Potential Effects of Climate Change on the Threatened Lahontan Cutthroat Trout

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Research has shown that the annual mean temperature in North America has increased from 1955 to 2005; however, the magnitude varies spatially across the continent, is most pronounced during spring and winter months, and has affected daily minimum temperatures more than daily maximum temperatures (Field *et al*. 2007). Other effects of climate change include, but are not limited to, changes in types of precipitation (Knowles *et al*. 2006), earlier spring run-off (Stewart *et al*. 2005), longer and more intense fire seasons (Westerling *et al*. 2006, Bachelet *et al*. 2007), and more frequent extreme weather events (Rosenzweig *et al*. 2007). These changes in climate and subsequent effects can be attributed to the combined effects of greenhouse gases, sulphate aerosols, and natural external forcing (Karoly *et al*. 2003, Barnett *et al*. 2008).

Warming trends seen over the past 50 years are predicted to continue (Intergovernmental Panel on Climate Change (IPCC) 2007). The expected warming of the atmosphere is also expected to increase the temperature of freshwater ecosystems which will negatively affect coldwater species (Poff *et al*. 2002, Dunham *et al*. 2003b, Kundzewicz *et al*. 2007). Several studies have modeled the effects of increased water temperatures on North American salmonids (Keleher and Rahel 1996, Jager *et al*. 1999, Rahel 2002, Mohseni *et al*. 2003, Flebbe *et al*. 2006, Preston 2006, Rieman *et al*. 2007). The extent of habitat predicted to become unsuitable for salmonids ranges from 17 to 97 percent, depending on various factors such as the magnitude of the temperature increase and the region of North America in which the species exists (Rahel 2002, Flebbe *et al*. 2006, Preston 2006, Rieman *et al*. 2007). Additionally, these studies predict the loss of suitable habitat for salmonids, mainly at the southern extent of their range and at lower elevations.

In response to increasing temperatures, salmonids will shift their distributions to northern latitudes (if possible) and/or higher elevations to find adequate stream temperatures (Keleher and Rahel 1996, Poff *et al*. 2002). This will likely increase fragmentation of populations and coupled with increases in stochastic events, will further disrupt metapopulation dynamics which increases the probability of extinction (Dunham *et al*. 1997, Fagan 2002, Opdam and Wascher 2004, Frankham 2005, Wilcox *et al*. 2006). Restoring physical connections among aquatic habitats may be the most effective and efficient step in restoring or maintaining the productivity and resilience of many aquatic populations (Bisson *et al*. 2003, Dunham *et al*. 2003a, Rieman *et al*. 2003, Dunham *et al*. 2007). The focus should be to protect aquatic communities in areas where they remain robust and restore habitat structure and life history complexity of native species where aquatic ecosystems have been degraded (Gresswell 1999).

	Population Isolated	Weakly Networked	Moderately Networked	Strongly Networked	Total
# of Conservation Populations	50 (70.4%)	14 (19.7%)	4 (5.6%)	3 (4.2%)	71
Stream Miles	170.4 (35.9%)	157.5 (33.2%)	35.8 (7.5%)	111.2 (23.4%)	474.9

Density Category (fish/mile)	Occupied Stream Miles	Percentage of Occupied Stream Miles
0-50	257.9	40.3
51-150	195.1	30.4
151-400	73.2	11.4
> 400	100.3	15.7
unknown	14.4	2.3

Habitat Category	Occupied Stream Miles	Percentage of Occupied Stream Miles
Excellent	29.9	4.7
Good	265.5	41.4
Fair	321.0	50.1
Poor	12.5	2.0
Unknown	11.8	1.8

Hayhoe *et al*. 2004

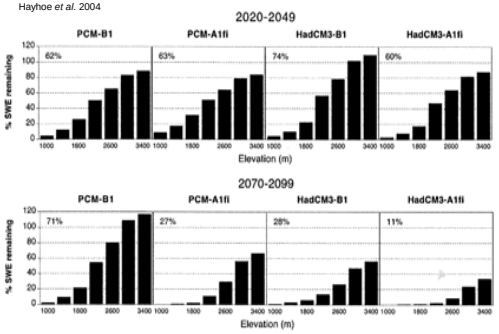
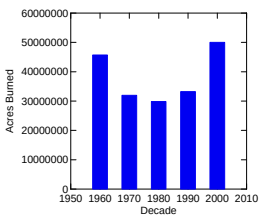


Fig. 2. Average snowpack SWE for 2020–2049 and 2070–2099 expressed as a percent of the average for the reference period 1961–1990 for the Sierra Nevada region draining into the Sacramento–San Joaquin river system. Total SWE losses by the end of the century range from 29–72% for the B1 scenario to 73–89% for the A1fi scenario. Losses are greatest at elevations below 3,000 m, ranging from 37–79% for B1 to 81–94% for A1fi by the end of the century. Increases in high elevation SWE for midcentury HadCM3 B1 and end-of-century PCM B1 runs result from increased winter precipitation in these simulations.

Acres Burned in the United States by Decade



Acres Burned in the Great Basin 2001-2007