Sierra Nevada Individual Species
Vulnerability Assessment Briefing: American Marten

Martes americana

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 the American marten is ranked moderate/high, due to its moderate-high sensitivity to climate and non-climate stressors, moderate adaptive capacity, and moderate-high exposure.

American martens are directly and indirectly sensitive to climate-driven changes such as:

- decreased snowpack,
- increased climatic water deficit, and
- altered fire regimes.

Sensitivity of the American marten to climate change will likely be driven by its habitat specificity and reliance on deep snowpack. Deep and persistent snow is a critical winter habitat element for American marten, and snowpack reductions and rising snowline are predicted over the next century. Martens are also sensitive to factors that may lead to loss of fragmentation of high-elevation mature forests, such as climatic water deficit, resulting in part from loss of snowpack, and altered fire regimes.

American martens are also sensitive to non-climate stressors including:

- habitat fragmentation (e.g. roads, timber harvest).

American marten habitat is currently fragmented by timber harvest, and may be further fragmented and reduced in the future by altered fire regimes. The capacity of the marten to adapt to climate change is limited by its reliance on deep snow for access to prey in winter.

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Sensitivity & Exposure

Sensitivity to climate and climate-driven changes

Sensitivity of the American marten to climate change will likely be driven by its habitat specificity and reliance on deep snowpack. The primary determinant of marten distribution may be the distribution of mature forests (Kirk and Zielinski 2009). Marten prefer high-elevation (approximately 1400 m to 3000 m) (4593 ft to 9843 ft) (Purcell et al. 2012), late-successional mixed-conifer, and red fir forests for resting and denning (Verner and Boss 1980, Meslow et al. 1981 cited in Spencer et al. 1983). Marten are highly selective of microhabitats, preferring complex structures near the ground, closed canopy (Slauson et al. 2007; Kirk and Zielinski 2009) and large diameter trees (Martin and Barrett 1991; Buskirk and Powell 1994; Slauson et al. 2007; Kirk and Zielinski 2009). For example, snags, stumps, and logs made up 61% of resting sites found near Sagehen Creek in Tahoe National Forest, and tree canopy accounted for another 13% of resting sites (Martin and Barrett 1991). Snag diameters averaged 43.9 cm, stump diameters averaged 83 cm, and log diameters averaged 69.4 cm (Martin and Barrett 1991). Large- scale or uncharacteristically severe wildfire and drought that precipitate reductions in the distribution and connectivity of large diameter stands with high canopy cover are likely to reduce available habitat for marten.

Moreover, martens rely on thick snowpack to exclude predators, provide high-quality hunting conditions, and provide winter resting and denning sites (Martin and Barrett 1991; Buskirk and Powell 1994; Bull and Heater 2000). Martens in Oregon have been found to spend the majority of their time in subnivean rest sites, which provide good thermal regulation, are often inaccessible to predators (Bull and Heater 2000). Abandonment of subnivean sites prior to complete snowmelt suggests that saturated ground may make the sites undesirable (Bull and Heater 2000). Future reductions in snowpack, compounded by earlier onset of spring and more frequent winter melt events may substantially reduce availability of adequate winter habitat for martens.

Winter diet of marten is specialized to a few accessible or abundant prey items, many of which rely on deep snow for subnivean foraging and caching opportunities (Grinnell et al. 1937, Marshall 1946, Cowan and Mackay 1950, Weckwerth and Hawley 1962, Francis and Stephenson 1972, and Soutiere 1979 cited in Zielinski et al. 1983; Zielinski and Duncan 2004). In winter, as subnivean dens and cone caches begin to be used by larger animals, martens appears to switch to larger prey, which likely representing a greater energy gain per capture (Zielinski et al. 1983). Winter prey includes voles (*Microtus spp*.), Douglas squirrels (*Tamiasciurus douglasii*), snowshoe hares (*Lepus americanus*), and flying squirrels (*Glaucomys sabrinus*) (Zielinski et al. 1983). The subnivean environment provides stable temperatures, and decreased snowpack is expected to result in colder and more thermally variable subnivean space, despite warming winter temperatures (Pauli et al. 2013), potentially affecting both marten and prey species. Colder and more variable temperatures within the subnivean space may have major impacts on mammal communities that have evolved under these mild and stable subnivean conditions (Pauli et al. 2013). Marten have a competitive advantage over fisher in deep snow, due to higher foot loading in marten; decreasing snowpack may remove this advantage and benefit fishers, potentially altering marten and fisher spatial distributions (Krohn et al. 1997).

Future climate exposure

Important climate and climate-driven factors to consider for American marten include changes in snowpack, wildfire, and dominant vegetation type.

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).

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).

Vegetation shifts: Models suggest that increased temperature as a result of climate change and an increase in plant fuel could augment both the severity and frequency of fire, potentially leading to vegetation conversion and a corresponding decrease in old growth forest (Lenihan et al. 2008) important for marten habitat. Loss of red fir/lodgepole communities in the Sierra Nevada may be accelerated by changes in the severity and frequency of fire (PRBO Conservation Science 2011), although increased fire may create opportunities to expand for some component species, such as lodgepole pine (Bartlein et al. 1997).

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

Martens are sensitive to disturbances that may limit habitat availability and quality (Kirk and Zielinski 2009; Slauson et al. 2007), including grazing pressure (Spencer et al. 1983), road density (Wasserman et al. 2010), timber harvest, and forest management practices (Zielinski et al. 2005). Forest fragmentation may reduce marten numbers, and may influence fragmentation of population distribution (Phillips 1994; Zielinski et al. 2005; Kirk and Zielinski 2009). Fragmentation of marten habitat by timber harvest and road construction may be amplified by increased fire intensity and frequency, and vegetative shifts along elevational gradients, resulting in greater population isolation. Martens, however, appear to tolerate recreational activities such as snowmobile use (Zielinski et al. 2008).

In addition, pesticides employed in illegal marijuana cultivations are known to cause mortality and decreased fitness in Pacific fishers, and may pose a risk to martens in the Sierra Nevada (Gabriel et al. 2012). Sublethal exposure to pesticides has been associated with reduced thermoregulatory capacity in birds and mice (Grue et al. 1991, Gordon 1994 cited in Thompson et al. 2013), and may impact the capacity of martens to cope with increased snowmelt events and reduced thermal snow cover.

Adaptive Capacity

The marten's capacity to accommodate future changes in climate may be limited by its habitat specialization and reliance upon deep snow. Distribution of martens has decreased since the early 1900s, and is fragmented in the southern Cascades and northern Sierra Nevada (Zielinski et al. 2005). Distribution of mature forests may be the primary determinant of marten distribution (Kirk and Zielinski 2009), and lack of connectivity of suitable habitat may inhibit adaptive capacity. Martens do not persist in forest systems where >30% of the original forest cover has been removed (Bissonette et al. 1997; Chapin et al. 1998; Hargis et al. 1999; Potvin et al. 2000).

Moreover, dramatic reduction of habitat area will likely be accompanied by large decreases in local population size, increasing likelihood of local extinction (Wasserman et al. 2012). Climate change may shift suitable bioclimate conditions up the elevational gradient, reducing connectivity of important habitat for high elevation species (Wasserman et al. 2010), such as martens. Habitat patchiness and population isolation is predicted to genetically isolate the marten, reducing genetic allelic richness and expected heterozygosity (Wasserman et al. 2012). Inbreeding depression has been strongly linked to extinction risk and the loss of allelic diversity reduces evolutionary potential.

A shift in range to higher elevations may also limit forested habitat available to martens (Purcell et al. 2012). While martens have been documented using boulder fields, talus slopes, and rockslides in areas with reduced forest cover (Slauson et al. 2007; Green 2007 cited in Purcell et al. 2012), those habitats may not provide for year-round habitat needs (Green 2007 cited in Purcell et al. 2012). Furthermore, because the marten requires thermal cover provided by snow in subalpine and montane habitats during winter (Buskirk et al. 1989, Taylor and Buskirk 1994 cited in Halofsky et al. 2011), changes in the structure and quality of the subnivean environment due to reduced snowpack (Pauli et al. 2013) could expose the marten to lethally cold temperatures (Halofsky et al. 2011).

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