Chapter 8: Recommendations for Managers

Wildland fires will accelerate ecosystem change in many areas of the United States, both in areas where fire has been common and in areas where fire has been largely absent, as fire regimes respond to 21st Century climate change (Flannigan et al. 2009; Krawchuk et al. 2009; Swetnam and Anderson 2008; Mack et al. 2011). As a result fire managers need to plan for increased fire activity (longer fire seasons, more large fires, and increased fire severity) in many areas of the country. The potential for these changes also means that other resource managers, whose focus may be on ecosystem restoration or carbon sequestration, consistently need to incorporate the potential of increased fire activity in their planning efforts. Fire is an important component of both climate change mitigation and adaptation planning (Pan et al. 2011; Littell et al. 2011; National Research Council 2010a; National Research Council 2010b; National Research Council 2010c). 21st Century fuels management includes managing fuels to increase carbon sequestration or reduce carbon losses (mitigation) and to increase ecosystem health and resiliency in a changing environment (adaptation). Because increases in extent and severity of fire events and other disturbances, such as insect-induced mortality and expansion of invasive species, are some of the first impacts of changing climate on ecosystems, they can be viewed as opportunities to accelerate ecosystem adjustments to climate change. For example, by planning for post-fire replanting with climate adapted species managers can foster more rapid adjustment of ecosystems to future climate (Millar et al. 2007). Planning success is more likely when informed by both knowledge of place based fire history and monitoring of climate-driven fire regime change in the context of ecosystem structure and dynamics. Acquisition and maintenance of place-based fire history is best done at the operating unit level, but monitoring is best supported by standardized, nationally agreed to indicators (variables that can be measured) of change that are mapped over time at regional through smaller scales (Bailey Division through Province and Sector). Time and space scale considerations should always be present when applying climate-related information (see discussion in Chapter 5 of this synthesis), particularly for climate model projections. Following Gedalof (2011), we suggest categorization of scale dependent fire applications of climate/weather information at short (synoptic to seasonal), intermediate (annual to interannual) and long (decadal to centennial) time scales.

Progress has been made in the five years since Federal agencies were criticized for slow response to climate change concerns although concerns remain that agency funding and priorities are not aligned (US Government Accountability Office 2007; Littell et al. 2011; US Government Accountability Office 2011). Millar et al. (2007) note in their conclusion *"Although general principles will emerge, the best preparation is for managers and planners to remain informed both about emerging climate science as well as land-use changes in their region, and to use that knowledge to shape effective local solutions."* We fully agree and suggest the foundation for this preparation consists of 1) maintaining an accessible knowledge base of developing climate science information applicable to fire and natural resource management issues; 2) consistently applying fire regime concepts as a bridge between climate change and fire business; 3) monitoring fire regime indicators to quantify change at the Bailey Division and Province level; 4) using and/or developing information relationships based on Bailey's classification to foster sharing of fire related climate information of interest to fire and other natural resource managers; 5) adhering to short, intermediate and long time scale categories to align information about climate/weather change, variability, and patterns with fire information needs; 6) developing

(where absent) and/or updating (where available) fire history information at the local operating unit level as a knowledge base benchmarking future change and 7) continuing to improve the capability of land management planning models to incorporate fire/climate interactions.

Climate Science

- Federal agencies with climate and fire science responsibilities should provide an annually updated review of climate science progress for use by managers
- Managers and scientists should actively incorporate expected progress in climate/weather forecasts associated with ENSO, and other coupled atmosphere-ocean patterns, that drive intermediate scale fire variability into their planning efforts
- Progress in forecasting how climate change will influence future statistical distributions of short scale weather that drives actual fire events, for example Santa Ana winds and lightning activity, is less clear, but managers should actively press scientists for improvement in this arena
- Fire scientists should actively collaborate with scientists working on projected ecosystem vegetation responses to climate change in order to have disturbance fully incorporated in those efforts and to have fuel relevant outputs become available to better inform long time scale fuel management planning
- Fire managers and scientists should become more aware of the growing importance of carbon sequestration as a natural resource management issue and actively develop ways to quantify fire management options for enhancing sequestration and diminishing emissions of carbon by fire

Fire Regimes and Fuel Management

- Scientists should work with managers to agree to a standardized set of measurable fire regime indicators that can be monitored for change and be offered as endpoints for coupling to regional GCM outputs, and to coordinate the development of these indicators with international partners
- Paleofire history knowledge, particularly from tree ring/fire scar studies, is making rapid and significant progress in many geographic areas where fire has been historically important. Managers should actively utilize information advances that help to explain fire regime variability over time and space
- The Monitoring Trends in Burn Severity project and LANDFIRE should be fully supported, both to maintain and update data bases, and for ongoing research for validation and for evaluating and improving methods as appropriate
- Satellite-based fire monitoring data used for global and regional models needs to be developed to include consistent assessment of fire severity and modeling of emissions that takes into account fuel structure, fuel condition (eg. moisture) and fire weather
- Understanding basic concepts of fuels and how to manage them for landscape resilience, and having a way to evaluate effectiveness of fuel treatments, is a good combination for sustainable management at large spatial scales

- Managers should keep in mind the four principles for a fire-safe forest introduced by Agee and Skinner (2005): (1) reduce surface fuels, (2) increase height to live crown, (3) decrease crown bulk density, and (4) retain large trees
- Managers should anticipate and plan for changes in species composition and plant assemblages borne of climate change and other disturbance processes that can affect future fire activity and fire management response. Citations to consider include: Iverson and Prasad (2002); Lenihan et al. (2003); Mouillot et al. (2002); Pausas (1999)

Ecosystem Classification

- The fire community should seek to use and incorporate the Bailey (or similar biophysically based vegetation classification) system, whenever feasible in order to gain access to a broad array of existing and future information and to build information bridges with the larger natural resources community that is increasingly interested in fire
- While climate information at the Province level remains desirable, managers should plan to use Division level climate change information for the immediate future at most locations. Where Province level information is available, the usefulness of the finer scale information should be quantified to justify funding in support of its expanded production
- Fire researchers should work closely with the remote sensing community to ensure that satellite-based vegetation classification systems used for global and regional models include sufficient categorization of vegetation for distinguishing vegetation types (e.g. conifers with dominant crown fire vs. conifers with dominant surface fire regimes)
- Bailey's ecosystem classification system provides a standardized hierarchical method of describing ecosystems which enables the application and interpretation of interaction of climate and ecological processes. This perspective enables assessing the geographic patterns and connection between actions at one scale and effects at another scale
- Ecosystem classification systems are recognized as a valuable tool for translating climate change projections into ecological impacts.

Scale dependent variability and change

- Fire occurs at the nexus of atmosphere-ecosystem interactions and displays variability over a broad range of scales. Managers should work with fire scientists to identify the information they need for short, intermediate, and long time scale planning based on changing fire variability
- Because climate change projections are inherently future statistical distributions of weather, managers should utilize risk assessment methodologies when applying those projections to fire planning
- Planning at scales that are too fine will fail to account for disturbances that arise outside small management units; planning at scales that are too coarse, such as regional scales, will not account for local patterns of spatial and temporal variability and are in danger of applying one-size-fits-all solutions (Heyerdahl 2001)

- Increasing the size of management units to hundreds or thousands of hectares across logical biogeographic entities such as watersheds will improve the likelihood of accomplishing objectives (Smith and Lenhart 1996). For example, large strategically located blocks of forest land subjected to fuel treatments will reduce fire spread more effectively than smaller dispersed units (Finney 2001)

Fire History

- Managers should be familiar with both paleo and contemporary fire history. Fire history reinforces our understanding of the interaction and dependencies of climate, vegetation and fire. Also, the absence of fire can enable changes in plant communities that may or may not be desireable. Further, the absence of fire of may set the stage for more destructive fires by enabling the build-up of fuels

- Managers and planners should consider Native American traditional use of fire in future programs for ecosystem management. This traditional knowledge was based on adaptive practices maintain ecosystems which evolved over millennia

- Because of fire's importance as an ecosystem process at large and small scales, Managers should understand: (1) the response of fires to past, present, and future climate change for global change assessments; and (2) the role of fire in maintaining forest health and promoting ecosystem change for better forest management. Like many types of paleoenvironmental data, information on past fires can be interpreted in climatic terms as well as used as an indicator of how particular ecosystems respond to known climate changes. The benefit of the knowledge of fire history is to both…understand the cause and ecological consequences of climate change

- Managers and planners should seek to understand differences in fire history not only between the east and the west (Domains) but also differences in fire history between Bailey's Divisions and perhaps Provinces