remain climatically stable and 70% of the current range projected to contract (i.e., become climatically unsuitable).

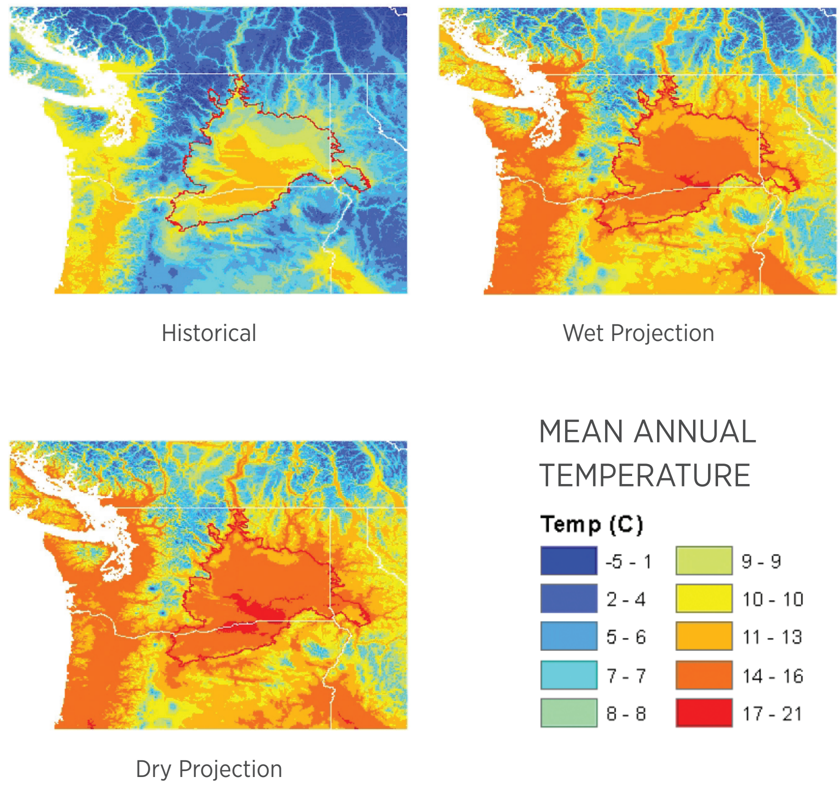


Figure 1. Maps of air temperature around the Columbia Plateau. Historical (annual average 1961-1990) and projected values (change from historical) for two alternative futures: (1) a wetter future (21% more precipitation annually), and (2) a slightly drier future (1% decrease in annual precipitation). All projections use the A2 emissions scenario (medium-high emissions scenario) and represent averages for 2070-2099. From Michalak et al. 2014.

Temperature is projected to increase in all seasons, in all scenarios. In general, summers are likely to get drier and have greater drought risk, while other seasons will likely get wetter. Increased fire frequency, severity, intensity, and total area burned are also projected for the state.

[4] Information in this section comes from: (1) Michalak, J. L., J. C. Withey, J. J. Lawler, S. Hall and T. Nogeire. 2014. Climate Vulnerability and Adaptation in the Columbia Plateau, WA. Report to the Great Northern Landscape Conservation Cooperative; and (2) Washington Department of Fish and Wildlife. 2015. Washington's State Wildlife Action Plan: 2015 Update, Appendix C. Washington Department of Fish and Wildlife, Olympia, Washington, USA

Climate Change
Vulnerability Assessment

Looking together at sensitivity and exposure, the shrub-steppe systems evaluated in this assessment exhibit overall moderate-high vulnerability (moderate confidence) to climate changes including shifts in precipitation, drought, and altered fire regimes (Figure 2). Shifts in precipitation and soil moisture will likely affect distribution and composition of these systems, while altered fire regimes (e.g., increased fire frequency and/or intensity) could reduce shrub cover, favor shifts to grassland habitat, and/or increase invasive species establishment and dominance (e.g., cheatgrass). Invasive annual grasses such as cheatgrass, as well as exotic weeds, that have already degraded these systems will likely exacerbate the impacts of climate change. For example, increased cheatgrass abundance may contribute to more frequent and intense fires due to higher fuel densities and shorter fire return intervals. Many of the species closely associated with shrub-steppe are relatively specialized, and exhibit sensitivity to climatic factors that drive habitat extent, quality, and connectivity, as well as those that impact prey availability. Additionally, shrub-steppe species are often vulnerable to changes in precipitation and severe weather events that may impact reproductive success.

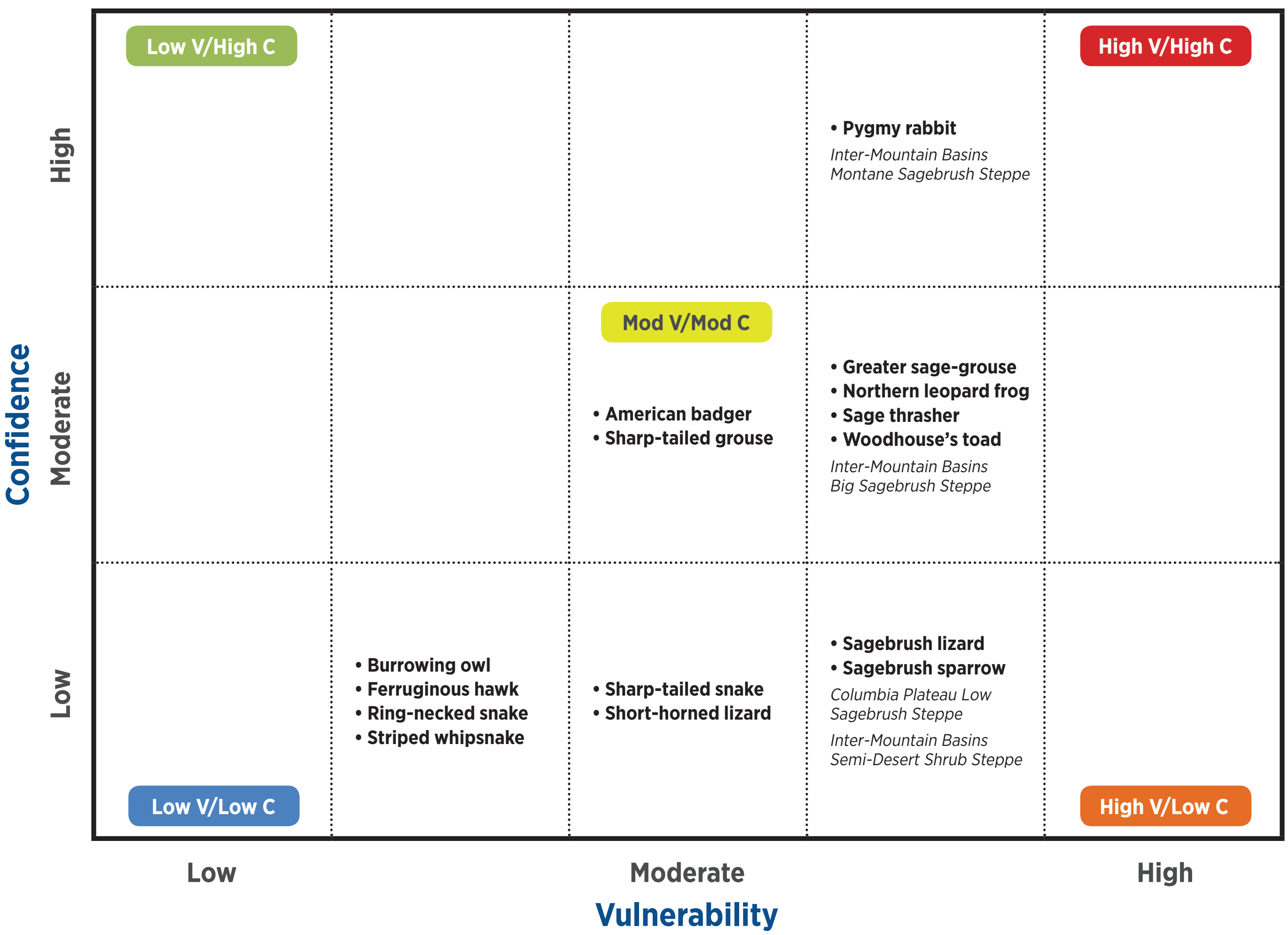
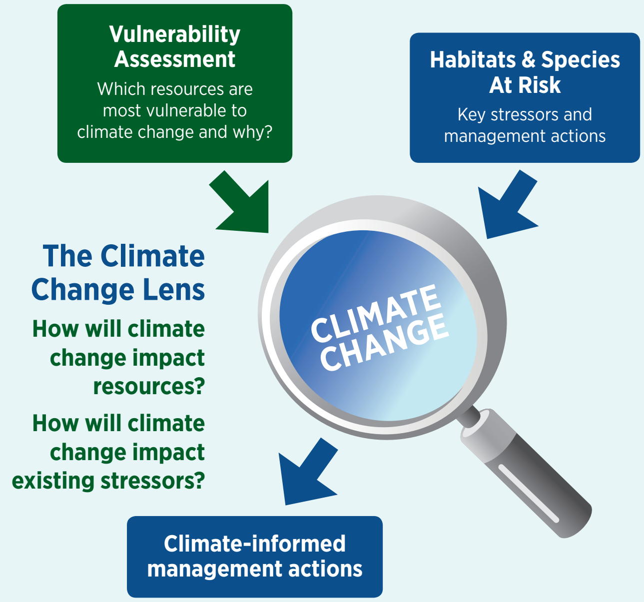


Figure 2. Vulnerability and confidence rankings plotted for shrub-steppe systems and closely-associated species. Those systems and species with high vulnerability to climate change and high confidence are located in the upper right; those systems and species with low vulnerability to climate change and low confidence are located in the bottom left. Figure created by EcoAdapt.

Adapting to
Climate Change

Climate change adaptation strategies attempt to reduce the negative impacts of, or take advantage of opportunities presented by, climate change. To begin identifying adaptation options, it's helpful to consider the management actions proposed or currently underway and think about them in the context of climate change. For example, how may climate change affect the success of a given action (i.e., does it present a new or unexpected challenge)? Alternatively, does the action help to minimize climate vulnerabilities, making it a priority for implementation? Adding this climate 'lens' to what is already being done helps to mainstream adaptation into current decision-making frameworks.



There are five basic types of adaptation strategies; resistance, resilience, transition, knowledge, and collaboration. Managers can select adaptation strategies that best suit a given situation (e.g., long-term management plan vs. on-the-ground project), although they are encouraged to consider both near- or short-term options (e.g., resistance, resilience) as well as those more suitable in the long-term (e.g., transition). Additionally, managers can use the confidence evaluations from vulnerability assessments to identify where more research or monitoring is needed. For example, the sensitivity of sagebrush lizard was evaluated as moderate-high, but the confidence in that ranking was low due to a lack of data and information on how oviposition sites may be influenced by soil moisture patterns. A knowledge-gathering adaptation strategy to address this issue could be to collect data on typical oviposition sites in order to determine whether sites are linked with environmental factors likely to be affected by climate change (e.g., soil moisture).

With shrub-steppe systems

Changes in precipitation, soil moisture, and altered fire regimes

Can increase invasive species establishment and dominance and/or convert these systems to grasslands

Which cause reductions or changes in habitat extent, quality, and connectivity

affecting forage and prey availability

and nesting and reproductive success of species that depend on these systems

To sustain resources into the future, conservation actions and strategies must take into account future climatic conditions and consider multiple stressors and broad geographic scales.

What are the types of adaptation strategies?

Resistance strategies: Prevent the effects of climate change from affecting a resource.
Near-term approach

Resilience strategies: Buffer against climate change impacts by avoiding the effects of or recovering from changes.
Near- to mid-term approach

Transition strategies: Intentionally accommodate change and adaptively respond to variable conditions.
Long-term approach

Knowledge strategies: Gather information about climate impacts and/or management effectiveness in addressing climate change challenges.
Near- to long-term approach

Collaboration strategies: Coordinate efforts and capacity across landscapes and agencies.
Near- to long-term approach

Adaptation strategies for shrub-steppe systems and species

ADAPTATION CATEGORY	ADAPTATION STRATEGIES
RESISTANCE	• Prevent invasive species establishment and spread • Protect shrublands from more frequent and/or intense fires
RESILIENCE	• Promote native genotypes adapted to a range of climate conditions • Restore habitats to buffer against climate impacts • Reduce the impact of existing non-climate stressors
TRANSITION	• Maintain, create, and/or protect refugia • Promote connected landscapes that can facilitate species migration • Facilitate change to desired species assemblages and/or species adapted to future conditions
KNOWLEDGE	• Monitor, model, and conduct research to improve understanding about climate changes and impacts on species and habitats • Monitor, model, and conduct research and adaptive management to support adaptation actions and evaluate effectiveness
COLLABORATION	• Communicate with other agencies and organizations about projects and coordinate on-the-ground activities (e.g., invasive species management) • Leverage resources (e.g., funding, partnerships) and priorities across jurisdictional and political boundaries to implement landscape-scale adaptation strategies

For more information about this project or other WDFW climate change initiatives, please visit **wdfw.wa.gov/conservation/climate_change** or contact Lynn Helbrecht at **lynn.helbrecht@dfw.wa.gov** or **(360) 902-2238**

Fact sheet developed by EcoAdapt.