

**AGENTS OF CHANGE IN THE SIERRA NEVADA:
FACING AN UNPRECEDENTED AND UNPREDICTABLE FUTURE**

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Abstract: More than 2500 years ago, Heraclitus noted that nothing is permanent except change. While human societies have generally managed to adapt to past global changes, expected changes over the next few decades promise to be especially challenging, for two reasons: they will be unprecedented, and they will be unpredictable. Over the past few decades, climatic warming and its effects have become evident in the Sierra Nevada. The Sierra has warmed by 1 to 2° F, glaciers continue to melt, and winter snowpacks are melting earlier in the spring. The consequent lengthening and deepening of the summer drought has lengthened the fire season. Many species of small mammals have moved up in elevation, and tree mortality rates have doubled. These recent changes likely foreshadow much greater changes to come, which promise to have unprecedented effects on Sierra Nevada ecosystems and their services. Surprises are inevitable, and a significant wildcard is geoengineering (purposeful alteration of the global climate to combat warming), which may reduce the rate of warming but cause other climatic and ecosystem changes. Future climate and ecosystem conditions will have no analog in the past, meaning we can't automatically use past conditions as a management target. Additionally, other significant agents of change in the Sierra Nevada -- including altered fire regimes, air pollution, invasive species, and habitat fragmentation -- will likely interact in unexpected ways with climatic changes. Thus, at the local and regional levels most important to land managers, the rate, magnitude, and even direction of future environmental changes and consequent ecosystem responses are effectively unpredictable. Fortunately, the unprecedented and unpredictable nature of the future does not mean we cannot act. Rather, it means we need to think in new ways and adopt some fundamentally new approaches to resources management. Some broad classes of responses worth considering in this workshop are "the four Rs": restraint, resistance, resilience, and realignment.