# Future-Oriented Wildlife Management in the Pike-San Isabel and Arapaho-Roosevelt National Forests Under a Warming Climate: Anticipating Change and Facing Uncertainties With a Focus on Avian Species

Angela M. White

## Introduction

Climate change has impacted terrestrial, freshwater, and ocean ecosystems across the globe changing disease dynamics, disturbance regimes, and nutrient cycling, resulting in the degradation of key ecosystem services (Cooley et al. 2022; Parmesan et al. 2022). Birds provide a diverse array of ecosystem services, including pest control, pollination, seed dispersal, and nutrient cycling (Sekercioğlu et al. 2004, 2006), and are of conservation concern due to human impacts on avian diversity and abundance (Gaston et al. 2003; Jetz et al. 2007; Rosenburg et al. 2019). Relative to other taxa, birds are predicted to be less vulnerable to climate change due to their vagility and ability to shift their range and phenology in response to environmental changes (Pacifici et al. 2017; Siegel et al. 2014; Tingley et al. 2009); however, a species' ability to adapt can vary significantly with cascading impacts on communities. For example, avian range shifts can result in new species interactions and vulnerabilities that may have consequences for ecosystem function and stability (Weiskopf et al. 2020).

Planning and responding to climate concerns with the appropriate environmental and conservation actions often rely on an understanding of individual species' sensitivity to climate-induced changes, the rate and magnitude of climate-induced change, and the species' ability to adapt to these changes (Fischlin et al. 2007). The application of adaptive management approaches is not only complicated by the uncertainties in species' responses to climate change, but also differences in climate projections that predict different rates and magnitude of change. Therefore, predicting climate change impacts on biodiversity remains a major challenge (Bellard et al. 2012; Pacifici et al. 2015; Pereira et al. 2010), yet managers are frequently tasked with the identification, prioritization, and implementation of adaptive management options to lessen the impacts of climate change on the resources they manage.

Although we cannot predict how most species will respond to climate change, several assessments have identified species or habitats in the Rocky Mountain Region that are particularly vulnerable to climate change (Halofsky et al. 2018a,b; Rice et al. 2018). For avian species, the Forest Service Manual for the Rocky Mountain Region (USDA Forest Service Manual, Chapter 2670) provides a list of 21 species that are considered sensitive due to their geographic distribution, dispersal ability, population dynamics, life history strategies, and habitat requirements (table 1). Risk-reduction management actions to protect these vulnerable species are likely to mitigate impacts, but traditional conservation strategies focused on resisting change may not be possible or economically prudent under a changing climate (Aplet and Cole 2012). This chapter adds to the existing assessments applicable to the Pike-San Isabel and Arapaho-Roosevelt National

Forests (PSI-AR) while applying future-oriented conservation planning strategies (van Kerkhoff et al. 2019; Wyborn et al. 2016; fig. 1) that are designed around anticipating changes, recognizing societal values, shared governance, and ongoing learning.

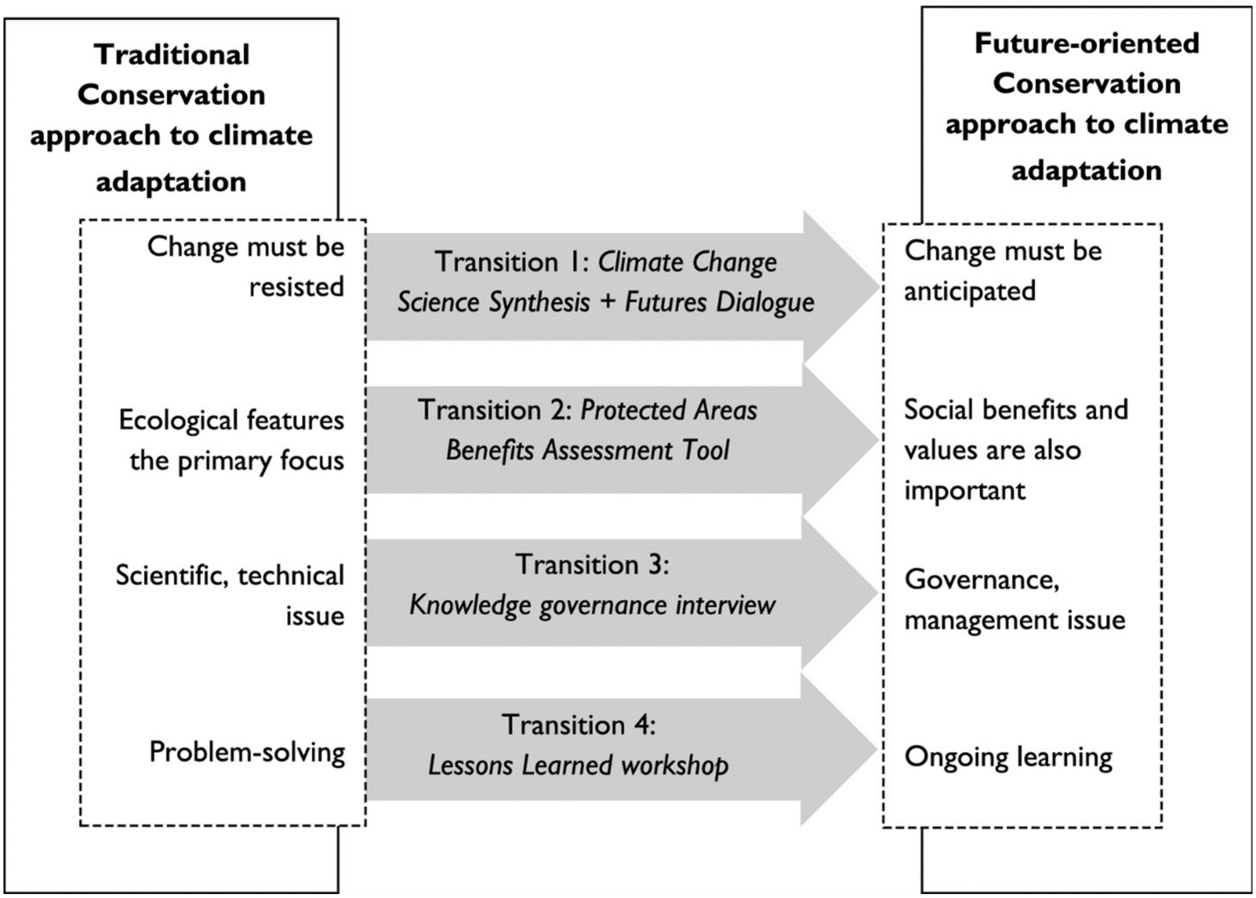


**Figure 1—**Four conceptual transitions and the tools that support them, from traditional conservation thinking and practices towards future-oriented conservation. Figure from van Kerkhoff et al. 2019.

**Table 1**—List of sensitive avian species identified in the Forest Service Manual for Rocky Mountain Region (USDA Forest Service Manual, Chapter 2670) that are found within the Pike (P), San Isabel (SI), Arapaho (A), and Roosevelt (R) National Forests. Residency status (i.e., breeding, non-breeding, migrant, or annual resident) and rationale for inclusion are given for each species.

| Species | Status | Rationale |
|---|---|---|
| Northern goshawk (*Accipiter gentilis)* | Resident (PS-IAR) | Widely distributed across coniferous forests, but locally rare. This species requires mature coniferous and aspen forests, and there have been significant declines in habitat quantity and quality due to harvest and/or development activity in previously suitable nesting habitat. Most local range on Forest Service lands. |
| Boreal owl (*Aegolius funereus)* | Resident (PSI-AR) | Evidence of long-term population decline, patchily distributed in the late-seral spruce forest habitat. Species is a secondary cavity nester dependent on woodpeckers and/or natural processes for nest site construction. |
| Short-eared owl (*Asio flammeus)* | Resident (AR), Non-breeding (PSI) | Long-term habitat declines of high-structured grasslands for nesting. Declining population trend. |
| Burrowing owl (*Athene cunicularia)* | Breeding (PSI-AR) | Primarily nests in prairie dog burrows in open grasslands; declining black-tailed prairie dog (candidate for ESA listing) colonies provide principal habitat. Declining population trends across range. |
| American bittern (*Botaurus lentiginosus)* | Breeding (PSI-AR) | Declining population trend, likely due to habitat decline. Loss and degradation of wetlands with robust emergent vegetation, due to drainage, filling, conversion to agriculture or recreational use, siltation, and pollution; needed for nesting and wintering habitat. |
| Ferruginous hawk (*Buteo regalis)* | Resident (PSI-AR) | High concern for declining habitat, localized downward population trends, and sensitivity to disturbance at nest sites. Habitat of open pinyon-juniper woodlands has declined with fire suppression and industrial and recreational activities impact reproductive success. |
| Chestnut-collared longspur (*Calcarius ornatus)* | Migrant (PSI-AR) | Habitat is declining range wide due to conversation of grasslands to croplands. Declining population trends across range. |
| Greater sage-grouse (*Centrocercus urophasianus)* | Resident (PSI-AR) | Significant population declines range wide, with several local extirpations linked to loss, fragmentation, and degradation of sagebrush habitat by conversion to croplands, mining and energy development, urbanization, invasive species, increase wildfire size, and overgrazing. |
| Mountain plover (*Charadrius montanus)* | Breeding (PSI-AR), Migrant (AR) | Significant population decline at key breeding areas. This species is associated with shortgrass and shrub-steppe habitats throughout its breeding and wintering range. Disturbance by prairie dogs, bison, heavy grazing, fire, drought, and cultivation create preferred large, flat grassland expanses with sparse, short vegetation, and bare ground. |

Table 2 continued.

| Species | Status | Rationale |
|---|---|---|
| Black tern (*Chlidonias niger*) | Breeding (PSI-AR) | Declining population trends with small and localized breeding populations leading to vulnerability of local extirpation. Primary threat is habitat loss and conversion of freshwater marsh habitat for nesting sites. |
| Northern harrier (*Circus hudsonius*) | Resident (PSI-AR) | This species is widely distributed, but declining population trends throughout western United States. Livestock grazing affects habitat quality of wetlands or grasslands with tall dense vegetation and high residual cover. |
| Olive-sided flycatcher (*Contopus cooperi*) | Breeding (PSI-AR) | Continent-wide declining population trend likely due to habitat alteration or loss on wintering grounds in Central and South America. Declines in breeding habitat quality and vulnerability to habitat modification by fire suppression, salvage logging, and timber management practices. |
| White-tailed ptarmigan (*Lagopus leucura*) | Resident (PSI-AR) | Populations are regionally isolated and population sizes are small, with poor ability to colonize new areas, thus susceptible to local extirpation. Many populations may not be self-sustaining. Cadmium from mining may be affecting lifespans of this species. Most range in Forest Service lands. |
| Loggerhead shrike (*Lanius ludovicianus*) | Breeding (PSI-AR) | Substantial population decline from historic levels, reasons uncertain. This species prefers open habitat of grasses and forbs of low stature, interspersed with bare ground and shrubs or tress, and often is associated with cropland and pastures. |
| Lewis's woodpecker (*Melanerpes lewis*) | Resident (PSI-AR) | Both habitat and population declines. Depends on large-diameter standing snags and diseased trees in late-successional forests, and mature lowland riparian cottonwood forests, both habitat types being lost or degraded. |
| Long-billed curlew (*Numenius americanus*) | Breeding (PSI) | Declining population trend. Habitat of grassland is being converted to cropland and is unable to adjust to grazed lands or cropland. |
| Cassin's sparrow (*Peucaea cassinii*) | Breeding (PSI) | While numbers fluctuate markedly from year to year, significant decrease in population across North America. Species needs structured grasslands that are often lost with intensive grazing and as grasslands turn to shrublands. |
| Purple martin (*Progne subis*) | Migrant (PSI-AR), Breeding (PSI) | Since areas of necessary habitat components are relatively sparse and widely separated, breeding colonies are small and vulnerable to local extirpation. This species is associated with large stands of pure mature aspen that have healthy populations of cavity excavators and large diameter trees with heart rot near large open areas with summer water. |

Table 2 continued.

| Species | Status | Rationale |
|---|---|---|
| Flammulated owl (*Psiloscops flammeolus*) | Breeding (PSI-AR) | Habitat vulnerability of late successional ponderosa pine habitat with historical alteration. Declining population trends and low reproductive rates makes this species vulnerable to local or regional extirpation. |
| McCown's longspur (*Rhynchophanes mccownii*) | Migrant (PSI-AR)<br>Breeding (AR) | Extremely restricted national range with weak declining population trend data range wide. Productivity linked to rangeland health. |
| Brewer's sparrow (*Spizella breweri*) | Breeding (PSI-AR) | Significant and historic declines in high risk, vulnerable habitat due to sagebrush conversion and invasion of cheatgrass. Strong population declines across species range, including its heart—the Great Basin. |

## Pike-San Isabel and Arapaho-Roosevelt National Forests (PSI-AR)

The PSI-AR lies within the Southern Rocky Mountains Steppe–Open Woodland–Coniferous Forest–Alpine Meadow Province of the United States Temperate Steppe Ecoregion (McNab et al. 2007; fig. 2). The climate of this ecoregion is characterized by short, warm summers and long, cold winters. Average current temperatures (1985–2015) in the ecoregion vary substantially throughout the year with average daily temperatures ranging typically from 57 °F in the summer (June, July, August) to 20 °F in the winter (December, January, February). Precipitation is moderate, increasing with altitude where it generally occurs as snow. Topography varies from high mountains to gently rolling valleys in the north to steeply sloped, precipitous, flat-topped mountains in the south. Vegetation is varied and includes predominately lodgepole pine, ponderosa pine, alpine tundra, and sagebrush cover types in the northern sections and ponderosa pine, pinyon-juniper, fir-spruce, chaparral-mountain shrub, and alpine tundra in the south.

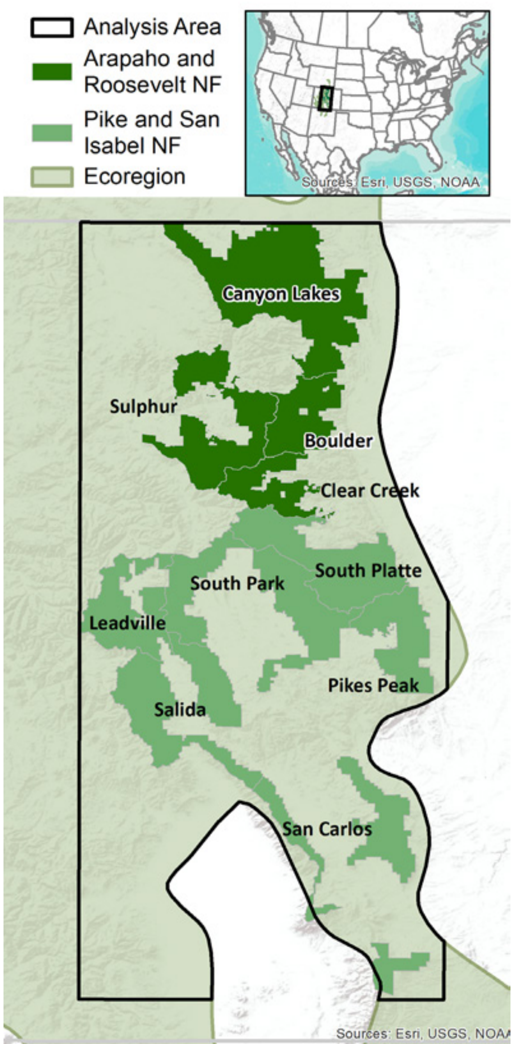


**Figure 2—**The location of the Pike, San Isabel, Arapaho, and Roosevelt (PSI-AR) National Forests (including district boundaries) within the Southern Rocky Mountains Steppe–Open Woodland–Coniferous Forest–Alpine Meadow Province of the United States Temperate Steppe Ecoregion focal area.

## Climate Change Projections for the PSI-AR

Future climate projections can be used by decision-makers to proactively address the impacts of climate change on the resources they manage. However, a range of assumptions about the magnitude and pace of future emissions are used by scientists to develop different emission scenarios, upon which climate model projections are based. Different general circulation models (GCMs) provide alternative representations of the Earth's natural climate variability and response to emissions that influence predicted change in global surface temperatures. These global models are too coarse (100 km resolution) to resolve many important regional climatic patterns, and statistical downscaling techniques are used to translate large-scale data into smaller spatial scales appropriate for managers. Therefore, climate projections are dependent upon choice of GCM, emission scenario, and downscaling method. Differences in the outputs of these projections complicate our ability to manage adaptively for a set of potential "known" future conditions.

Rangwala et al. 2024 (this report) provided four downscaled climate models that forecast climatic conditions for the period 2035–2065. Relative to current conditions (1985–2015), these models resulted in future climates that were Warm and Wet (WW), Hot (H), Very Hot and Wet (VHW), and Very Hot and Dry (VHD). All four climate projections predicted an increase in daily temperatures (fig. 3), although increases in temperature varied seasonally and by climate model. The predicted increase in temperature was lowest in the WW scenario (ESM2M.rcp8.5). The H scenario (CNRM-CM5.rcp8.5) predicted similar temperature increases as the WW scenario in spring (defined here as the months of March, April, May) and fall (September, October, November), but relatively higher summer (June, July, August) and winter (December, January, February) temperatures. Temperatures in the VHW (CanESM2.rcp8.5) and VHD (IPSL-CM5A-MR.rcp8.5) scenarios predicted the largest temperature increases, with average summer temperatures increasing by > 5 °F. Increases in the VHD model tended to be higher than the VHW scenario, except in the spring months when VHW temperatures exceeded that of VHD. In the spring, average daily temperatures in the VHW scenario shifted relative to current conditions by ~7 °F, such that this scenario resulted in a range of mean daily spring temperatures that had little overlap with current spring temperatures (fig. 3).

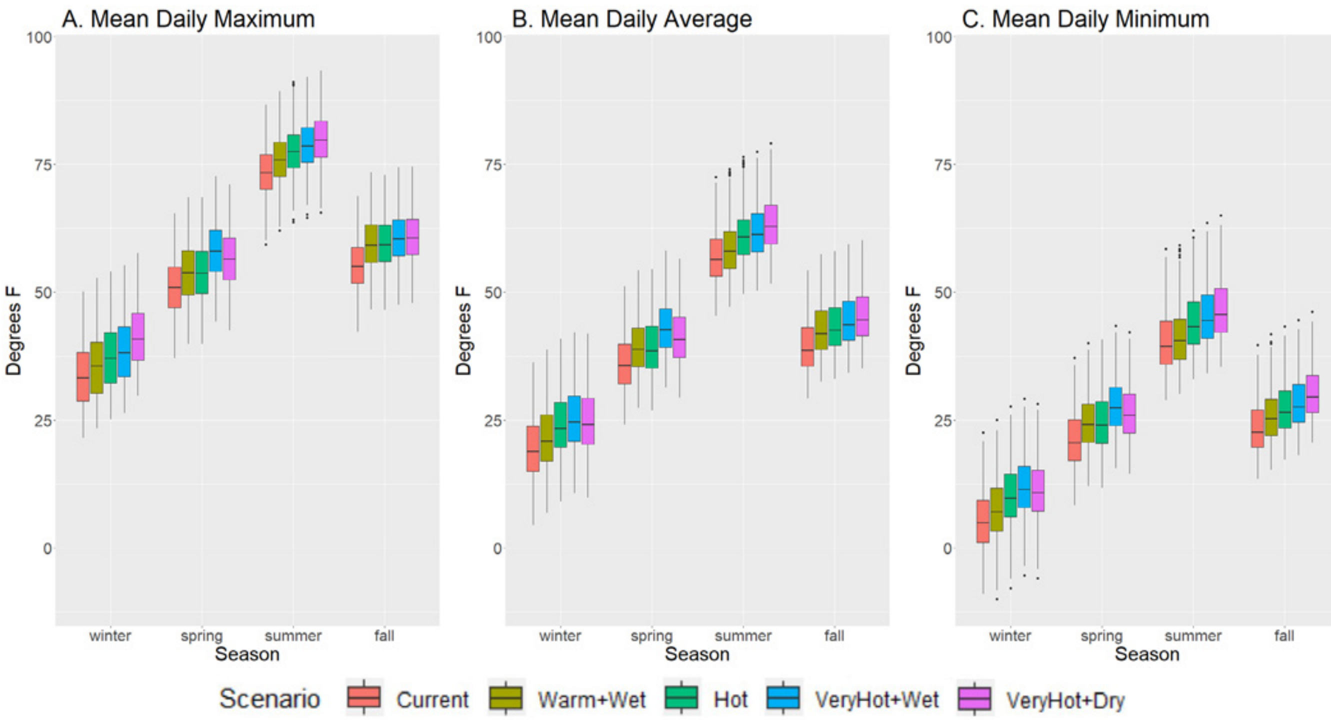


**Figure 3a-c**—Boxplots displaying mean daily maximum, daily average, and daily minimum temperatures predicted under four different climate change scenarios relative to current temperatures.

Increases in temperature not only varied by scenario and season, but also varied across the PSI-AR, with more extreme increases in spring temperature in the southwestern ranger districts (fig. 4). By contrast, in the summer months, temperature increases in these ranger districts were predicted to be less severe, although the degree of difference varied by climate model (fig. 4). In the fall and winter, temperatures tended to be highest in the Canyon Lakes Ranger District.

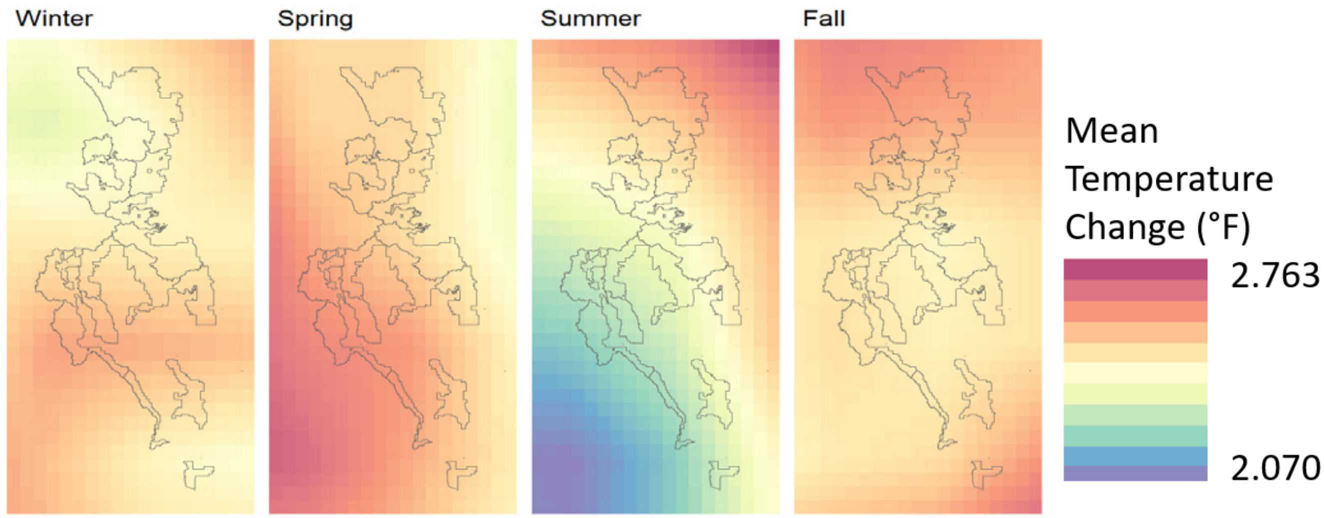


**Figure 4a**—Average mean temperature change(degrees F) predicted across the PSI-AR by season under four climate scenarios.

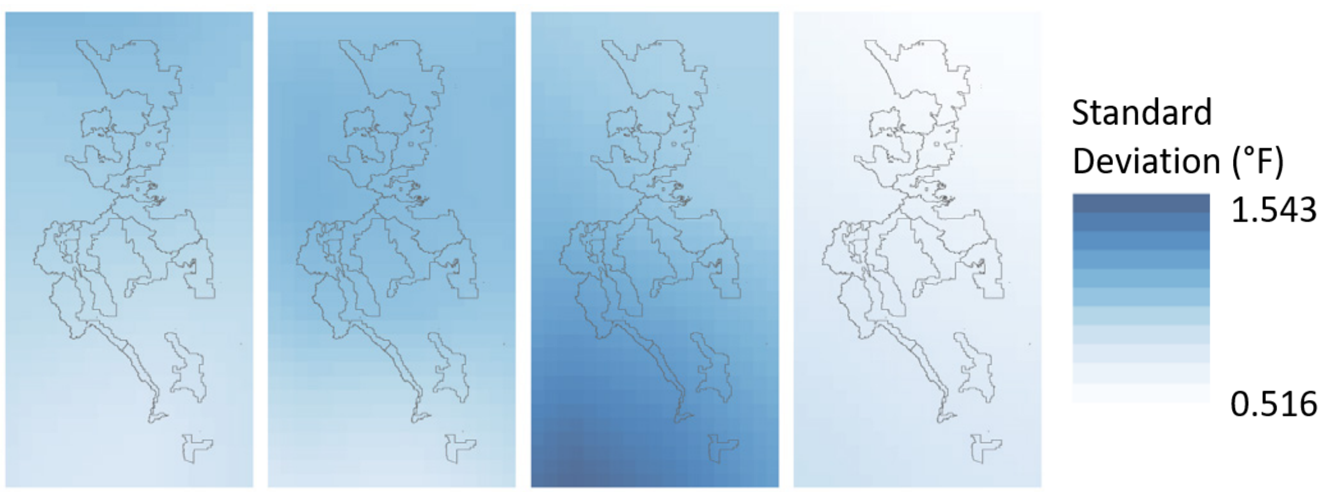


**Figure 4b**—Standard deviations (degrees F) predicted across the PSI-AR by season under four climate scenarios.

## Climate Change Impacts on Avian Species Within the PSI-AR

Frequently the climatic condition over a species' current distribution is used as a proxy for a species' physiological tolerances (i.e., temperature and moisture requirements necessary for a species to survive and reproduce). Based on a species' physiological tolerance, climate change models can be used to predict where a species' distribution is likely to contract (reduce in size), expand (increase in size), and/or shift (occur in a different location). Existing datasets on bird species distributions indicate that 269 bird species have current distributions that include parts of the PSI-AR (BirdLife

International 2018). Birds use habitat within the PSI-AR for breeding (132 species), wintering (69 species), for migration (36), or to support their populations year-round (101 species, Appendix A). For most of these species the focal area is only a small portion of their entire distribution (see fig. 5); for these species local management decisions are less likely to influence a species conservation status as these species range across wide environmental gradients. Species with larger portions of their range (> 10 percent) within the focal area include brown-capped rosy finch (*Leucosticte australis*) and Gunnison sage-grouse (*Centrocercus minimus*), and the migratory range of the lark bunting (*Calamospiza melanocorys*). In addition, two species have genetically distinct breeding populations that occur within the focal area: the least flycatcher (*Empidonax minimus*) and western bluebird (*Sialia mexicana*). In mountainous regions, observed changes in climate have not only resulted in changes to the geographic range of avian species, but also the timing of their seasonal life cycles (phenology).

## Anticipating Climate-Induced Changes in Species Distributions

How vulnerable an individual species is to changes in climate will be influenced by its exposure to climatic changes and its sensitivity to these changes. To better understand the probability of changes in avian communities under each of the four climate projections, I first calculated the change in mean and maximum temperatures across the distributions of each of the 132 species that breed within the PSI-AR (BirdLife International 2018) at a 30-m pixel resolution. For each pixel, I classified the predicted change in temperature as < 3.9 °F, 3.9–4.4 °F, 4.5–5.0 °F, 5.1–5.5 °F, 5.6–6.0 °F, and > 6 °F based on NatureServe's Climate Change Vulnerability Index (Young et al. 2011, fig. 6). The Climate Change Vulnerability Index can be used to interpret the likely effect of changes in temperature on a species' vulnerability to climate change whereby a species vulnerability increases with increasing changes in temperature.

As the predicted change in temperature was not always uniform across the species distribution (e.g., fig 6, bottom row), an overall species vulnerability index was assigned to each species under each scenario based on the temperature changes experienced across the majority of their range. Based on these calculations, all species would be experiencing an increase in temperature across their distributions, with the VHD and VHW scenarios predicting temperature increases > 5.6 °F (fig. 7). As changes in species' distributions have already occurred in several mountainous bird species in the northern hemisphere in response to current climate change (reviewed in Scridel et al. 2018), we would predict changes in species distributions even under the more moderate WW and H climate scenarios (< 3.9 °F). In addition to range contractions, we need to anticipate a redistribution of species, including the addition of species whose ranges will likely shift to include parts of the PSI-AR where they currently do not occur.

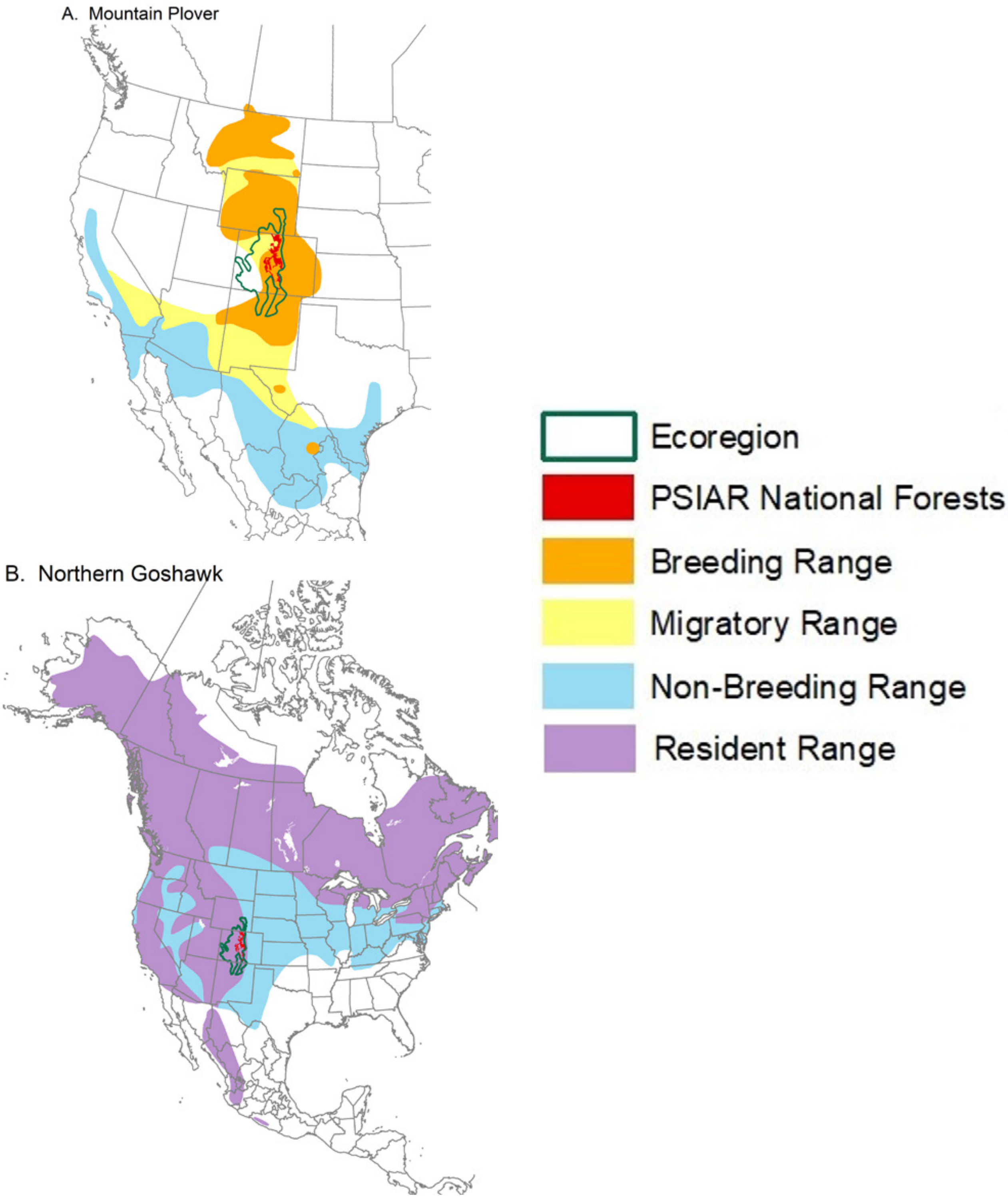


**Figure 5a-b—**Distribution of two bird species found within the Pike, San Isabel, Arapaho, and Roosevelt (PSI-AR) National Forests that are included in table 1. A green outline delineates the Southern Rocky Mountains Steppe–Open Woodland–Coniferous Forest–Alpine Meadow Province of the United States that was used as the ecological boundary for the PSI-AR (outlined in red).

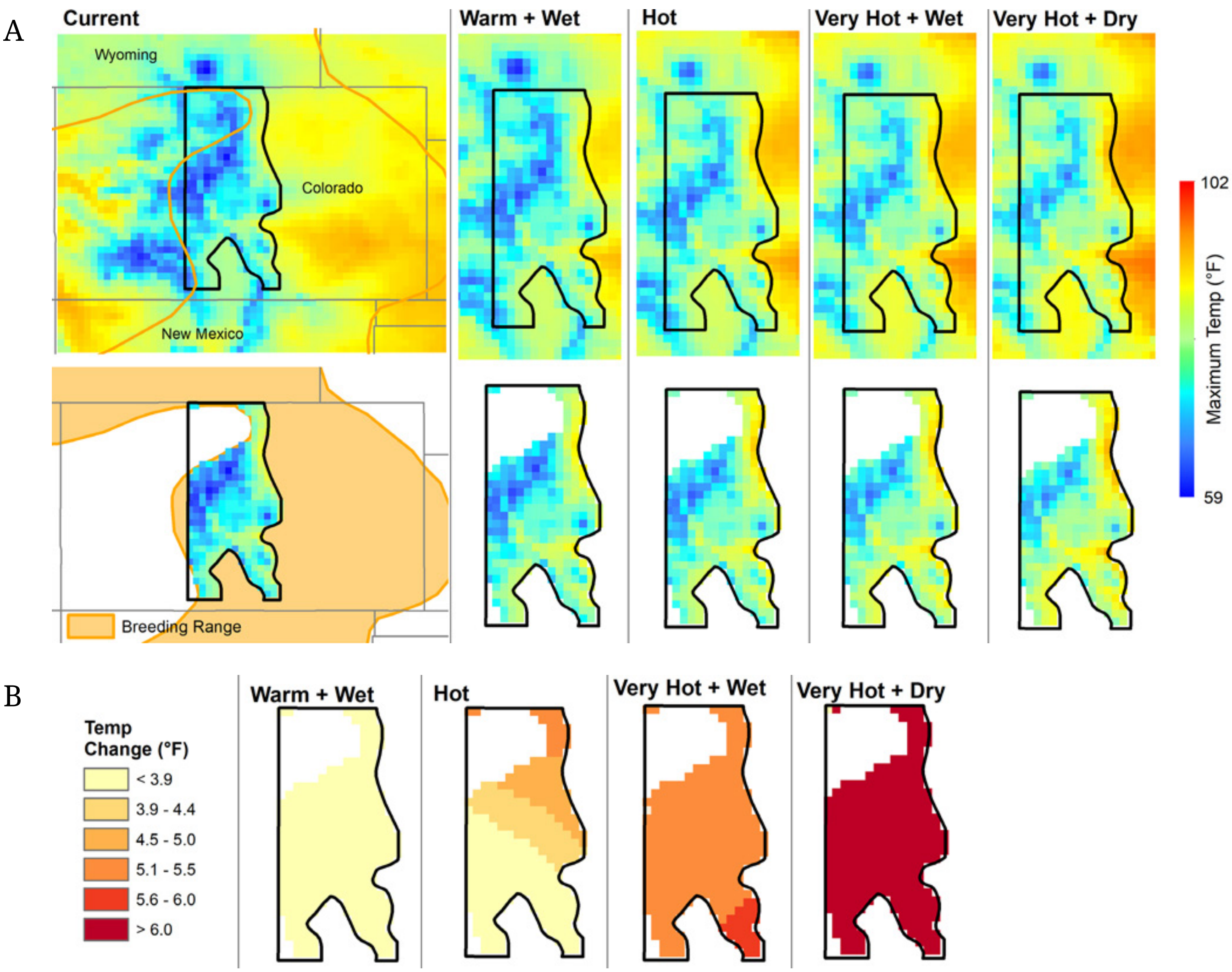


**Figure 6a-b—**Example of workflow used to assign species vulnerability index. (a) Mean maximum summer temperatures (June, July, August) experienced currently (1985–2015) compared to future temperatures (2035–2065) predicted under four different climate change scenarios (top). Second row provides an example of a single species current distribution (orange) within the larger ecoregion assessment area (black outline) that was used in individual species calculations. (b) shows how the scenario impacted projections of temperature across the range of the species.

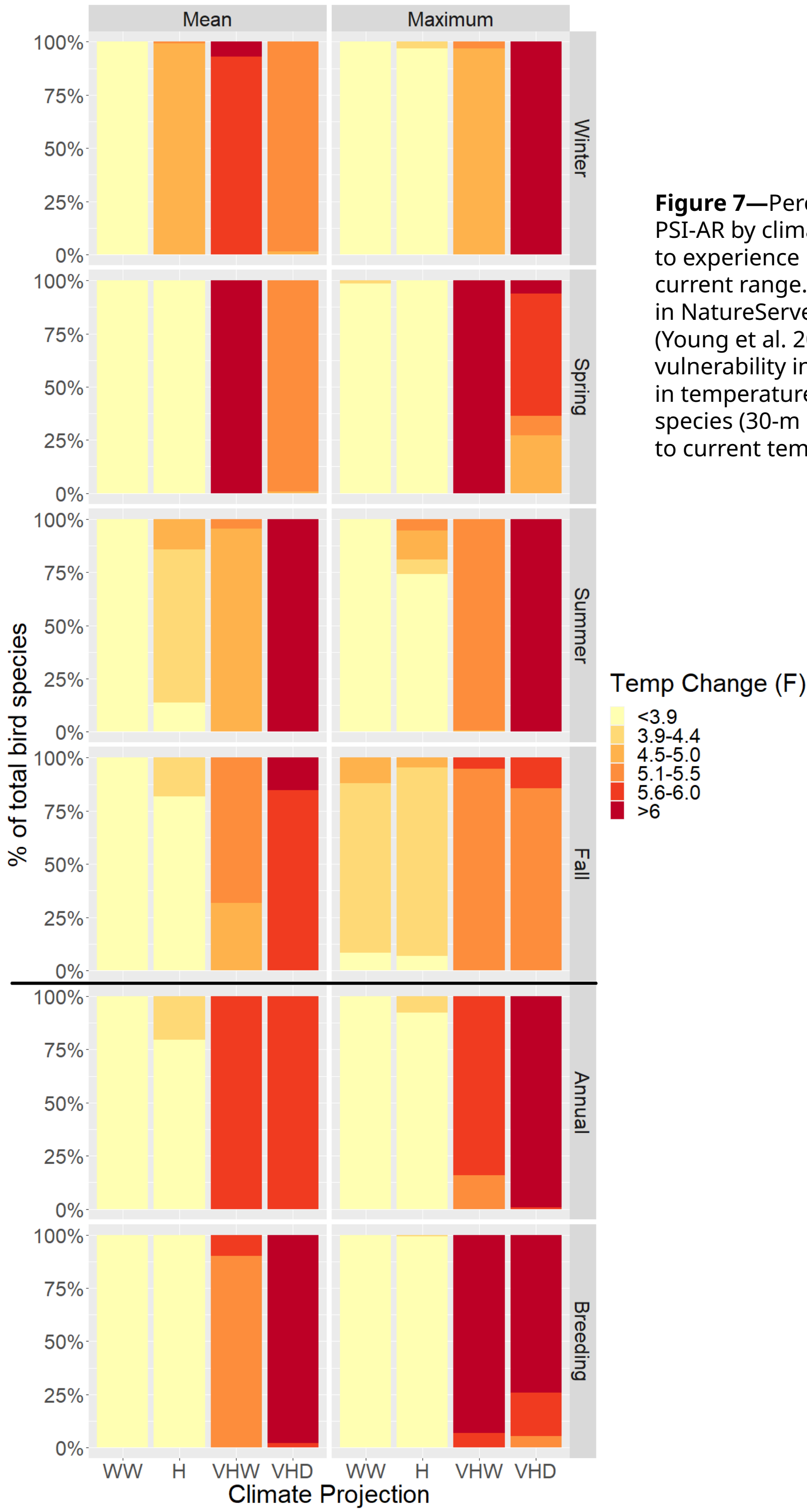


**Figure 7—**Percentage of 132 species breeding within the PSI-AR by climate scenario and season that are predicted to experience increases in temperature across their current range. Temperature bins are based on guidelines in NatureServe's Climate Change Vulnerability Index (Young et al. 2011). Counts of species into a species vulnerability index is based on spatially-explicit changes in temperature across the current distribution of each species (30-m pixel) under each climate scenario relative to current temperatures.

## Anticipating Climate-Induced Changes in Phenology

Bird species that are year-around residents of the PSI-AR (101 of the 269 species) are exposed to temperatures that vary dramatically throughout the year from mean daily temperatures of 15 °F in the winter to 60°F in the summer (fig. 3). These species would have experienced evolutionary pressure to thrive within the range, average, and extreme conditions experienced throughout the year and are adapted to a wide range of climatic conditions. As year-round residents, these species are better positioned to respond to local changes in climate and timing of these changes. Conversely, migratory species, and spring migrants in particular (i.e., those species that use the PSI-AR for breeding grounds), require special consideration, as they must time their departure from wintering grounds with conditions and resource availability at their breeding grounds. Recent work has shown that population declines are most widely reported in migratory species that are not advancing their migration dates in response to climate change (Møller et al. 2008).

Within the PSI-AR, 132 species have populations that generally begin breeding in late spring to begin breeding (Birdlife International 2018). Species that are unable to shift the timing of spring migration will not only have a shorter duration of time in which to breed, but will face increased breeding season temperatures (Halupka and Halupka 2017), particularly under the VHW and VHD scenarios (fig. 7). Changes in the timing of spring migration are the most commonly reported phenological responses to climate change (reviewed in Gill et al. 2014) and can lead to phenological mismatches with prey resources (e.g., resources may peak in response to earlier spring conditions) before birds arrive/fledge, which can lead to lower reproductive success (Ross et al. 2017). Earlier spring conditions are predicted under all climate scenarios (2-3 weeks earlier; Rangwala et al. 2024 (this report).

## Anticipating Climate-Induced Changes in Habitat

Forest structure and composition provide the environmental conditions needed to support essential food, resting, and breeding requirements for wildlife and changes in forest structure will impact suitable habitat for any given species (Fontaine and Kennedy 2012; Stephens et al. 2014; White et al. 2013). Therefore, forest structure and composition, often targeted by management actions such as fuel reduction (i.e., forest thinning) and mediated by temperature and precipitation, will also determine whether species can persist on the landscape.

The amount of annual precipitation within the PSI-AR ecoregion is also highly variable and seasonal, with most precipitation occurring in the spring and summer. All climate change scenarios, with the exception of the VHD scenario, predict an increase in summer and spring precipitation relative to current conditions. In contrast, the VHD scenario predicts a decrease in precipitation throughout the year (fig. 8). Under all models, seasonal changes in precipitation and temperature are predicted to lead to a shift in snowline elevation from its current levels (8,400 ft) to 9,360 ft in the WW scenario, to as much as 10,400 ft in the VHD scenario. Decreases in snow will have negative impacts on some wildlife species that are dependent on snow for hunting and or thermoregulatory requirements (Penczykowski et al. 2017), and the volume and timing of snowmelt will impact fish, amphibians, and other riparian-associated species (Smith et al. 2024, this report).

Although changes in precipitation are often used as a proxy for water availability, the availability of water for plants also depends on ambient temperature, soil type, vegetation conditions, and whether precipitation falls as rain or snow. A more informative proxy for water availability for plants is climatic water deficit (CWD). CWD is when the evaporative demand of vegetation exceeds annual water availability, and mean annual CWD across all scenarios is expected to increase slightly relative to the current deficit (fig. 8). Therefore, despite predictions that precipitation may increase, all models predict that vegetation will likely be more water stressed in the future—a deficit which is expected to be most severe in the VHD model. Water-stressed vegetation is likely to influence the availability and abundance of resources for birds including fruits/seeds and insects (Barton and Ives 2014; McCluney et al 2012). Changes in temperature and CWD can also change habitat structure and composition by altering the probability of insect outbreaks and severity of wildfires—changes already being observed within the PSI-AR (Chapman et al. 2020). The pace of these changes is likely to be most rapid under the VHD model compared to the other climate scenarios as changes in temperature and moisture availability will also influence seedling establishment and survival (Davis et al. 2019).

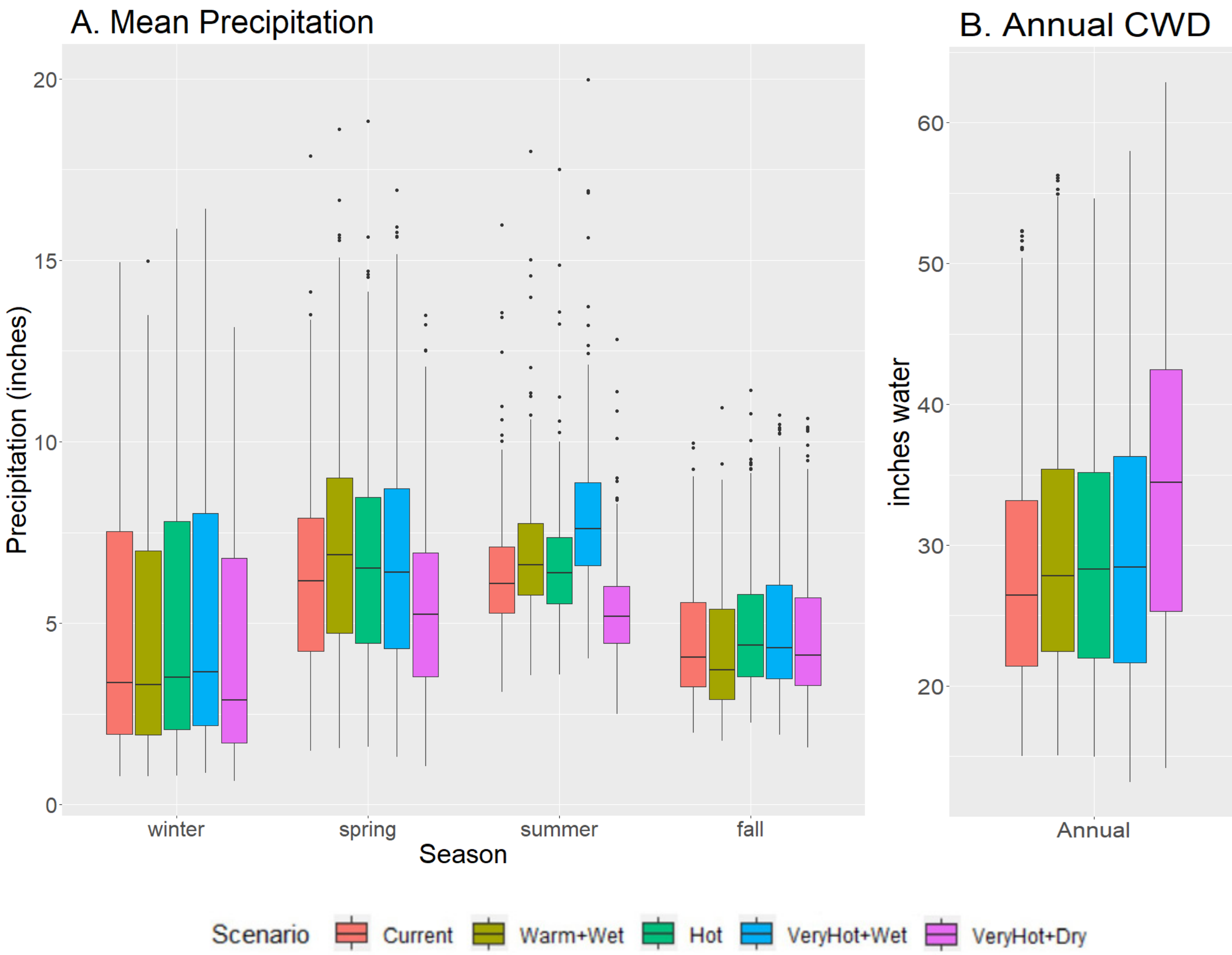


**Figure 8a-b—**Boxplots displaying seasonal precipitation under current and future climate scenarios. Patterns of precipitation throughout the year influence annual climatic water deficit.

## Embracing the Uncertainties and Moving Forward

Adaptive capacity describes the ability of individuals within a species to change in response to stimuli or inputs from the environment, thus the overall vulnerability of a species will ultimately be influenced by its adaptive capacity. Although we have some ability to predict how populations of some species are likely to respond to changing environmental conditions, differences in climate change models can lead to different future conditions with corresponding management challenges. In addition, information about how biodiversity and ecosystems will respond is lacking, although some evidence suggests that species are not adapting quickly enough (Radchuk et al. 2019). Important questions arise of which we rarely have immediate answers: *How is a species' reproductive success impacted as their environmental thresholds are reached? Which species can shift their current distributions in response to a warming climate? What happens to ecosystems when there is species loss or turnover?* These uncertainties can be paralyzing, and the four climate change scenarios modeled here predict different futures that will impact species differently based on their life history. These uncertainties can make it challenging to invest in specific management interventions. However, we do have a high level of confidence in certain climate-induced changes.

The climate is warming with greater warming occurring at higher latitudes. In mountainous areas, different topoclimates within narrow elevational gradients result in high levels of species biodiversity, and mountains support one-quarter of terrestrial biodiversity and contain nearly half of the world's biodiversity hotspots. A warming climate has been linked to increased drought and wildfire and there is a large body of evidence that animals and plants are responding to climate change through shifts in their distribution, phenology (e.g., timing and duration of breeding, migration), and changes in population size.

Most species do not exist within the confines of social-political boundaries in which management actions are implemented (e.g. fig. 2). Therefore, when attempting to address the impacts of climate change on the social-ecological sustainability of resources, it will be prudent to consider both adaptation strategies to maintain current populations and resources, and strategies that anticipate change in the distribution of species both within and outside of National Forest boundaries (i.e., shared governance, Transition 3, fig. 1). Under the WW scenario, a focus on more conventional conservation strategies (fig. 1) may help support the conservation of existing species and habitats within their current boundaries over the near-term. However, under the VHD and VHW scenarios, changes in climate are likely to result in intense pressure on species to shift their current distributions. Therefore, in addition to assessing climatic vulnerabilities, we should anticipate climate-induced changes in species distributions, work across social-political boundaries, and invest in shared learning as we navigate the many uncertainties that stall management action (fig. 1).

## Future-Oriented Conservation Approach and Guidelines

Climate change adaptation refers to the process of adjusting strategies to reduce risks to natural and human systems from changes in climate. Many tools have been developed to help managers articulate and evaluate different climate adaptation approaches (Abrahms et al. 2017). These tools are not typically designed to help establish conservation and management goals, which are driven as much by societal values, economic constraints, and political feasibility (Transition 2, fig. 1), as they are by scientific knowledge (Camacho et al. 2010). Instead, they are designed to help assess climate risk based on scientific knowledge. In many cases, our scientific knowledge is lacking due to uncertainty in future conditions, incomplete knowledge of species adaptive capacity, novel species assemblages, and cascading effects on ecosystem function and stability.

Below are some general conservation guidelines to address scientific uncertainties and need for management action under a future-oriented conservation approach to climate adaptation:

1. Change must be anticipated
    a. Expect changes in species distribution, abundance, and phenology.
    b. Minimize barriers to movement (within and across jurisdictions).
    c. Protect trailing-edge populations where appropriate (i.e., resist change), while facilitating population transition to other areas.
2. Recognize societal benefits and values
    a. Identify societal values, economic constraints, and political feasibility as part of a conservation strategy.
    b. Emphasize maintaining ecosystem function and ecosystem services.
3. Governance management
    a. Work across political boundaries to protect ecosystems and the species which rely on them.
    b. Rethink and redefine measures of success (i.e., maintaining species within an ecoregion, or sustaining functional diversity).
4. Invest in and apply ongoing learning
    a. Embrace heterogeneity in thought and practice—protect against loss by supporting more than one possible result.
    b. Refrain from thinking of change as “failure.”
    c. Focus learning and research on reducing uncertainties that hinder management action.

## References

Abrahms, B.; DiPietro, D.; Graffis, A.; [et al.]. 2017. Managing biodiversity under climate change: Challenges, frameworks, and tools for adaptation. Biodiversity and Conservation. 26(10): 2277–2293. https://doi.org/10.1007/s10531-017-1362-4

Aplet, G.H.; Cole, D.N. 2012. The trouble with naturalness: Rethinking park and wilderness goals. In: Cole, D.N.; Yung, L., eds. Beyond naturalness: Rethinking park and wilderness stewardship in an era of rapid change. Washington, DC: Island Press: 12–29.

Barton, B.T.; Ives, A.R. 2014. Species interactions and a chain of indirect effects driven by reduced precipitation. Ecology. 95(2): 486–494. https://doi.org/10.1890/13-0044.1

Bellard, C.; Bertelsmeier, C.; Leadley, P.; [et al.]. 2012. Impacts of climate change on the future of biodiversity. Ecology Letters. 15(4): 365–377. https://doi.org/10.1111/j.1461-0248.2011.01736.x

BirdLife International and Handbook of the Birds of the World [Birdlife International]. 2018. Bird species distribution maps of the world. Version 2018.1. Available at https://datazone.birdlife.org/species/requestdis

Camacho, A.E.; Doremus, H.; McLachlan, J.S.; [et al.]. 2010. Reassessing conservation goals in a changing climate. Issues in Science and Technology. 26(4): 21–26. https://issues.org/p_camacho/

Chapman, T.B.; Schoennagel, T.; Veblen, T.T.; [et al.]. 2020. Still standing: Recent patterns of post-fire conifer refugia in ponderosa pine-dominated forests of the Colorado Front Range. PLoS One. 15(1): e0226926. https://doi.org/10.1371/journal.pone.0226926

Cooley, S.; Schoeman, D.; Bopp, L.; [et al.]. 2022. Oceans and coastal ecosystems and their services. In: Pörtner, H.-O.; Roberts, D.C.; Tignor, M.; [et al.], eds. Climate change 2022: Impacts, adaptation and vulnerability. Contribution of working group II to the sixth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK, and New York, NY, USA: Cambridge University Press: 379–550. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Chapter03.pdf [Accessed 24 June 2024]

Davis, K.T.; Dobrowski, S.Z.; Higuera, P.E.; [et al.]. 2019. Wildfires and climate change push low-elevation forests across a critical climate threshold for tree regeneration. Proceedings of the National Academy of Sciences of the United States of America. 116(13): 6193–6198. https://doi.org/10.1073/pnas.1815107116

Fischlin, A.; Midgley, G.F.; Price, J.T.; [et al.]. 2007. Ecosystems, their properties, goods, and services. In: Parry, M.L.; Canziani, O.F.; Palutikof, J.P.; [et al.], eds. Climate change 2007: Impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press: 211–272. https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg2-chapter4-1.pdf [Accessed 24 June 2024]

Fontaine, J.B.; Kennedy, P.L. 2012. Meta-analysis of avian and small-mammal response to fire severity and fire surrogate treatments in U.S. fire-prone forests. Ecological Applications. 22(5): 1547–1561. https://doi.org/10.1890/12-0009.1

Gaston, K.J.; Blackburn, T.M.; Goldewijk, K.K. 2003. Habitat conversion and global avian biodiversity loss. Proceedings of the Royal Society of London. Series B: Biological Sciences. 270(1521): 1293–1300. https://doi.org/10.1098/rspb.2002.2303

Gill, J.A.; Alves, J.A.; Sutherland, W.J.; [et al.]. 2014. Why is timing of bird migration advancing when individuals are not? Proceedings of the Royal Society B: Biological Sciences. 281(1774): 20132161. https://doi.org/10.1098/rspb.2013.2161

Halofsky, J.S.; Conklin, D.R.; Donato, D.C.; [et al.]. 2018a. Climate change, wildfire, and vegetation shifts in a high-inertia forest landscape: Western Washington, USA. PLoS One. 13(12): e0209490.

Halofsky, J.S.; Donato, D.C.; Franklin, J.F.; [et al.]. 2018b. The nature of the beast: Examining climate adaptation options in forests with stand-replacing fire regimes. Ecosphere. 9(3): e02140. https://doi.org/10.1002/ecs2.2140

Halupka, L.; Halupka, K. 2017. The effect of climate change on the duration of avian breeding seasons: A meta-analysis. Proceedings of the Royal Society B: Biological Sciences. 284(1867): 20171710. https://doi.org/10.1098/rspb.2017.1710

Jetz, W.; Wilcove, D.S.; Dobson, A.P. 2007. Projected impacts of climate and land-use change on the global diversity of birds. PLOS Biology. 5(6): e157. https://doi.org/10.1371/journal.pbio.0050157

McCluney, K.E.; Belnap, J.; Collins, S.L.; [et al.]. 2012. Shifting species interactions in terrestrial dryland ecosystems under altered water availability and climate change. Biological Reviews. 87(3): 563–582. https://doi.org/10.1111/j.1469-185X.2011.00209.x

McNab, W.H.; Cleland, D.T.; Freeouf, J.A.; [et al.] 2007. Description of ecological subregions: sections of the conterminous United States. Gen. Tech. Rep. WO-76B, 76: 1–82. https://doi.org/10.2737/WO-GTR-76B

Møller, A.P.; Rubolini, D.; Lehikoinen, E. 2008. Populations of migratory bird species that did not show a phenological response to climate change are declining. Proceedings of the National Academy of Sciences of the United States of America. 105(42): 16195–16200. https://doi.org/10.1073/pnas.0803825105

Pacifici, M.; Foden, W.B.; Visconti, P.; [et al.]. 2015. Assessing species vulnerability to climate change. Nature Climate Change. 5(3): 215–224.

Pacifici, M.; Visconti, P.; Butchart, S.H.; [et al.] 2017. Species' traits influenced their response to recent climate change. Nature Climate Change. 7(3): 205–208. https://doi.org/10.1038/nclimate3223

Parmesan, C.; Morecroft, M.; Trisurat, Y.; [et al.]. 2022. Terrestrial and freshwater ecosystems and their services. In: Pörtner, H.-O.; Roberts, D.C.; Tignor, M.; [et al.], eds. Climate change 2022: Impacts, adaptation and vulnerability. Contribution of working group II to the sixth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK, and New York, NY, USA: Cambridge University Press: 197–377. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Chapter02.pdf [Accessed 24 June 2024]

Penczykowski, R.M.; Connolly, B.M.; Barton, B.T. 2017. Winter is changing: Trophic interactions under altered snow regimes. Food Webs. 13: 80–91. https://doi.org/10.1016/j.fooweb.2017.02.006

Pereira, H.M.; Leadley, P.W.; Proença, V.; [et al.]. 2010. Scenarios for global biodiversity in the 21st century. Science. 330(6010): 1496–1501. https://doi.org/10.1126/science.1196624

Radchuk, V.; Reed, T.; Teplitsky, C.; [et al.]. 2019. Adaptive responses of animals to climate change are most likely insufficient. Nature Communications. 10(1): 3109. https://doi.org/10.1038/s41467-019-10924-4

Rangwala, I. 2024. Chapter 3: Future climate scenarios for Colorado's Front Range forests. In: Hanberry, B.B.; Foster, A., eds. Colorado Front Range climate change vulnerability assessment for National Forests. Gen. Tech. Rep. RMRS-GTR-438. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: **XX-XX** https://doi.org/10.2737/RMRS-GTR-438

Rice, J.R.; Joyce, L.A.; Regan, C.; [et al.]. 2018. Climate change vulnerability assessment of aquatic and terrestrial ecosystems in the U.S. Forest Service Rocky Mountain Region. Gen. Tech. Rep. RMRS-GTR-376. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. https://doi.org/10.2737/RMRS-GTR-376

Rosenberg, K.V.; Dokter, A.M.; Blancher, P.J.; [et al.]. 2019. Decline of the North American avifauna. Science. 366(6461): 120–124. https://doi.org/10.1126/science.aaw1313

Ross, M.V.; Alisauskas, R.T.; Douglas, D.C.; [et al.]. 2017. Decadal declines in avian herbivore reproduction: Density-dependent nutrition and phenological mismatch in the Arctic. Ecology. 98(7): 1869–1883. https://doi.org/10.1002/ecy.1856

Scridel, D.; Brambilla, M.; Martin, K.; [et al.]. 2018. A review and meta-analysis of the effects of climate change on Holarctic mountain and upland bird populations. Ibis. 160(3): 489–515. https://doi.org/10.1111/ibi.12585

Şekercioğlu, Ç.H. 2006. Increasing awareness of avian ecological function. Trends in Ecology & Evolution. 21(8): 464–471. https://doi.org/10.1016/j.tree.2006.05.007

Şekercioğlu, Ç.H.; Daily, G.C.; Ehrlich, P.R. 2004. Ecosystem consequences of bird declines. Proceedings of the National Academy of Sciences of the United States of America. 101(52): 18042–18047.

Siegel, R.; Pyle, P.; Thorne, J.; [et al.]. 2014. Vulnerability of birds to climate change in California's Sierra Nevada. Avian Conservation and Ecology. 9(1). https://doi.org/10.5751/ACE-00658-090107

Smith, M. 2024. Chapter 4: Water resources of the Front Range National Forests. In: Hanberry, B.B.; Foster, A., eds. Colorado Front Range climate change vulnerability assessment for National Forests. Gen. Tech. Rep. RMRS-GTR-438. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 57-122. https://doi.org/10.2737/RMRS-GTR-438

Stephens, S.L.; Bigelow, S.W.; Burnett, R.D.; [et al.]. 2014. California spotted owl, songbird, and small mammal responses to landscape fuel treatments. BioScience. 64(10): 893–906. https://doi.org/10.1093/biosci/biu137

Tingley, M.W.; Monahan, W.B.; Beissinger, S.R.; [et al.]. 2009. Birds track their Grinnellian niche through a century of climate change. Proceedings of the National Academy of Sciences of the United States of America. 106(Supplement 2): 19637–19643. https://doi.org/10.1073/pnas.0901562106

USDA Forest Service Manual [FSM] and Forest Service Handbooks [FSH]. 2011. Office of the Chief of the Forest Service. https://www.fs.usda.gov/about-agency/regulations-policies/national-directives [Accessed 24 June 2024]

van Kerkhoff, L.; Munera, C.; Dudley, N.; [et al.]. 2019. Towards future-oriented conservation: Managing protected areas in an era of climate change. Ambio. 48(7): 699–713. https://doi.org/10.1007/s13280-018-1121-0

White, A.M.; Zipkin, E.F.; Manley, P.N.; [et al.]. 2013. Conservation of avian diversity in the Sierra Nevada: Moving beyond a single-species management focus. PLOS ONE. 8(5): e63088. https://doi.org/10.1371/journal.pone.0063088

Weiskopf, S.R.; Rubenstein, M.A.; Crozier, L.G.; [et al.]. 2020. Climate change effects on biodiversity, ecosystems, ecosystem services, and natural resource management in the United States. Science of the Total Environment. 733: 137782. https://doi.org/10.1016/j.scitotenv.2020.137782

Wyborn, C.; van Kerkhoff, L.; Dunlop, M.; [et al.]. 2016. Future oriented conservation: Knowledge governance, uncertainty and learning. Biodiversity and Conservation. 25: 1401–1408. https://doi.org/10.1007/s10531-016-1130-x

Young, B.; Byers, E.; Gravuer, K; [et al.]. 2011. Guidelines for using the NatureServe climate change vulnerability index. Arlington, VA: NatureServe. https://www.natureserve.org/sites/default/files/guidelines_natureserveclimatechangevulnerabilityindex_r2.1_apr2011.pdf [Accessed 24 June 2024]

# Appendix A: List of avian species whose distribution overlaps portions of the Pike San Isabel and Arapaho-Roosevelt National Forests

List of avian species whose distribution overlaps portions of the Pike-San Isabel and Arapaho-Roosevelt National Forests (BirdLife International 2018). Species are organized by family and listed alphabetically by scientific name.

Capital letters in columns indicate that the species occurs throughout a National Forest (PSI = Pike-San Isabel, AR = Arapaho-Roosevelt), whereas lowercase letters refer to Ranger Districts (bo = Boulder, cc = Clear Creek, cl = Canyon Lakes, le = Leadville, pa = South Park, pl = South Platte, pp = Pike's Peak, sa = Salida, sc = San Carlos, su = Sulphur).

Ranger Districts that are italicized and in parentheses indicate a species occurs throughout the National Forest except for the Ranger District(s) indicated. Species with smaller ranges or in taxonomic families with fewer species may warrant special consideration.

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| **Accipitridae** | Northern goshawk *(Accipiter gentilis)* | PSI, AR | | | |
| | Golden eagle *(Aquila chrysaetos)* | PSI, AR | | | |
| | Rough-legged buzzard *(Buteo lagopus)* | | | | PSI, AR |
| | Ferruginous hawk *(Buteo regalis)* | PSI, AR | | | |
| | Northern harrier *(Circus hudsonius)* | PSI, AR | | | |
| | Bald eagle *(Haliaeetus leucocephalus)* | PSI, AR | | | |
| | Cooper's hawk *(Accipiter cooperii)* | PSI, AR | | | |
| | Sharp-shinned hawk *(Accipiter striatus)* | PSI, AR | | | |
| | Red-tailed hawk *(Buteo jamaicensis)* | PSI, AR | | | |
| | Swainson's hawk *(Buteo swainsoni)* | | PSI, AR | | |
| **Aegithalidae** | Bushtit *(Psaltriparus minimus)* | PSI *(le)* | | | |
| **Alaudidae** | Horned lark *(Eremophila alpestris)* | | PSI, AR | | |
| **Alcedinidae** | Belted kingfisher *(Megaceryle alcyon)* | PSI, AR | | | |
| **Anatidae** | Wood duck *(Aix sponsa)* | | AR, le, pa, pl | | |
| | Northern pintail *(Anas acuta)* | | cl | | pa, pl, pp |
| | Green-winged teal *(Anas crecca)* | PSI, AR | | | |
| | Mallard *(Anas platyrhynchos)* | PSI, AR | | | |
| | Snow goose *(Anser caerulescens)* | | | le, pl, sa, su | |
| | Ross's goose *(Anser rossii)* | | | PSI *(pp)*, cc, su | sc |
| | Lesser scaup *(Aythya affinis)* | | cl, sc | PSI, AR | |
| | Redhead *(Aythya americana)* | | PSI, AR | | |
| | Ring-necked duck *(Aythya collaris)* | cl, su | | bo, cl, su | PSI *(cl)*, AR |
| | Canvasback *(Aythya valisineria)* | PSI, cc | AR | | |
| | Canada goose *(Branta canadensis)* | PSI, AR | | | |
| | Cackling goose *(Branta hutchinsii)* | | | PSI-AR *(sc)* | pl, pp, sa, sc |
| | Bufflehead *(Bucephala albeola)* | su | | | PSI, AR |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| | Common goldeneye *(Bucephala clangula)* | | | | PSI, AR |
| | Barrow's goldeneye *(Bucephala islandica)* | | | | PSI *(pp)*, AR |
| | Tundra swan *(Cygnus columbianus)* | | | | |
| | Hooded merganser *(Lophodytes cucullatus)* | | | | PSI *(sa)*, AR |
| | American wigeon *(Mareca americana)* | PSI, AR | | | |
| | Gadwall *(Mareca strepera)* | | PSI, cl, su | | |
| | Common merganser *(Mergus merganser)* | PSI *(pp)*, AR | | | pa, pl, pp, sc |
| | Red-breasted merganser *(Mergus serrator)* | | | PSI, AR | |
| | Ruddy duck *(Oxyura jamaicensis)* | | PSI, AR | | |
| | Northern shoveler *(Spatula clypeata)* | | PSI, AR | | |
| | Cinnamon teal *(Spatula cyanoptera)* | | PSI, AR | | |
| | Blue-winged teal *(Spatula discors)* | | PSI, AR | | |
| **Anhingidae** | American white pelican *(Pelecanus erythrorhynchos)* | | cl, pl, pp, sc | PSI, AR | |
| **Apodidae** | White-throated swift *(Aeronautes saxatalis)* | | PSI, AR | | |
| | Chimney swift *(Chaetura pelagica)* | | AR | sc | |
| Ardeidae | Great blue heron *(Ardea herodias)* | PSI, AR | | | |
| | American bittern *(Botaurus lentiginosus)* | | PSI, AR | sc | |
| | Cattle egret *(Bubulcus ibis)* | | PSI, AR | | |
| | Snowy egret *(Egretta thula)* | | PSI *(le)*, AR | | |
| | Black-crowned night-heron *(Nycticorax nycticorax)* | | PSI, AR | | |
| **Bombycillidae** | Cedar waxwing *(Bombycilla cedrorum)* | PSI, AR | | | pa, pp, sc |
| | Bohemian waxwing *(Bombycilla garrulus)* | | | | PSI, AR |
| **Calcariidae** | Lapland longspur *(Calcarius lapponicus)* | | | | PSI, AR |
| | Chestnut-collared longspur *(Calcarius ornatus)* | | | PSI, AR | |
| | Snow bunting *(Plectrophenax nivalis)* | | | | PSI, AR |
| | McCown's longspur *(Rhynchophanes mccownii)* | | bo, cl, su | PSI-AR *(cl)* | |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| **Caprimulgidae** | Common nighthawk *(Chordeiles minor)* | | PSI, AR | | |
| | Common poorwill *(Phalaenoptilus nuttallii)* | | PSI, AR | | |
| **Cardinalidae** | Lazuli bunting *(Passerina amoena)* | | PSI *(pa, pp)*, AR | | |
| | Blue grosbeak *(Passerina caerulea)* | | pa, pp, sc | | |
| | Indigo bunting *(Passerina cyanea)* | | PSI | | |
| | Rose-breasted grosbeak *(Pheucticus ludovicianus)* | | | PSI-AR *(le, sa)* | |
| | Black-headed grosbeak *(Pheucticus melanocephalus)* | | PSI, AR | | |
| | Hepatic tanager *(Piranga hepatica)* | | pl, pp, sa, sc | | |
| | Western tanager *(Piranga ludoviciana)* | | PSI, AR | pp, sc | |
| | Dickcissel *(Spiza americana)* | | bo, cl, pa, pp | | |
| **Cathartidae** | Turkey vulture *(Cathartes aura)* | | PSI, AR | | |
| | Brown creeper *(Certhia americana)* | PSI, AR | | | |
| **Charadriidae** | Mountain plover *(Charadrius montanus)* | | PSI, AR | cl, su | |
| | Snowy plover *(Charadrius nivosus)* | | sa, sc | | |
| | Semipalmated plover *(Charadrius semipalmatus)* | | | cl | |
| | Killdeer *(Charadrius vociferus)* | PSI, AR | | | |
| **Cinclidae** | American dipper *(Cinclus mexicanus)* | PSI, AR | | | |
| **Columbidae** | Band-tailed pigeon *(Patagioenas fasciata)* | | le, pl, sa, sc | | |
| | Mourning dove *(Zenaida macroura)* | PSI, AR | | | |
| **Corvidae** | California scrub-jay *(Aphelocoma californica)* | PSI *(cl)*, AR | | | |
| | American crow *(Corvus brachyrhynchos)* | PSI, AR | | | |
| | Common raven *(Corvus corax)* | PSI, AR | | | |
| | Blue jay *(Cyanocitta cristata)* | AR, pa, pl, pp | | | |
| | Steller's jay *(Cyanocitta stelleri)* | | | | |
| | Pinyon jay *(Gymnorhinus cyanocephalus)* | bo, cl, le, pl, sa, sc | | | |
| | Clark's Nutcracker *(Nucifraga columbiana)* | PSI, AR | | | |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| | Canada jay *(Perisoreus canadensis)* | PSI, AR | | | |
| | Black-billed magpie *(Pica hudsonia)* | PSI, AR | | | |
| **Cuculidae** | Yellow-billed cuckoo *(Coccyzus americanus)* | | sc | | |
| | Black-billed cuckoo *(Coccyzus erythropthalmus)* | | AR, pa, pl, pp | sc | |
| | Greater roadrunner *(Geococcyx californianus)* | sc | | | |
| **Emberizidae** | Black-throated sparrow *(Amphispiza bilineata)* | | pp | | |
| | Lark bunting *(Calamospiza melanocorys)* | | cl | PSI, AR | |
| | Lark sparrow *(Chondestes grammacus)* | | PSI, AR | | |
| | Dark-eyed junco *(Junco hyemalis)* | PSI, AR | | | |
| | Lincoln's sparrow *(Melospiza lincolnii)* | | PSI, AR | pa, pl, pp, sa | |
| | Song sparrow *(Melospiza melodia)* | PSI, AR | | | |
| | Canyon towhee *(Melozone fusca)* | le, pl, sa, sc | | | |
| | Savannah sparrow *(Passerculus sandwichensis)* | | cl, su | PSI, AR | |
| | American tree sparrow *(Passerella arborea)* | | | | PSI, AR |
| | Slate-colored fox sparrow *(Passerella schistacea)* | | PSI *(pp, sc), AR (cl)* | PSI *(le, sa), AR (cl)* | |
| | Cassin's sparrow *(Peucaea cassinii)* | | pp, pp, sc | | |
| | Green-tailed towhee *(Pipilo chlorurus)* | | PSI, AR | | |
| | Spotted towhee *(Pipilo maculatus)* | sc | 6 | | sc |
| | Vesper sparrow *(Pooecetes gramineus)* | | PSI, AR | | |
| | Brewer's sparrow *(Spizella breweri)* | | PSI, AR | sc | |
| | Clay-colored sparrow *(Spizella pallida)* | | | PSI, AR | |
| | Chipping sparrow *(Spizella passerina)* | | PSI *(pl)*, AR | cc, pa, pp | |
| | White-throated sparrow *(Zonotrichia albicollis)* | | | PSI, AR | bo, cl, sa, sc, su |
| | White-crowned sparrow *(Zonotrichia leucophrys)* | cc, le, pl, sa, su | | | PSI *(le)*, AR |
| | Harris's sparrow *(Zonotrichia querula)* | | | AR *(cc)* | |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| **Falconidae** | Merlin *(Falco columbarius)* | AR, le, pl, sa | | | PSI |
| | Prairie falcon *(Falco mexicanus)* | PSI, AR | | | |
| | Peregrine falcon *(Falco peregrinus)* | | PSI, AR | cl | |
| | American kestrel *(Falco sparverius)* | PSI, AR | | | |
| **Fringillidae** | Common redpoll *(Acanthis flammea)* | | | | AR *(cc)* |
| | Cassin's finch *(Haemorhous cassinii)* | PSI *(pp)*, AR | | | |
| | House finch *(Haemorhous mexicanus)* | PSI, AR | | | |
| | Evening grosbeak *(Hesperiphona vespertina)* | PSI, AR | | | |
| | Black rosy-finch *(Leucosticte atrata)* | | | | PSI *(pp)*, AR |
| | Brown-capped rosy-finch *(Leucosticte australis)* | | PSI *(pp)*, AR | | PSI, AR |
| | Gray-crowned rosy-finch *(Leucosticte tephrocotis)* | | | | PSI *(pp)*, AR |
| | Red crossbill *(Loxia curvirostra)* | PSI, AR | | | |
| | White-winged crossbill *(Loxia leucoptera)* | le | | | PSI, AR |
| | Pine grosbeak *(Pinicola enucleator)* | PSI, AR | | | |
| | Pine siskin *(Spinus pinus)* | PSI, AR | | | |
| | Lesser goldfinch *(Spinus psaltria)* | | PSI, AR | | |
| | American goldfinch *(Spinus tristis)* | AR *(cc)* | | | PSI-AR *(cl)* |
| **Gruidae** | Sandhill crane *(Antigone canadensis)* | | | PSI, AR | |
| **Hirundinidae** | Barn swallow *(Hirundo rustica)* | | PSI, AR | | |
| | Cliff swallow *(Petrochelidon pyrrhonota)* | | PSI, AR | | |
| | Purple martin *(Progne subis)* | | le | PSI, AR | |
| | Bank swallow *(Riparia riparia)* | | PSI, AR | | |
| | Northern rough-winged swallow *(Stelgidopteryx serripennis)* | | PSI, AR | | |
| | Tree swallow *(Tachycineta bicolor)* | | PSI, AR | | |
| | Violet-green swallow *(Tachycineta thalassina)* | | PSI, AR | | |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| **Icteridae** | Red-winged blackbird *(Agelaius phoeniceus)* | PSI, AR | | | |
| | Bobolink *(Dolichonyx oryzivorus)* | | PSI, AR | pp, sc | |
| | Brewer's blackbird *(Euphagus cyanocephalus)* | PSI, AR *(le, sa)* | le, pl, sa, sc, su | | |
| | Bullock's oriole *(Icterus bullockiorum)* | | PSI, AR | | |
| | Orchard oriole *(Icterus spurius)* | | cl | | |
| | Brown-headed cowbird *(Molothrus ater)* | | PSI, AR | | |
| | Great-tailed grackle *(Quiscalus mexicanus)* | | | | |
| | Common grackle *(Quiscalus quiscula)* | | PSI, AR | | |
| | Western meadowlark *(Sturnella neglecta)* | PSI, AR | cl, su | | |
| | Yellow-headed blackbird *(Xanthocephalus xanthocephalus)* | | PSI, AR | | |
| **Laniidae** | Northern shrike *(Lanius borealis)* | | | | PSI, AR |
| | Loggerhead shrike *(Lanius ludovicianus)* | | PSI, AR | | |
| **Laridae** | Black tern *(Chlidonias niger)* | | PSI, AR | sc | |
| | California gull *(Larus californicus)* | | | PSI, AR | |
| | Ring-billed gull *(Larus delawarensis)* | | cl | AR *(cc)* | PSI-AR *(cl)* |
| | Bonaparte's gull *(Larus philadelphia)* | | | PSI, AR | |
| | Franklin's gull *(Larus pipixcan)* | | | PSI, AR | |
| | American herring gull *(Larus smithsonianus)* | | | PSI *(pp), AR (bo)* | PSI *(le, sa)*, AR |
| | Forster's tern *(Sterna forsteri)* | | PSI, AR | le, pl, sa, sc | |
| **Mimidae** | Gray catbird *(Dumetella carolinensis)* | | PSI, AR | | |
| | Northern mockingbird *(Mimus polyglottos)* | PSI, AR | | | |
| | Sage thrasher *(Oreoscoptes montanus)* | | PSI, AR | | |
| | Brown thrasher *(Toxostoma rufum)* | | PSI *(le, sa)*, AR | | |
| **Motacillidae** | American pipit *(Anthus rubescens)* | | PSI, AR | cl, pa, pp, sc | |
| **Odontophoridae** | Gambel's quail *(Callipepla gambelii)* | sc | | | |
| | Scaled quail *(Callipepla squamata)* | pp, sc | | | |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| | Northern bobwhite *(Colinus virginianus)* | cl | | | |
| **Pandionidae** | Osprey *(Pandion haliaetus)* | | PSI *(pp, sc)*, AR | PSI | |
| **Paridae** | Juniper titmouse *(Baeolophus ridgwayi)* | PSI *(pa)* | | | |
| | Black-capped chickadee *(Poecile atricapillus)* | PSI, AR | | | |
| | Mountain chickadee *(Poecile gambeli)* | PSI, AR | | | |
| **Parulidae** | Wilson's warbler *(Cardellina pusilla)* | | PSI *(pp)*, AR | PSI *(sa), AR (bo)* | |
| | MacGillivray's warbler *(Geothlypis tolmiei)* | | PSI, AR | pa, pp, sc | |
| | Common yellowthroat *(Geothlypis trichas)* | | PSI, AR | | |
| | Yellow-breasted chat *(Icteria virens)* | | PSI, AR | | |
| | Orange-crowned warbler *(Leiothlypis celata)* | | cl, cc, le, pl, su | PSI, AR | |
| | Tennessee warbler *(Leiothlypis peregrina)* | | | PSI, AR | |
| | Nashville warbler *(Leiothlypis ruficapilla)* | | | PSI, cc | |
| | Virginia's warbler *(Leiothlypis virginiae)* | | PSI *(le, sa)* | | |
| | Black-and-white warbler *(Mniotilta varia)* | | | PSI, AR | |
| | Northern waterthrush *(Parkesia noveboracensis)* | | | PSI, AR | |
| | Ovenbird *(Seiurus aurocapilla)* | | pp | | |
| | Yellow-rumped warbler *(Setophaga coronata)* | | PSI, AR | cl | |
| | Grace's warbler *(Setophaga graciae)* | | sc | | |
| | Black-throated gray warbler *(Setophaga nigrescens)* | | PSI *(pa, pp)* | | |
| | Yellow warbler *(Setophaga petechia)* | | PSI, AR | | |
| | American redstart *(Setophaga ruticilla)* | | bo, cl, pa, pp | PSI, AR | |
| | Townsend's warbler *(Setophaga townsendi)* | | | PSI, AR | |
| **Passeridae** | House sparrow *(Passer domesticus)* | PSI, AR | | | |
| **Phalacrocoracidae** | Double-crested comorant *(Nannopterum auritus)* | | AR, pa, pl, pp | PSI *(pa)* | |
| **Phasianidae** | Gunnison sage-grouse *(Centrocercus minimus)* | sa | | | |
| | Greater sage-grouse *(Centrocercus urophasianus)* | PSI *(pp)*, AR | | | |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| | Dusky grouse *(Dendragapus obscurus)* | PSI *(pp, sc)*, AR | | | |
| | White-tailed ptarmigan *(Lagopus leucura)* | PSI *(sc)*, AR | | | |
| | Wild turkey *(Meleagris gallopavo)* | PSI, AR | | | |
| | Ring-necked pheasant *(Phasianus colchicus)* | PSI, AR | | | |
| | Sharp-tailed grouse *(Tympanuchus phasianellus)* | | | | |
| **Picidae** | Northern flicker *(Colaptes cafer)* | PSI, AR | | | |
| | Downy woodpecker *(Dryobates pubescens)* | PSI, AR | | | |
| | Hairy woodpecker *(Leuconotopicus villosus)* | PSI, AR | | | |
| | Red-headed woodpecker *(Melanerpes erythrocephalus)* | | PSI, AR | | |
| | Lewis's woodpecker *(Melanerpes lewis)* | PSI, AR | | | |
| | Three-toed woodpecker *(Picoides tridactylus)* | PSI, AR | | | |
| | Red-naped sapsucker *(Sphyrapicus nuchalis)* | | PSI, AR | | |
| | Williamson's sapsucker *(Sphyrapicus thyroideus)* | | PSI, AR | | |
| **Podicipedidae** | Clark's grebe *(Aechmophorus clarkii)* | | PSI, AR | | |
| | Western grebe *(Aechmophorus occidentalis)* | | PSI, AR | | |
| | Horned grebe *(Podiceps auritus)* | | | cl | pl |
| | Eared grebe *(Podiceps nigricollis)* | pa, pl, pp | PSI *(pp)*, AR | | |
| | Pied-billed grebe *(Podilymbus podiceps)* | PSI, AR | | | |
| | Blue-gray gnatcatcher *(Polioptila caerulea)* | | sc | | |
| **Psittacidae** | Carolina parakeet *(Conuropsis carolinensis)* | PSI, AR | | | |
| **Rallidae** | American coot *(Fulica americana)* | cl | PSI, AR | | |
| | Sora *(Porzana carolina)* | | PSI, AR | | |
| | Virginia rail *(Rallus limicola)* | | PSI, AR | | |
| **Recurvirostridae** | Black-necked stilt *(Himantopus himantopus mexicanus)* | | PSI *(le, sa)* | | |
| | American avocet *(Recurvirostra americana)* | | PSI, AR | | |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| **Regulidae** | Ruby-crowned kinglet *(Regulus calendula)* | | cl, le, sa | | |
| | Golden-crowned kinglet *(Regulus satrapa)* | PSI, AR | | | |
| **Scolopacidae** | Spotted sandpiper *(Actitis macularius)* | | PSI, AR | | |
| | Upland sandpiper *(Bartramia longicauda)* | | | PSI, AR | |
| | Pectoral sandpiper *(Calidris melanotos)* | | | PSI, AR | |
| | Least sandpiper *(Calidris minutilla)* | | | PSI, AR | |
| | Semipalmated sandpiper *(Calidris pusilla)* | | | PSI, AR | |
| | Wilson's snipe *(Gallinago delicata)* | PSI, AR | | | |
| | Long-billed dowitcher *(Limnodromus scolopaceus)* | | | PSI, AR | |
| | Long-billed curlew *(Numenius americanus)* | | pa, pp, sc | | |
| | Wilson's phalarope *(Steganopus tricolor)* | | cl | PSI, AR | |
| | Lesser yellowlegs *(Tringa flavipes)* | | | PSI, AR | |
| | Greater yellowlegs *(Tringa melanoleuca)* | | | PSI, AR | |
| | Solitary sandpiper *(Tringa solitaria)* | | | | |
| **Sittidae** | Red-breasted nuthatch *(Sitta canadensis)* | PSI, AR | | | |
| | White-breasted nuthatch *(Sitta carolinensis)* | PSI, AR | | | |
| | Pygmy nuthatch *(Sitta pygmaea)* | PSI, AR | | | |
| **Strigidae** | Northern saw-whet owl *(Aegolius acadicus)* | PSI *(cl)*, AR | | | bo, cl, pa, pp, sc |
| | Boreal owl *(Aegolius funereus)* | PSI, AR | | | |
| | Short-eared owl *(Asio flammeus)* | AR | | | PSI, AR *(bo, cl)* |
| | Long-eared owl *(Asio otus)* | PSI *(pp, sa)*, AR | | | PSI |
| | Burrowing owl *(Athene cunicularia)* | | PSI, AR | | |
| | Great Horned owl *(Bubo virginianus)* | PSI, AR | | | |
| | Northern Pygmy-owl *(Glaucidium californicum)* | PSI, AR | | | |
| | Eastern Screech-owl *(Megascops asio)* | cl | | | |
| | Western Screech-owl *(Megascops kennicottii)* | le, sa, sc | | | |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| | Flammulated owl *(Psiloscops flammeolus)* | | PSI, AR *(su)* | | |
| | Spotted owl *(Strix occidentalis)* | | | | |
| **Sturnidae** | European starling *(Sturnus vulgaris)* | PSI, AR | | | |
| **Threskiornithidae** | White-faced ibis *(Plegadis chihi)* | | PSI, AR | cl | |
| **Trochilidae** | Broad-tailed hummingbird *(Selasphorus platycercus)* | | cl, sc, su | | |
| **Troglodytidae** | Canyon wren *(Catherpes mexicanus)* | PSI, AR | | | |
| | Marsh wren *(Cistothorus palustris)* | PSI, AR | cl, su | | |
| | Rock wren *(Salpinctes obsoletus)* | sc | PSI, AR | | |
| | Bewick's wren *(Thryomanes bewickii)* | | cl | | |
| | House wren *(Troglodytes aedon)* | | PSI, AR | | |
| | Winter wren *(Troglodytes hiemalis)* | | | | PSI *(le, sa)* |
| **Turdidae** | Veery *(Catharus fuscescens)* | | PSI, AR | sc | |
| | Hermit thrush *(Catharus guttatus)* | | PSI, AR | | |
| | Swainson's thrush *(Catharus swainsoni)* | | PSI *(pp)*, AR | PSI, AR | |
| | Townsend's solitaire *(Myadestes townsendi)* | PSI, AR | | | |
| | Mountain bluebird *(Sialia currucoides)* | PSI, AR | cl | | |
| | Western bluebird *(Sialia mexicana)* | sc | PSI, AR *(bo, cl)* | | |
| | American robin *(Turdus migratorius)* | PSI, AR | | | |
| **Tyrannidae** | Olive-sided flycatcher *(Contopus cooperi)* | | PSI, AR | | |
| | Western wood-pewee *(Contopus sordidulus)* | | PSI, AR | | |
| | Hammond's flycatcher *(Empidonax hammondii)* | | PSI, AR | sc | |
| | Least flycatcher *(Empidonax minimus)* | | AR | cl, pa, pp | |
| | Dusky flycatcher *(Empidonax oberholseri)* | | PSI, AR | | |
| | Cordilleran flycatcher *(Empidonax occidentalis)* | | PSI, AR | | |
| | Willow flycatcher *(Empidonax traillii)* | | PSI, AR | | |
| | Gray flycatcher *(Empidonax wrightii)* | | PSI *(pp)* | | |

| Family | Common name *(Scientific name)* | Year-round | Breeding | Migratory route | Nonbreeding |
|---|---|---|---|---|---|
| | Ash-throated flycatcher *(Myiarchus cinerascens)* | | | | |
| | Say's phoebe *(Sayornis saya)* | | PSI, AR | | |
| | Eastern kingbird *(Tyrannus tyrannus)* | | AR, pa, pl, pp | | |
| | Western kingbird *(Tyrannus verticalis)* | | PSI, AR | | |
| **Tytonidae** | Barn owl *(Tyto alba)* | PSI, AR | | | |
| **Vireonidae** | Cassin's vireo *(Vireo cassinii)* | | | PSI, AR | |
| | Warbling vireo *(Vireo gilvus)* | | PSI, AR | | |
| | Red-eyed vireo *(Vireo olivaceus)* | | AR, pl, pp | pl, sc | |
| | Plumbeous vireo *(Vireo plumbeus)* | | PSI, AR | | |