Sierra Nevada Individual Species Vulnerability Assessment Briefing: Pacific Fisher

*Pekania pennanti (*formerly *Martes pennanti)*

Background and Key Terminology

This document summarizes the primary factors that influence the vulnerability of a focal resource to climate change over the next century. In this context, vulnerability is a function of the sensitivity of the resource to climate change, its anticipated exposure to those changes, and its capacity to adapt to changes. Specifically, sensitivity is defined as a measure of whether and how a resource is likely to be affected by a given change in climate, or factors driven by climate; exposure is defined as the degree of change in climate or climate-driven factors a resource is likely to experience; and adaptive capacity is defined as the ability of a resource to accommodate or cope with climate change impacts with minimal disruption (Glick et al. 2011). The purpose of this assessment is to inform forest planning by government, non-profit, and private sector partners in the Sierra Nevada region as they work to integrate climate change into their planning documents.

Executive Summary

The overall vulnerability of Pacific fisher is ranked as moderate, due to their moderate sensitivity to climate and non-climate stressors, moderate adaptive capacity, and moderate exposure.

The Pacific fisher is indirectly and directly sensitive to climate-driven changes such as:

- increased water deficit (e.g. drought),
- increased frequency and severity fire, and
- decreased snowpack.

As a habitat specialist, the Pacific fisher's sensitivity to climate change will likely be driven by changes that remove resting and denning habitat in late-successional mixed forests; these changes include increased climatic water deficit and altered wildfire regimes. However, predicted reductions in future snowpack could provide competitive benefit to fishers, whose movement ability is currently limited by deep snow, in relation to martens.

The Pacific fisher is also sensitive to several non-climate stressors including:

- predation pressure,
- habitat conversion (timber harvest and exurban development),
- disease,
- road mortality, and
- poisoning.

These non-climate stressors can cause direct mortality, reduced fitness, and amplify the effects of climate-driven changes. For example, habitat conversion reduces canopy cover, a habitat element that will likely be further reduced by wildfire regimes in the future. The capacity of the

Pacific fisher to adapt to future changes in climate is limited by its small population size, low reproductive rate, geographic and genetic isolation, and low genetic diversity.

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Sensitivity & Exposure

Sensitivity to climate and climate-driven changes

Although the Pacific fisher utilizes multiple prey (Zielinski et al. 1999) and multiple habitat elements, it is considered a habitat specialist (Weir et al. 2012), with resting and denning structures thought to be the most important habitat elements required for maintenance of fisher populations (Lofroth et al. 2010 cited in Zhao et al. 2012; Weir et al. 2012). Pacific fishers prefer habitats with dense canopy cover and decadent structures for denning and resting (Purcell et al. 2009), such as large trees with visible signs of decay (Weir et al. 2012). In the Sierra Nevada, Pacific fisher occur in late-successional mixed forest (Spencer and Rustigian-Romsos 2012; Zielinski et al. 2013) at approximately 1000 to 2100 m (3281 ft to 6890 ft) in elevation (Purcell et al. 2012; Thompson et al. 2013). In the southern Sierra Nevada, California black oaks (*Quercus kelloggii*) appear to contribute to fisher habitat quality by providing good cavities for denning and resting, as well as mast that support their prey (Purcell et al. 2012; Spencer and Rustigian-Romsos 2012), but black oaks may be less critical in other regions.

The Pacific fisher's sensitivity to climate change will likely be driven largely by factors that remove resting and denning habitats, including climatic water deficits and wildfire. Habitat persistence is sensitive to water deficit and altered fire regimes (Zielinski et al. 2013), and fisher habitat in the Sierra Nevada occurs at elevations where fire risk is greatest (Miller et al. 2009, Scheller et al. 2011 cited in Zielinski et al. 2013). Large-scale or uncharacteristically severe wildfire and drought may reduce canopy cover and kill larger trees, removing habitat value over large areas and potentially impacting prey dynamics. Periods of water shortage are associated with tree susceptibility to infections and insects, such as dwarf mistletoe (*Arceuthobium abietinum f. sp. magnificae*), root disease (*Heterobasidion annosum*), and bark beetles (North et al. 2002; Grulke et al. 2009; Grulke 2010), whose impacts can be both beneficial and detrimental to fisher, depending on the scale of the impact. Diseases such as mistletoe and rust broom in trees of declining health may be beneficial to Pacific fishers by creating perches and cavities (Purcell et al. 2012) used for denning and resting, whereas major mortality events resulting from pest complexes (e.g. root diseases/dwarf mistletoe/bark beetles) (North et al. 2002) may reduce habitat available to fisher.

Pacific fishers are also sensitive to high temperatures and snowpack depth. Fishers depend on the presence of water (Purcell et al. 2009), and appear to avoid extreme daily high temperature amplitudes by seeking dense canopies, canyon bottoms, and north slopes within home ranges. Fishers are associated with areas of low or intermediate snowfall in which topographic breaks change snowfall amounts over small areas, since deep snow limits movement ability and mitigates competitive interaction between fisher and marten (Krohn et al. 1997). Future reductions in snowpack could alter competitive relationships between martens and fishers, providing fishers a competitive advantage (Krohn et al. 1997; Purcell et al. 2012) and facilitating an upslope range shift for fisher. However, sensitivity of Pacific fisher prey species to climate change is largely unknown (Purcell et al. 2012).

Future climate exposure

Climate and climate-driven factors most relevant to consider for Pacific fisher include changes that impact fisher habitat, including decreased snow volume, increased climatic water deficit, altered wildfire regime, and changes in vegetation structure and distribution.

Snow volume and timing: Despite modest projected changes in overall precipitation, models of the Sierra Nevada region largely project decreasing snowpack and earlier timing of runoff (Miller et al. 2003; Dettinger et al. 2004b; Hayhoe et al. 2004; Knowles and Cayan 2004; Maurer 2007; Maurer et al. 2007; Young et al. 2009), as a consequence of early snowmelt events and a greater percentage of precipitation falling as rain rather than snow (Dettinger et al. 2004a, 2004 b; Young et al. 2009; Null et al. 2010). Annual snowpack in the Sierra Nevada is projected to decrease between 64-87% by late century (Thorne et al. 2012; Flint et al. 2013), with declines of 10-25% above 3750 m (12303 ft), and 70-90% below 2000 m (6562 ft) (Young et al. 2009). The greatest declines in snowpack are anticipated for the northern Sierra Nevada (Safford et al. 2012), with current pattern of snowpack retention in the higher-elevation southern Sierra Nevada basins expected to continue through the end of the century (Maurer 2007). The greatest losses in snowmelt volume are projected between 1750 m to 2750 m (5741 ft to 9022 ft) (Miller et al. 2003; Knowles and Cayan 2004; Maurer 2007; Young et al. 2009).

Snow provides an important contribution to spring and summer soil moisture in the western U.S. (Sheffield et al. 2004), and earlier snowmelt can lead to an earlier, longer dry season (Westerling et al. 2006). A shift from snowfall to rainfall is also expected to result in flashier runoff with higher flow magnitudes, and may result in less water stored within watersheds, decreasing meal annual flow (Null et al. 2010). Mean annual flow is projected to decrease most substantially in the northern bioregion (Null et al. 2010).

Climatic water deficit: Climatic water deficit, which combines the effects of temperature and rainfall to estimate site-specific soil moisture, is a function of actual evapotranspiration and potential evapotranspiration. Increases in potential evapotranspiration will likely be the dominant influence in future hydrologic cycles in the Sierra Nevada, decreasing runoff even under forecasts of increased precipitation, and driving increased climatic water deficits (Thorne et al. 2012). In the Sierra Nevada, climatic water deficit has increased slightly (~4%) in the past 30 years compared with the 1951-1980 baseline (Flint et al. 2013). Future downscaled water deficit modeling using the Basin Characterization Model predicts increased water deficits (i.e., decreased soil moisture) by up to 44%, with the greatest increases in the northern Sierra Nevada (Thorne et al. 2012; Flint et al. 2013; Geos Institute 2013).

Wildfire: Both the frequency and annual area burned by wildfires in the western U.S. have increased strongly over the last several decades (Westerling et al. 2006). Fire severity in the Sierra Nevada also rose from 17% to 34% high-severity (i.e. stand replacing) fire, especially in middle elevation conifer forests (Miller et al. 2009). In the Sierra Nevada, increases in large fire extent have been correlated with increasing temperatures and earlier snowmelt (Westerling and Bryant 2006), as well as current year drought combined with antecedent wet years (Taylor and Beaty 2005). Occurrence of large fire and total area burned in California are predicted to continue increasing over the next century, with total area burned increasing by up to 74% by 2085 (Westerling et al. 2011). The area burned by wildfire in the Sierra Nevada is projected to increase between 35-169% by the end of the century, varying by bioregion, with the greatest increases projected at mid-elevation sites along the west side of the range (Westerling et al. 2011; Geos Institute 2013).

Models by Scheller et al. (2011) project that the ability of fuel treatments to preserve fisher habitat vary by elevation, with higher elevations producing the best results. Additionally, treatments under more severe fire regimes, and in proximity to high-quality habitat (>0.5 fisher occurrence probability) resulted in the greatest benefit to fishers (Scheller et al. 2011). Under a heightened fire regime simulation, fuel treatments in marginal fisher habitat also benefited fishers as fires spread more readily between high and low quality habitat (Scheller et al. 2011).

Vegetation structure and distribution: In the Sierra Nevada, the Sierra mixed conifer/white fir/Jeffrey pine vegetation type is projected to decrease (by 12-32%), while blue oak/foothill pine and ponderosa pine/Klamath mixed conifer are projected to increase by 2070 (PRBO Conservation Science 2011). An increase in both the severity and frequency of fire could lead to vegetation conversion and a corresponding decrease in old growth forest (Lenihan et al. 2008). In the Sierra Nevada, conifer forests are predicted to be largely replaced by deciduous forests at low and middle elevations (Lenihan et al. 2008). Because California black oaks appear to enhance fisher habitat in the southern Sierra Nevada, predicted shifts of conifer-dominated forest types to mixed woodland and hardwood forest types may benefit fishers (Purcell et al. 2012). However, the expectation is for an overall decrease in the availability of fisher habitat as changes in fire regime are projected to result in loss of late seral habitat, and decreases in the density of large conifer and hardwood trees and canopy cover (Purcell et al. 2012). These changes will likely increase the threat to species associated with closed-canopy forests (McKenzie et al. 2004), such as fishers. A drier future may also result in the mixed conifer forest inhabited by fishers being replaced by grasslands and shrublands (Lenihan et al. 2008), which are unsuitable for fishers.

More information on downscaled projected climate changes for the Sierra Nevada region is available in a separate report entitled *Future Climate, Wildfire, Hydrology, and Vegetation Projections for the Sierra Nevada, California: A climate change synthesis in support of the Vulnerability Assessment/Adaptation Strategy process* (Geos Institute 2013). Additional material on climate trends for the system may be found through the TACCIMO website (http://www.sgcp.ncsu.edu:8090/). Downscaled climate projections available through the Data Basin website (http://databasin.org/galleries/602b58f9bbd44dffb487a04a1c5c0f52).

Sensitivity to non-climate stressors

The Pacific fisher population is also affected by numerous non-climate stressors that increase mortality directly or interact with climate-driven stressors to increase population vulnerability. Pacific fishers are sensitive to habitat alterations due to timber harvest (Zielinski et al. 2013), fire management (Scheller et al. 2011; Zielinski et al. 2013), and exurban development (e.g. cabins, summer homes) and its influence on fuel treatments. Habitat conversion may reduce canopy cover, a habitat element that will likely be further reduced by fire regimes in the future. However fuel treatments that reduce the risk of catastrophic fire may indirectly benefit fisher (Scheller et al. 2011).

In addition, mortality and reduced fitness may be a consequence of rodenticides and other pesticides used at marijuana grow-sites (Gabriel et al. 2012; Thompson et al. 2013), exposure to domestic pet diseases (Spencer and Rustigian-Romsos 2012), altered predation and prey availability (Spencer and Rustigian-Ramos 2012), and road mortality (Spencer and Rustigian-Romsos 2012). Direct and secondary exposure to rodenticides and pesticides represent a significant risk to isolated California populations (Gabriel et al. 2012), and appear to cause both mortality and decreased fitness by increasing fisher susceptibility to hypothermia, parasites, pathogens and predation (Berny et al. 1997, Winters et al. 2010, and Lemus et al. 2011 cited in Thompson et al. 2013; Gabriel et al. 2012). Poisoning risk has the potential to shift a population from positive to negative growth rate (Thompson et al. 2013). Predation by bobcats (*Lynx rufus*) and cougars (*Puma concolor*) appears to be the leading cause of mortality, facilitated by road building and forest thinning, which likely provide predators access to fisher habitat while reducing available cover and escape (Spencer and Rustigian-Romsos 2012). Pacific fishers in the southern Sierra Nevada lack the larger prey (e.g. porcupines, lagomorphs) that compose a large portion of fisher diet in other regions, but the effects of prey availability are poorly understood, and sensitivity of Pacific fisher prey species to climate change is largely unknown (Purcell et al. 2012). Prey consumed by fishers in the southern Sierra Nevada, including small mammals, birds, carrion, insects and plant material (Zielinski et al. 1999), may expose them to direct and secondary toxicants (Thompson et al. 2013).

Adaptive Capacity

The Pacific fisher's capacity to accommodate changes in climate is likely limited by its small population size, low reproductive rate, and geographic and genetic isolation (Purcell et al. 2009; Purcell et al. 2012; Spencer et al. 2011; Tucker et al. 2012; Zielinski et al. 2013). The Pacific fisher is a candidate species for listing under Federal, Oregon and California Endangered Species Acts (Zhao et al. 2012; Thompson et al. 2013). In California, fishers occur in two isolated populations (Davis et al. 2007, Knaus et al. 2011 cited in Zhao et al. 2012); the southern Sierra Nevada population is completely isolated and has an estimated 100 to 400 individuals (Lamberson et al. 2000 cited in Zielinski et al. 2013; Spencer et al. 2011). A second, larger fisher occupancy area extends from the northern Sierra Nevada into the Klamath-Cascades region of southern Oregon. Pacific fisher populations are considered at high risk of local extinction from stochastic events such as disease or wildfire (Spencer et al. 2011; Thompson et al. 2013).

The adaptive capacity of Pacific fishers is further diminished by its difficulty expanding into viable habitats. Assisted migration and reintroduction have been suggested as a method to help Pacific fisher accommodate climatic shifts, however, the southern Sierra Nevada fisher population has failed to disperse into historically occupied habitat (Thompson et al. 2013) despite substantial mobility. Spencer et al. (2011) suggest that the population's potential for expansion into unoccupied habitat may be limited by a 10-20% reduction in fisher survival (Spencer et al. 2011). Installation of movement corridor structures may aid expansion (Spencer and Rustigian-Romsos 2012) and reduce mortality from road strikes.

Conversely, the capacity for fisher to adapt to changing conditions may be strengthened by its ability to use resting sites to regulate body temperature (Powell and Zielinski 1994 cited in Zhao et al. 2012), as well as its ability to utilize a wide prey base. Fishers in the southern Sierra Nevada exploit a wide range of resources including small mammals, birds, carrion, insects, lizards, and plant material (Zielinski et al. 1999; Zielinski and Duncan 2004). However, consumption of these prey species is associated with potential lethal and sub-lethal exposure to toxicants (Thompson et al. 2013).

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