Chapter 9: Conclusions

The over whelming preponderance of scientific evidence is that anthropogenic driven climate change will be significant, inevitable and increasing during the remaining years of the 21st Century and beyond. There is no indication that international actions will produce sufficient reductions of global GHG emissions (particularly CO_2 emissions from fossil fuel consumption) to mitigate projected climate change. There is no credible evidence available to countervail these conclusions.

Fire has been an important component of Earth history for over 420 million years, with historic fire variability well correlated with past climate change and variability. Fire regimes and ecosystem classifications are proven useful means for consolidating fire and ecosystem characteristics and relating them to climate change and variability. Fire regimes and ecosystem pattern and structure will undergo substantial change in response to ongoing 21st Century climate change. The rate of climate change will likely accelerate, resulting in significantly greater change after mid-century. Fire regime change is also likely to accelerate in response to climate, with fire activity increasing for those ecosystems where vegetative growth continues to produce sufficient fuel and where current fuel limited regimes respond to climate change with added fuel accumulation.

Climate is, by definition, the long-term (commonly 30 years) statistical compilation of weather events (commonly observed hourly and reported daily) that helps to shape ecosystems and ecosystem functions, including disturbances such as fire. Ecosystem classification systems are dominated by climatic factors at larger to mid-range scales. Managers should incorporate concepts of change, variability, pattern and scale in their planning to maximize utility of information about atmosphere-ecosystem-fire relationships and how they are changing with climate.

Climate change scaling considerations can be described from a fire perspective as follows. Basic fire event components and processes will not be altered by climate change, but their frequency, amplitude, and duration will. In differing ways at differing locations the type and condition of fuels, frequency of ignition, length of fire season, period of high fire danger rating and other traditional fire business metrics will change the short term (seasonal) probability characteristics of fire regimes, including the behavior and ecosystem impacts of fires. There is also growing evidence that a likely consequence of climate change will be changes in occurrence patterns of daily (synoptic scale) weather systems, such as Santa Ana winds, that are a predominant factor in certain fire regimes and the basis for synoptic weather pattern classifications that inform modern fire weather forecasting. Managers can expect significant increases of climate variability information needed to better inform seasonal fire probability projections and can expect to begin to receive projections of future changes in Santa Ana and similar dominant fire weather patterns resulting from climate change.

Fire history and other fire science studies are providing increasing evidence of the importance of natural climate variability, as personified by the El Nino Southern Oscillation (ENSO) coupled atmosphere-ocean circulation pattern, to fire at Intermediate (annual to interannual) time scales. Climate scientists are in turn developing strong evidence that climate change is altering the frequency, amplitude and persistence of these naturally occurring examples of climate variability. As a result we are experiencing more frequent, higher amplitude and longer lasting episodes of heat waves and drought. Anyone who has had to deal with seasonal and longer term assessments of fire risk is familiar with Palmer Drought Severity Index (PDSI) patterns of fuel desiccation and heightened fire danger that have been an increasing feature of seasonal and longer fire potential outlooks. Managers should actively engage in rapid utilization of improvements in both prediction of ENSO and other patterns of climate variability and knowledge of how they impact fire regime variability.

At long (decadal to centennial) time scales, fire should be viewed more as an ecosystem function that, along with other disturbances, is likely to accelerate ecosystem adjustment to climate change, abruptly alter ecosystem function trajectories (such as carbon sequestration) and ultimately help to determine transitions to future ecosystems for given locations. Holocene fire history is extremely useful for understanding how ecosystems have evolved during past climate change and how ecosystems will evolve in response to ongoing and future climate change, but it is important to recognize that the rates of change may be considerably more rapid than during most perios in the Holocene. Fire managers should have an important role in planning for long-term ecosystem based approaches for adapting to climate change by assuring that the increasing role of fire is included in such planning and in helping to describe how fire management can seek to increase the resilience of existing and future ecosystems in the face of climate change.

Fire management has been on a converging pathway with climate change for more than a Century. One hundred years ago, the seminal events shaping modern fire management and our understanding of how humans are altering our climate began parallel paths that now intertwine and will continue to do so for the rest of this Century and beyond. We now realize that climate change considerations will be prominent for all aspects of fire management as well as for many other aspects of natural resources management impacted by fire. Our understanding of climate change and variability and how they historically relate to fire has grown substantially in recent years. When coupled with advances in climate change science, that understanding provides knowledge to help inform fire management about changes in historic fire activity resulting from longer, hotter, dryer fire seasons with increased ignitions for different ecosystems and fire regimes. For those fire regimes affected by seasonal to multi-year drought, advances in seasonal to interannual prediction of climate variability provide unprecedented opportunities for effective seasonal to multi-year fire planning. Managers will be challenged to adopt this new intermediate scale information in their planning structures. Finally, all managers will be challenged to fully incorporate fire in planning long-term adaptive responses to climate change. The option of restoring future ecosystems to what they once were will simply not exist in the 21st Century. Instead, adapting ecosystems to be fully functional within the bounds of future climate, and getting them there with likely increased fire accelerating the transition, is the challenge to be addressed. Fire and fuel management will be critical components for climate change adaptation, for both traditional fire management objectives and for new climate related emphases such as carbon sequestration. We believe the literature reported in this synthesis supports these conclusions and offers managers a foundation for building their ecosystem specific plans.