



## Wide-Ranging Mammals

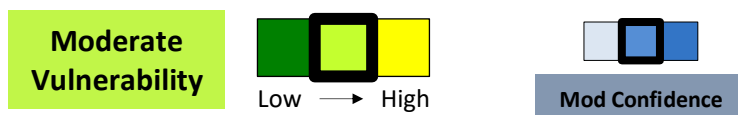
*Climate Change Vulnerability Assessment for the Santa Cruz Mountains Climate Adaptation Project*

*This document represents an initial evaluation of mid-century climate change vulnerability for wide-ranging mammals in the Santa Cruz Mountains region based on expert input during an October 2019 vulnerability assessment workshop as well as information in the scientific literature.*

### Species Group Description

Wide-ranging mammals within the Santa Cruz Mountains region that are covered in this assessment include mountain lion (*Puma concolor*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), and Columbian black-tailed deer (*Odocoileus hemionus columbianus*). These species are characterized by their large home ranges, and many exhibit seasonal shifts in distribution in response to breeding requirements and/or food availability<sup>1</sup>.

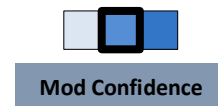
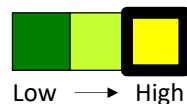
### Vulnerability Ranking



Wide-ranging mammals are sensitive to climate stressors (e.g., changes in precipitation patterns, increased drought, and altered stream flows) that alter forage/prey and water availability and quality. In general, scarcity of these resources negatively affects mammal survival and reproduction, ultimately influencing population stability. Altered wildfire regimes and increased disease can cause direct mortality of wide-ranging mammals, and wildfire can impact habitat quality and resource availability. Non-climate stressors (e.g., residential/commercial development, roads/highways, poisons, invasive vegetation, livestock grazing, fire exclusion/suppression, recreational activities, timber harvest, hunting) can exacerbate species group sensitivity to climate-driven changes by causing direct mortality and/or by impacting habitat availability, quality, and connectivity.

The distribution and abundance of wide-ranging mammals has declined due to habitat loss and fragmentation within the study region, which has impacted population connectivity and dispersal. Although these species have high behavioral flexibility, genetic diversity is low for mountain lions and likely for other species in this group. Generalist habitat use, varied diets, and high mobility also reduces vulnerability of this species group to climate change. However, carnivores generally have low population density and slow population growth rates, reducing the ability of populations to recover following disturbance events. Management strategies designed to reduce the vulnerability of wide-ranging mammals to climate change are likely to focus on reducing non-climate stressors associated with human land use (e.g., protecting corridors to allow movement and dispersal).

## Sensitivity and Exposure



**Sensitivity** is a measure of whether and how a species is likely to be affected by a given change in climate and climate-driven factors, changes in disturbance regimes, and non-climate stressors.

**Exposure** is a measure of how much change in these factors a species is likely to experience.

### Sensitivity and future exposure to climate and climate-driven factors



Wide-ranging mammals are sensitive to changes in climate factors that reduce prey/forage and water availability, which can impact fitness, survival, and reproduction.

Climate Stressor	Trend Direction	Projected Future Changes
Precipitation	▲ ▼	<ul style="list-style-type: none"> <li>Shorter winters and longer, drier summers likely, with higher interannual variability<sup>2,3</sup></li> </ul>
Streamflow	▲ ▼	<ul style="list-style-type: none"> <li>Generally, wet season flows are projected to increase and dry season flows are projected to decrease<sup>4</sup></li> </ul>
Drought	▲	<ul style="list-style-type: none"> <li>Increased frequency of drought years, including periods of prolonged and/or severe drought<sup>2,5</sup></li> </ul>

- Changes in patterns of precipitation** are likely to alter the availability and quality of forage for mule deer<sup>6-8</sup>, which is strongly associated with both the amount and timing of seasonal rainfall<sup>9</sup>. These changes may affect ungulate survival and reproduction due to nutritional deficiencies, which are a major cause of adult and fawn mortality<sup>8</sup>. Nutritionally-stressed deer also take more risks to forage, increasing their vulnerability to predation and other causes of mortality (e.g., vehicle strikes)<sup>10,11</sup>.
- Reduced stream flows and increases in the frequency and/or severity of drought** are likely to impact the availability of water sources for wide-ranging mammals<sup>12</sup>. For some species, concentration of animals at remaining water sources can increase disease transmission (e.g., brain hemorrhaging in deer)<sup>12,13</sup>. Drought is also associated with reduced overall fitness and reproductive success due to factors such as reduced forage and prey availability<sup>7,12</sup>.

### Sensitivity and future exposure to climate-driven changes in disturbance regimes



Wide-ranging mammals are sensitive to changes in disturbance regimes that directly impact survival as well as those that reduce habitat availability and quality.

Disturbance Regimes	Trend Direction	Projected Future Changes
Wildfire	▲	<ul style="list-style-type: none"> <li>Slight to moderate increase in wildfire risk, particularly in areas of higher rainfall<sup>14,15</sup></li> </ul>
Disease	▲	<ul style="list-style-type: none"> <li>Possible increases in susceptibility, pathogen production, disease transmission, and/or abundance of disease vectors<sup>13</sup></li> </ul>

- **Climate-driven changes in wildfire regimes** (e.g., increased occurrence of large, high-intensity fires) are likely to reduce habitat suitability for wide-ranging mammals<sup>12</sup>. Additionally, shifts in vegetation community composition associated with more frequent and/or severe fires may reduce forage availability and quality for deer over longer time scales<sup>7,11</sup>. Direct mortality from fires is relatively low because wide-ranging mammals are highly mobile<sup>11</sup>. However, changes in the timing of moderate- to high-intensity fires could increase injury or mortality, especially if fires become more likely to occur during the breeding season when young animals may be less able to escape<sup>11</sup>.
- **Disease** can cause high rates of mortality, with the potential for rapid declines or extirpation of local populations<sup>8,12,16,17</sup>. Diseased animals are also more vulnerable to secondary stressors and mortality factors, such as malnutrition or predation<sup>8,18</sup>. In and around developed areas, contact with domestic animals (e.g., dogs and cats) can increase disease transmission<sup>7,19–21</sup> and exposure to anticoagulant rodenticides can increase susceptibility to disease within bobcats<sup>16,22,23</sup>. Climate change has the potential to impact patterns of disease directly by allowing expansion of diseases into new areas, increasing pathogen production, or altering the abundance/distribution of disease vectors (e.g., ticks)<sup>13</sup>. Climate change may also have indirect impacts on disease transmission by increasing animal density around fewer resources<sup>13,24</sup> or enhancing susceptibility to disease in stressed individuals<sup>25</sup>.

#### Dependency on habitat and/or other species



Wide-ranging mammals are habitat generalists, utilizing a variety of forest, woodland, shrubland, grassland, wetland, and urban habitats across their range<sup>7,26</sup>. However, they are dependent on certain habitat elements for persistence, including prey or forage availability, denning sites or cover, and water sources<sup>7,26</sup>, with the latter being particularly important in drier areas<sup>12</sup>.

Shifts in food availability associated with changing climate conditions are likely to impact this species group. For instance, expansion of grasslands associated with warmer, drier conditions and more frequent fires may increase forage availability for deer<sup>12</sup>. Shifts in the abundance or distribution of prey species may also have cascading effects on the food web, impacting mountain lions and other predators<sup>12</sup>.

#### Sensitivity and current exposure to non-climate stressors



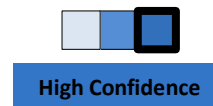
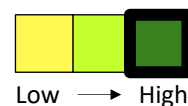
Non-climate stressors can exacerbate species group sensitivity to changes in climate factors and disturbance regimes by directly increasing mortality and/or indirectly by impacting habitat availability and connectivity.

- **Residential/commercial development** result in the loss and fragmentation of habitat for wide-ranging mammals<sup>7,27–29</sup>. This is particularly true for carnivores such as mountain lions and bobcats<sup>27–30</sup>, as they have to expend more energy to find and kill prey than their non-urban counterparts<sup>12</sup>. Gray foxes utilize developed areas, but their core habitat is generally located away from development<sup>28</sup> and overall populations are smaller<sup>27</sup>. By contrast, the presence of coyotes increases in urban areas<sup>27</sup>, facilitated in part by increased availability of prey following the loss of larger carnivores<sup>31</sup> as well as the presence of garbage and other human-related food<sup>30</sup>. Human development and use of natural water sources within urban areas further limits wildlife access to water<sup>12</sup>. Exposure to domestic animals (e.g., dogs, cats, livestock) also increases disease risk<sup>7,19,20</sup>.

Because many species (e.g., mountain lions, bobcats) avoid paved **roads and highways**, they create barriers that restrict mammal movement and gene flow<sup>7,28,32,33</sup>. Vehicular collision is also a frequent cause of mortality for wide-ranging mammals<sup>7,20,30</sup>.

- **Anticoagulant rodenticides** cause direct mortality of carnivores and mesocarnivores and have contributed to population declines of these species in some areas<sup>17,20,26,34</sup>. Rodenticides and other poisons also accumulate within carnivores that consume exposed prey, resulting in toxins that move up the food chain at increasing concentrations<sup>35</sup>. Thus, mountain lions and bobcats are at high risk of secondary exposure<sup>23,35</sup>. In addition to direct mortality, common sub-lethal impacts that affect mammal survival and fitness include skin irritation, altered metabolism, decreased wound healing and immune response, and increased susceptibility to disease (e.g., notoedric mange in bobcats)<sup>16,22,23</sup>.
- **Invasive vegetation** likely reduces forage availability, quality, and diversity for mule deer by altering native plant communities<sup>7</sup>, although there are few direct studies of the impacts of non-native plants on ungulates. Generally, invasive species are less palatable and nutritionally valuable, with potential implications for fitness<sup>7</sup>.
- **Livestock grazing** reduces the availability of forage for mule deer, and competition between deer and livestock has increased as the extent of natural landscapes has declined<sup>1,7,36</sup>. Livestock can also compete with native ungulates for available surface water<sup>7</sup>. Competition impacts are particularly acute during resource-scarce periods (e.g., late summer and fall; drought periods)<sup>1,7</sup>. The presence of livestock can also increase human-wildlife conflicts between ranchers and mountain lions<sup>12</sup>.
- **Fire exclusion and suppression** has altered species composition and habitat structure, and has caused declines in early-successional landscapes such as grasslands and shrublands<sup>1,37</sup>. These changes can reduce forage availability and quality for deer, as herbaceous vegetation abundance and diversity is generally associated with disturbances such as fire<sup>7</sup>. Within forests and woodlands, fire exclusion has increased fuel availability structure, enhancing vulnerability to large, high-intensity fires that may cause direct mortality and/or habitat loss<sup>12</sup>.
- **Recreational activities** can result in immediate impacts (i.e., fleeing) and/or longer-term avoidance of heavily-used areas<sup>7,38</sup>. These behavioral changes can reduce fitness by elevating energetic costs and/or decreasing time spent foraging or hunting<sup>7,39</sup>.
- **Timber harvest and fuelbreak construction** can reduce habitat availability<sup>40</sup> and affect how wide-ranging mammals move through the landscape<sup>12</sup>.
- **Deer hunting** affects the local movements and population numbers of native ungulates, and is managed by state agencies with the goal of maintaining herds at landscape-sustainable levels<sup>41</sup>.

## Adaptive Capacity



**Adaptive capacity** is the ability of a species to accommodate or cope with climate change impacts with minimal disruption.

### Species extent, integrity, connectivity, and dispersal ability



Wide-ranging mammals are highly mobile, which allows movement across the landscape in order to utilize variable resources under changing environmental conditions<sup>12,42</sup>. However, habitat loss and fragmentation as a result of land-use conversion, roads/highways, timber harvest, and fuelbreaks have affected population connectivity and dispersal within the region<sup>12</sup>, with the potential to severely restrict gene flow in species such as mountain lions<sup>43,44</sup> and bobcats<sup>33,34</sup>. Additionally, the San Francisco Peninsula inherently restricts movement, creating a connectivity bottleneck that is further exacerbated by development and associated infrastructure (e.g., large highways)<sup>12</sup>. These factors may limit the ability of wide-ranging mammals to track changes in climate and/or access potential refugia outside of the immediate region<sup>12,42,45</sup>.

### Intraspecific/life history diversity



Overall, this species group generally exhibits high variability in behavioral responses; for instance, mountain lions utilize a wide variety of prey, but may preferentially hunt for deer<sup>46</sup>. The widespread distribution of coyotes and bobcats also suggests high behavioral plasticity/adaptability relative to other large carnivores<sup>29</sup>. Coyotes, in particular, demonstrate highly adaptable behavior that allows them to exploit food resources within urban areas<sup>20,29</sup>.

Within the Santa Cruz Mountains region, mountain lion genetic diversity is low compared to other areas of the state, and this may be true for other species in the group as well<sup>12</sup>.

### Resistance and recovery



Among wide-ranging mammals, resistance to climate change impacts is supported by generalist habitat use, varied diets, and high mobility<sup>7,42</sup>. However, landscape carrying capacity and habitat connectivity may be significantly affected by a combination of climate-driven changes (e.g., prolonged drought, uncharacteristically large and/or severe fires) and various land-use and management activities that impact mammal abundance and recruitment<sup>7,42</sup>. Carnivores (e.g., mountain lions, coyotes) are particularly vulnerable to population declines following habitat loss and fragmentation, as they generally have low population density and slow population growth rates<sup>47</sup>. However, recovery can occur following the removal of significant stressors; for instance, mountain lion populations rebounded once hunting ceased<sup>12</sup>.

### Management potential



As charismatic megafauna, wide-ranging mammals are highly valued for photographic and wildlife-watching opportunities<sup>7,11,12</sup>. Deer are also valued for hunting opportunities<sup>7,11</sup>, and revenue from hunting permits can support habitat management activities that sustain deer populations<sup>41</sup>.

Management strategies designed to reduce the vulnerability of wide-ranging mammals to climate change are likely to focus on reducing non-climate stressors associated with human land use<sup>12</sup> and

increasing landscape connectivity through the protection and maintenance of movement corridors<sup>27,32</sup>. More study is also needed to understand the likely impacts of climate change on wide-ranging mammals, particularly in terms of cascading impacts on the food chain<sup>12</sup>.

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## Recommended Citation

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Further information on the Santa Cruz Mountains Climate Adaptation Project is available on the project page (<http://ecoadapt.org/programs/awareness-to-action/santa-cruz-mountains>).

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