Fostering resilience in Southwestern ecosystems: Proceedings from a problem solving workshop

Tucson, Arizona from February 25-27, 2014

Proceedings summarized by Alexander Evans and Anne Bradley, March 2015

Executive summary

The Southwest Fire Science Consortium (SWFSC) workshop, "Fostering resilience in Southwestern ecosystems," engaged 168 professionals from a range of disciplines. Through facilitated discussions participants identified challenges and strategies for success pre-fire, during fire, post-fire, and in building fire adapted communities. The workshop objectives were to:

- Bring together scientists and natural resource managers to discuss concepts of *resilience* in a time of changing climate and fire regimes;
- Identify and evaluate current and potential resilience building practices;
- Identify management goals and objectives for improving practice;
- Identify and prioritize future research needs;
- Collaboratively develop a set of key recommendations and next steps; and
- Improve natural resource managers' ability to help communities become fire adapted.

The SWFSC chose an experimental workshop structure. While some invited speakers gave presentations, most of the workshop consisted of a series of facilitated roundtable discussions addressing five major themes:

- Definitions of Resiliency
- Building pre (severe) fire landscape resilience
- Using wildfire as a resiliency tool: Tactics, strategies, and communication
- Post-fire management options for building resiliency
- Collaborative problem-solving: Accelerating the development of fire adapted communities

The first series of discussions focused on defining resilience and highlighted the very broad range of human and ecological elements that managers are trying to make more resilient to a changing climate. The list ranged from keystone species to aquatic systems to mycorrhizae to fire crews. Next participants discussed current land management activities that are successfully building resilience. Some of the successful activities include complete forest fuel reduction treatments (e.g., thinning and burning to remove slash); and proactive use of fire, including fire for resource benefit. Participants also highlighted the importance of connecting treatments across the landscape. For example, small scale thinning, hand piling, and burning in the wildland urban interface (WUI) combined with large scale, moderate severity, prescribed fire outside of the WUI. Participants also identified some barriers to treatments, many of which came back to funding. For example, funding is often directed at mechanical treatments with little left for the necessary prescribed fire follow up. Participants also identified the challenge of working across boundaries as a barrier to effective resilience building. Another big barrier participants identified was the social acceptance of management actions. For example, participants felt there was insufficient public acceptance of prescribed fire, managed wildfires, the smoke fire produces, or the post-fire aesthetics of high severity patches.

It is easy enough to complain about what is not working, but participants quickly moved on to solutions. Participants acknowledged collaboration is an important strategy to improve pre-fire management practices. Since many of the barriers stemmed from funding difficulties, key strategies included:

- Shifting funding from suppression to pre-fire treatment;

- Capitalizing on existing forest industry; and
- Creating management plans that optimized existing budgets and personnel.

Participants discussed improving practices so that suppression operations enhance the ecological benefits of fire and improve resiliency at the landscape level. A key suggestion from participants was pre-planning, particularly pre-planning that includes prescriptive criteria. Participants felt that improved information sharing, spatial planning, programmatic endangered species consultations, and decision support would improve suppression. Another off-season activity participants suggested was education for decision makers, suppression team, and resources advisors. This education could not only improve understanding of resilience, but also the challenges different positions and disciplines face. Participants thought building trust between local and non-local teams is important.

The workshop next addressed post fire management in the context of resilience. A key post fire issue for participants was the lack of a long-term focus on rebuilding resiliency. Participants' recommendations for large changes to post fire managements focused on two themes: 1) monitoring and evaluation and 2) communication, both within agency and with the public. A large part of this would include pre-planning for the post-fire environment and incorporating long-term management strategies within these areas.

The final piece of the workshop was focused on accelerating the development of fire adapted communities. Participants discussed the importance of communication with communities before, during, and after fires. They suggested that communication be transparent, direct, and respectful at all times–and face-to-face communication is best. The body of the report lists a number of specific suggestions participants made for how to communicate with communities, but in general participants called for constant, consistent communication via a wide variety of media to share information on fire and resilience.

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Introduction

Ecosystems and fire regimes are moving into new domains as a consequence of climate change, disturbance, and other causes. Fire professionals and land managers in the southwest are confronted with new fire regimes, fire effects, and ecosystem recovery trajectories following disturbance. To help fire and ecosystem managers and scientists in the Southwest understand and address ecosystem resilience under changing conditions, the Southwest Fire Science Consortium (SWFSC) hosted "Fostering resilience in Southwestern ecosystems: A problem solving workshop" February 25-27, 2014 in Tucson, Arizona.

The primary workshop objectives included:
- Bring together scientists, natural resource managers to reframe the concept of resilience in a time of changing climate, and changing fire regimes.
- Identify and review current resilience-building practices in light of changing circumstances
- Develop management objectives and practices for building resilience in large burned landscapes
- Improve natural resource managers' understanding of social resilience and ability to productively integrate the public in the management of changing landscapes.

The workshop was designed to move beyond the traditional conference lecture format and take advantage of the combined expertise of participants. Most of the workshop time was dedicated to facilitated roundtable discussions where participants identified challenges and strategies for success pre-fire, during fire, post-fire, and in building fire adapted communities. Since much of the workshop was focused on participant discussion, most of this report is devoted to capturing those discussions. The following summary attempts to pull the key discussion points from each of the discussion topics and provide a snapshot of the challenges and potential solutions for building resilience in the southwest as of 2014.

Participant demographics

The workshop brought 183 professionals together to discussion resiliency. Most were from Arizona (76%) and New Mexico (16%), but the workshop brought participants from as far away as Idaho and Wisconsin. Most participants worked for the federal government (35%) or a university (30%), but non-profit organizations, private companies, tribal, state, and local governments were also represented. Part of the purpose of the workshop was to work outside of the traditional disciplinary boundaries and find solutions that work for the full range of values natural ecosystems provide. To that end, organizers made an extra effort to reach out to managers from disciplines besides fire ecology and management. Organizers also took on the task of pushing interdisciplinary discussion by creating roundtable seating assignments that mixed up attendees. The workshop included experts on soils, social science, archaeology, range ecology, plant ecology, hydrology, fish and wildlife, and others. About 25% of the participants identified their primary expertise as fire ecology, 12% as silviculture or vegetation management, 10% fuels management, and 10% fire suppression. There was similar divisity in job roles; about 41% of participants were involved in research, 24% in implementation, 12% in decision making, 12% in public outreach, and 11% in planning.

Climate change, resilience, tipping points, and fire adapted communities

The workshop was prefaced by two webinars. The first reviewed the science behind climate change, documented climatic changes, and potential future consequences for the southwest. A recording of the presentation is available at www.frames.gov/rcs/16000/16668.html. The second pre-conference webinar covered the recent report (RMRS-GTR-310) *Restoring composition and structure in Southwestern frequent-fire forests: A science-based framework for improving ecosystem resiliency* (2013). A recording is available at www.frames.gov/rcs/16000/16671.html. These webinars were designed to set the stage for the workshop and ensure key pieces of scientific information could be taken for granted in workshop discussions. For example, the multiple lines of evidence presented in the climate change webinar left little doubt about the significant climate changes beginning to manifest themselves in the Southwest.

During the workshop four brief presentations aimed to quickly summarize extensive scientific research for managers. The presentations focused on defining resilience, linking resilience theory to management, ecological and social tipping points, and fire adapted communities. Dr. Don Falk discussed the difficulties of defining resilience (view his presentation here).

Dr. Connie Millar's talk on linking resilience theory to management added to the conceptual background and fueled participants' discussion of resilience in the first roundtable (view her presentation here). Millar emphasized that human perceptions of health and time are often at odds with ecological processes. Humans often perceive health as connected to lack of change and have short lifespans in comparison to the millennial scale of many ecological processes. She also explained that, in the past, ecological responses to climate change were often significant, abrupt, episodic, and involved dramatic changes in range, structure, composition, function, community type, and disturbance. This means that ecosystems in the southwest have changed significantly and, moreover, current climate change is likely to drastically alter ecosystems. Based on her work on climate adaptation (Millar et al. 2007, Peterson et al. 2011), Millar suggested working with the natural capacities of species to adapt to change and removing barriers that block natural adaptation.

In his talk, Dr. Tom Sisk discussed tipping points and how they differ for human and ecological communities (view his presentation here). For ecosystems, a tipping point can be when an event irreversibly changes key aspects of the system. For human communities, a tipping point can be when a new idea moves from the fringes to become commonplace. Sisk suggested that recent fires such as Las Conchas in New Mexico in 2011 could be examples of ecological tipping points because repeated high severity fire may have removed seed source and soil resources from a large enough area so that the systems have been irreversibly changed. A related social tipping point could be societal acceptance of fire as part of southwestern ecosystems. Sisk explained that achieving this kind of large social shift is likely to require a powerful movement within civil society.

Dr. Zander Evans continued on the idea of social change in his discussion of fire adapted communities (view his presentation here). A fire adapted community is one that takes responsibility for its wildfire risk. A fire adapted community starts with homeowners creating defensible space, includes community efforts such as FireWise and Ready, Set, GO!, extends to businesses and infrastructure, and supports resilient ecosystems (www.fireadapted.org). Evans

made the case that fire adapted communities are important to land managers because they endorse management action in the wildland, smoke tolerance from managed fires, and reduce the risk of escaped prescribed fire.

Success stories
In addition to the scientific presentations, the participants came together for two success stories. First, Chris Marks presented the work Grand Canyon National Park has done managing wildland fire to create and maintain resilient landscapes (view his presentation here). Because the Grand Canyon has treated so many acres in recent years, overlapping fires from past years now help moderate fire behavior when new ignitions occur. As the park moves towards managing third and fourth entry fires   and maintenance of less dense forest conditions, the management team has more options to manage wildfires. They are able to consider allowing more wildfires to burn and need fewer holding resources. A key piece of Grand Canyon's fire program is building public acceptance. Even though the park is an international destination that can be effected by too much smoke, there is support from decision makers for managing wildland fire. For example, they will use cutting edge methods in an upcoming prescribed fire project in an area identified as endangered species habitat (view example burn plan here). This burn was conducted in October 2014 and monitoring data will be available by fall of 2015. By building fire ecology into the educational goals of the park, staff is able to use fire to enhance rather than detract from the visitor experience.

The second success story also prominently featured public outreach. Mark Brehl described the city of Flagstaff's Watershed Protection Project (FWPP) (view his presentation here). The FWPP was built on years of previous work and long-term collaboration with a focus on preventing high severity wildfires in the city's watersheds. The 2010 Schultz Fire demonstrated the great potential for flood damage to the City and the City water supply from severe wildfire. Part of the solution was to reduce the threat of high severity fire through thinning, but funding additional thinning was a challenge. A key piece of the project was inspired by a Southwest Fire Science Consortium field trip to learn about the City of Santa Fe's efforts to get water users to fund forest restoration. The FWPP took this idea and put it before the voters. A big public outreach campaign based on strong partnerships resulted in 74% of the voters approving a bond to pay for treatments on federal lands.

Roundtable Discussions
Each set of roundtable discussions was guided by pre-crafted questions, led by a trained facilitator, and documented by a dedicated note taker. The summaries below are based on combining and distilling notes taken at 14 different discussion tables for each topic. All the notes from all the discussions are available online (sites.google.com/site/swfscresiliencyworkshop/presentations). All statements are based on the expertise of the participants and have not been weighed against the scientific evidence or compared to existing policy and/or guidance. The summaries below do not represent consensus and not all participants agreed on all points.

Defining Resiliency (roundtable 1)
The first roundtable discussion participants sat with other from their discipline. The disciplinary groups included fire ecology, fish and wildlife, fire suppression, fuels management, hydrology, plant ecology, social science, and silviculture. The first question asked participants to think broadly about what resilience meant in their discipline. The resulting list was long and wide ranging.

What resource and/or ecosystem processes are you trying to make resilient?

- Whatever we are told to make resilient
- Sustainability
- Diversity at all levels
    - Species diversity
    - Biodiversity
    - Vegetation and plant population diversity
    - Functional suite of biodiversity
    - Ecosystem connectivity
    - Historic range of variability
- Species
    - Keystone species
    - Bird species
    - Species at risk of extinction
    - Pollinators
    - Sensitive species
    - Species assemblage persistence
- Places
    - Large landscape resilience through fire management
    - Endangered species habitats
    - PNVTs (potential natural vegetation types)
    - Native vegetation communities
    - Wildland Urban Interface
    - Watersheds
    - Riparian areas
    - Aquatic systems
    - Natural Springs – Wetlands
    - Connectivity
    - Refugia
- Ecosystem Services
    - Nutrient cycling,
    - Foodwebs
    - Aesthetics
    - Recreational use of land
    - Water

- Air Quality
- Watershed function
- Pollination
- Timber
- Carbon sequestration
- Seed dispersal
- Seedling recruitment
- Interspecific competition
- Ecosystem attributes
    - Structure
    - Ecosystem function
    - Patch Dynamics
    - Maintaining food web structure
    - Fire regimes
    - Snowpack/Precipitation
    - Debris/biomass
    - Soil/Sediment/nutrients
    - Slope / soil stability
    - Microclimate
    - Habitat for wildlife
    - Microhabitat
    - Mycorrhizae
    - Heterogeneity, mosaics
- Water
    - Water filtration
    - Water storage
    - Water quality
    - Public water supplies
    - Base flow – water recharge
    - Stability/Integrity of the hydrological system

- Processes
  - The forest as a process
  - Fire as an ecosystem process
  - Hydrologic processes
  - Positive feedback loops
  - Process of perennial flows
  - Carbon cycling
  - Nitrogen fixation
  - Carbon uptake and storage
- Human communities
  - Fire crews and their decisions
  - Funding
  - Neighboring communities
  - Forest products/industries
  - Economies
  - Education
  - Public
  - Private property
  - Prescribed fire practitioners
  - Infrastructure
  - Agriculture
  - Cultural resources
  - Multiple human uses

When the groups turned to the question of what disturbances threatened our resources, the list was equally long and ranged even wider in scope. Disturbances included everything from high intensity fire to political and funding disruptions. The discussion at many tables included debate about how to create a functional definition of resilience. In some limited disciplinary contexts resilience was relatively easy to define. For instance, to a group of fire ecologists resilience meant maintaining a healthy fire regime. However, discussions expanded beyond simplistic views of resilience to include its multifaceted ecological, social and economic elements. There was significant discussion of the human and political element in resilience and the importance of recognizing the role of human values and beliefs in management decisions. Participants also emphasized that resilience might mean different things for different resources or ecosystems. For example, management actions to meet one goal (e.g. thinning to reduce catastrophic fire danger) might decrease the resilience of fish and wildlife populations by reducing the diversity within their habitats or by altering or destroying refugia. Participants also wrestled with the question of whether or not protecting islands of diversity, such as a wetland, could increase resilience, if it was at the expense of other habitats. Definitions of resilience also changed across temporal and spatial scales for participants.

Many participants thought of resilience as a process. Thinking about keeping processes intact meant a move away from focusing on composition, structure, or individual species. By the same token, participants noted that Southwestern ecosystems have many overlapping processes and managing for multiple processes is a challenge.

Participants highlighted that resilience is a new concept that will take time, and some personnel turnover, to build into institutional culture. Part of this cultural shift might include using the concept of resiliency to determine priorities. Participants underscored the importance of accepting the idea that landscapes will change; and that the resilience concept includes the idea of a changing landscape. One participant used the example of Mount Graham red squirrels that may not be able to survive under the new habitat conditions even with herculean management effort. Another central element to the concept of resilience participants mentioned was the long time needed to assess resiliency. In fact, participants pointed out that it would likely take more than a human life span to document an ecosystem's resilience. The difference between human and ecological time scales creates the need to educate the public so they understand that ecosystems may take a long time to bounce back.

As participants discussed resilience, they identified many barriers to managing for resilience including:
- effective cooperation;
- the limitations of existing federal policy frameworks;
- the difficulty of fitting changing systems into static regulatory structures;
- community acceptance of vegetation changes or conversion; and
- the difficulty of balancing long term resilience goals with short term political and social requirements.

Many of the barriers and problems groups identified around resilience were discussed in more detail in the later roundtables and are described below.

Large fire preparedness and resilience building (roundtable 2)
For the second topic of discussion, organizers split participants into roundtables based on ecosystem of interest (e.g., ponderosa pine, chaparral, grasslands, riparian, and woodlands). By design, each table had a mix of discipline and expertise. The first discussion question focused on current efforts to build resilience.

> *Are current land management activities, such as mechanical treatments and burning, successful at building resiliency?*

Much of the conversation this question sparked focused on land management and vegetation treatments. Many discussion tables recognized that complete forest fuel reduction treatments (e.g., thinning and burning to remove slash) have worked to make forests more resilient to fire. These treatments usually reduce tree density as well as surface and ladder fuels. Participants also pointed to more specific treatments such as uneven aged systems in ponderosa pine or mixed conifer forests. Proactive use of fire, including managed wildfires was mentioned as an effective treatment. Participants cited the Gila National Forest's fire program and large area prescribed burns on the Kaibab National Forest as examples that prove the utility of proactive use of fire.

Participants also highlighted the importance of connecting treatments across the landscape. For example, one participant pointed to the combination of shaded fuel breaks in ponderosa pine near the wildland urban interface (WUI) and prescribed fire with passive crown fire in more distant wet mixed conifer as an effective way to connect treatments. Another example of linking treatments across the landscape was small scale thinning, hand piling, and burning in the WUI combined with large scale, moderate severity, prescribed fire outside of the WUI. It is important to note that participants were not unanimous on treatment effects. For instance, while some participants felt that, when done properly grazing could be considered a tool for reducing fuels, other participants disagreed.

Though much of the conversation focused on fire, participants also discussed other disturbances such as invasive plants. Participants mentioned two successful approaches to invasive control: mechanical and herbicide treatments to reduce fire risk and invasive control to restore hydrologic connectivity and ecological processes. Interestingly, a key piece of the success of herbicide treatment of invasive buffelgrass was overcoming the public aversion to herbicide treatment.

A number of examples came up where a practice or treatment worked in one context or ecosystem, but not in another. Participants felt that, where it was occurring at the landscape-scale, planning and treatment were working, but in many cases that scale had yet to be achieved. In some places efforts to cross jurisdictional boundaries were paying off. For example, participants pointed to successes in proactive and cooperative grazing management. However, participants also shared examples of grazing management problems, due in part to lack of solid collaborative relationships. Participants noted some success in public education and sharing science. For instance, they indicated treatment demonstration areas have been helpful, some federal fire policies and decision support tools have improved, and internal collaboration of resource specialists has increased. On the public side, participants reported some progress in shifting some of the burden back to the community, in other words, communities are making progress in adapting to fire through programs like FireWise.

Participants also discussed practices and approaches that were not working. One discussion table highlighted the failure of not doing anything while others talked about the problems of not treating enough acres fast enough. Participants described the difficulty of keeping pace with the growing problem of uncharacteristic fire in dense forests, removing trees in grasslands, and the spread of invasive plants. The need to maintain treatments and the need to respond to the fuels left after a wildfire added to participants' concerns. Other practices that participants identified as not working included mechanical thinning that leaves debris in place and burning without sufficient consumption. Similarly, reintroduction of flooding in riparian systems is not working except when paired with thinning and/or burning. Some participants had concerns about the effectiveness of mastication in reducing fire severity. Other participants called attention to the failure of 'one size fits all' prescriptions.

What are the primary barriers to changing current practices?

When the discussion turned to the barriers to changing current practices, participants also discussed the barriers to completing effective treatments across more acres. Much of the conversation came back to funding. Participants felt the resources are not available to meet objectives. In addition to not having enough money in general, participants identified areas where funds might not be allocated efficiently. For example, funding is often directed at mechanical treatments with little left for the necessary prescribed fire follow up. In other cases, funding arrives too late, after the problem has expanded. Some participants linked the discussion of insufficient funding to lack of industry and markets (particularly for low value material).

Participants identified the challenge of working across boundaries as a barrier to effective resilience building. Some felt that collaboration among federal agencies worked fairly well, but that federal–state partnerships could be improved. Participants also said engaging all user groups around improving the grazing permitting system was another collaboration challenge.

Another big barrier participants identified was the social acceptance of management actions. For example, participants felt there was insufficient public acceptance of prescribed fire, managed fire, the smoke fire produces, or the post-fire aesthetics of high severity patches. Participants saw lack of public acceptance as a key driver of the US Forest Service policy requiring suppression of human-caused fires. Participants felt homeowners in the WUI fail to acknowledge to

inevitability of fire, causing a barrier to landscape scale treatments. Similarly, public understanding of water supply is a barrier and connected to the over allocation of water resources. Participants suggested public opinion is a barrier to management more generally and that there is public resistance to management that seems destructive or counter-intuitive. A related barrier participants mentioned was the opposition to cutting large trees by the environmental activist community.

Some participants went further to suggest that the public's lack of understanding of natural ecosystems and perception that natural environments were pristine created a significant barrier to management. Other barriers were linked to lack of information, such as the lack of information about appropriate desired conditions in woodland systems or about how to measure resiliency in riparian systems. A related barrier is the lack of monitoring feedback loops, i.e., not doing enough to find out if practices are really having the intended effects.

Participants also identified institutional barriers such as the complexity and slowness of NEPA funding. Some felt threatened and endangered species laws and recovery plans are limiting. Others commented that it is difficult to be proactive because of planning involved in prescribed fire. Another barrier is the focus on deliverables (e.g., acres treated) or convenience rather than real improvements in resilience. The need to do crisis management versus strategic management is also a barrier. Policy makers have added to barriers in some cases, such as resisting land reform which has hampered management of grasslands.

Participants also pointed out that disincentives to take risks are a barrier to good management. For example, people who make decisions about allowing fire to burn do not feel like they have the necessary support to make the decision. Prescribed burns are often done at a time of year when it is safe, not necessarily when plants are adapted to fire. Risk aversion and concerns about liability keep managers from using fire proactively. At the same time, taking no action, not using fire, is very likely to contribute to the threat of uncharacteristic fire or other declines in ecosystem health.

What are suggested strategies to improve pre-fire management practices?

It is easy enough to complain about what is not working, but participants quickly moved on to solutions. Participants acknowledged collaboration, which was mentioned as something that is already working in some places and is an important strategy to improve pre-fire management practices. Collaboration could be improved across boundaries, across agencies, between regional management and local management. Increased coordination between private / public stakeholders should include working with and respecting landowners / permittees, which will result in buy-in, as opposed to "telling" them what's best.

Collaboration with the public through education and outreach was another key strategy for participants. Ideas for connecting with the public included:
- General outreach on valuing ecosystem services,
- Invest in community education and information to accelerate fire-wise planning and maintenance of fire adapted communities, and
- Promote fire education and foster social acceptance of burning.

Participants felt it was important to tailor the message to the audience and to focus on what they care about. For example, drinking water might be a more relevant issue for the public than protection of a little known species.

Another set of strategies or changes participants suggested revolved around WUI and land use issues. For example, some suggested a surcharge be levied on homeowners in the WUI. Others suggested that land acquisition or zoning rules that protected against development might help slow the growth of WUI. Insurance companies and the pressure they could apply to homeowners might help encourage development of defensible space.

Since many of the problems and barriers stemmed from funding difficulties, many of the solutions also involved money. A key strategy suggested was shifting funding from suppression to pre-fire treatment. Other strategies included capitalizing on existing forest industry and creating management plans that optimized existing budgets and personnel.

The treatments participants identified as being strategic for improving pre-fire management are related to either practices they had previously identified as successes or the flip side of barriers. One improvement in pre-fire management participants suggested was taking a landscape approach. For instance, a landscape approach could include the strategic integration of upland forest and grasslands. Others described this landscape approach as 'integrated watershed management.' For thinning, a landscape approach meant creating greater heterogeneity and a long term commitment to maintenance treatments. Participants also framed a successful response to invasive plants as a long term commitment.

In the discussion of strategies, participants focused on re-establishing ecosystem processes such as fire and flooding. Proactive use of fire was a particularly important element in the discussion of improved pre-fire management practices. Participants identified management of wildfire for resource benefits as a key tool to increase the scale of treatment. Some went farther to say that wildland fire management and societal expectations of fire management needed to change. This would require a general recognition of changes to fire regimes that have already occurred.

Using Wildfire as a Resiliency Tool (roundtable 3)

The third roundtable started with a discussion of the positive and negative impacts of wildfire suppression techniques. Participants quickly listed the obvious benefits of suppression related to reducing the negative impacts of wildfire on lives, property, habitat, sensitive sites, infrastructure, and archaeological sites. In addition, participants went beyond these first order impacts to look at more complex benefits which included:

- The opening for communication between landowners, agencies, and others;
- The opportunity to burn things that wouldn't get permission for a prescribed fire, and
- The chance to garner public support of firefighters.

The list of negatives was longer. Many of the negatives of fire suppression stem from the need for fire in many southwestern ecosystems. Fire exclusion creates severe conditions and high fuel loads, delaying inevitable fire. Participants made the connection between fire suppression and the increased likelihood of high severity fire, which in turn:

- Puts fire fighters at risk,
- Wastes money and resources,
- Leads to depletion of local water resources,
- Degrades air quality,
- Reduces grass resources for herbivores
- Damages the seed bank,
- Eliminates habitat,
- Causes flooding and sedimentation,
- Kills aquatic species and vegetation, and
- Creates hydrophobic soils.

Participants also discussed the detrimental effects of specific suppression techniques. For example, participants mentioned that burnouts can lead to high severity impacts, particularly when conducted in the middle of the day or with aerial ignition. During suppression, sawyers sometimes cut snags with wildlife value that might otherwise have remained standing. Another tactic that concerned participants was the use of fire retardants because of the potential impact on water quality, fish, and the transport of aquatic pathogens. Dozer and hand lines have the risk of introducing exotics, damaging archaeological sites, fragmenting the landscape, affecting wilderness values, and leaving long-term scars. Heavy machinery in general can leak, pollute, and cause erosion.

> ***How can we improve practices so that suppression operations enhance the ecological benefits of fire and improve resiliency at the landscape level?***

Given the potential negative impacts of fire suppression, participants were eager to discuss ways to improve suppression operations. A key suggestion from participants was pre-planning, particularly pre-planning that includes prescriptive criteria. Participants felt that improved information sharing, spatial planning, programmatic endangered species consultations, and decision support would improve suppression. These pre-planning efforts need to occur before fire season and include interagency discussion of objectives that will benefit resources. In the long term, resiliency information could be incorporated into forest management plans. Participants highlighted the importance of engaging local experts and resource specialists both as part of pre-planning but also during suppression. A related suggestion was inviting air quality,

power, county, and other organizations into planning meetings. Participants identified the Wildfire Decision Support System (WFDSS; wfdss.usgs.gov) as a good tool for pre-planning, and emphasized the need to keep WFDSS up to date and use it during suppression.

Participants noted that after action reviews should include discussion of ecological effects and post-fire monitoring should continue long-term. One important element of post-fire monitoring is invasive species. Monitoring should be combined with weed wash stations and guidelines to use existing roads/trails during suppression.

Another off-season activity participants suggested was practitioner education. Off-season education would help line officers better understand the long-term and short-term risks of fire suppression choices. For example, more training could help decision makers know when a fire does not need suppression and can just run itself out and burn areas that increase landscape resilience in the long run. This might also require a change in incentives and improved protection of line officers from the threat of litigation. Participants also recommended educating igniters about how to use burnout operations to increase resilience. Some of the participants' suggestions may require a paradigm shift. For instance, accepting unburned islands within the perimeter of a fire may require a change in some managers' attitudes. Participants emphasized the importance of patience when possible and the need to wait for good windows for burnout operations. Other changes that could improve the effects of burnout operations include:
- Create crews that specialize in firing,
- Increase night shifts and burn more at night,
- Use pre-existing networks of highways, trails, and other features, and
- Integrate prescribed burn units or burn block in line locations.

The other main focus of participants' discussion of how to better align suppression operations to resiliency goals focused on communication. Communication between agencies is important to:
- Address issues before fire starts,
- Allow for adaptable objectives and management decisions on the site,
- Build a common language,
- Harmonize varying objectives among agencies,
- Prepare for fire crossing boundaries, and
- Build a shared vision.
Agency level liaisons are ideally placed to communicate and coordinate pre-planned strategies and tactics across jurisdictions.

According to participants, communication with the public is crucial and should be specific to the location. Public information officers who are engaged with the local community and messages based on local vegetation and conditions are more effective. Participants hoped that agencies would be willing to share a nuanced story with the public that could include negative aspects of wildfire in one location and beneficial impacts in other areas. Another suggestion was to change pre-season messaging to communicate probability, not certainty and to use reference points such as previous fire seasons in that area. Participants felt it is important to emphasize that the US Forest Service is not in charge of everything and lots of other organizations are engaged too.

What are key suggestions for improving communication between non-local fire suppression teams and local resource managers?

A crucial element of improving communication during suppression is the link between local resources and those from far away. For example, local people have relationships with landowners and can quickly identify resources that need protection. The first step participants identified for improving communication was better information sharing on the conditions of the burn area before arriving on site. As one table highlighted, solid preplanning cannot be stressed enough because it's safer and means that decisions at all levels (from crew leaders to policy makers to the public) are informed by reasonable expectations. Participants reiterated that existing tools such as WFDSS can help facilitate communication. Similarly, forest plans are an opportunity to clarify objectives and priorities prior to fire, and should be followed. Participants underscored the need to package local information on threatened and endangered species, archaeological sites, and other sensitive information in ways that non-local responders can easily access and understand.

In addition to sharing data, participants thought education and building trust between local and non-local teams are important. If local team members were to join suppression operations on distant units and if incident command team members participated on local units, then each group would understand the other better. Similarly, assigning resource advisors to national teams and giving them power to make decisions would help them better understand the constraints and challenges of suppression operations. Another method for building trust are workshops ahead of fire season to get people talking about qualifications, training, and tactics. Such workshops would also help local people be involved when a fire comes. Participants identified prescribed fire as a fundamental training need. The overarching goal behind many of the participants' suggestions was to establish a sense of community between fire suppression teams and local fire resource organizations.

Post fire management and resilience (roundtable 4)

The fourth set of round tables addressed the challenges of managing the landscape after large fires. The discussion tables started with discussions about what ecosystem functions and services need to be maintained post-disturbance. Not surprisingly the list was similar to the one generated in the first roundtable (see page 5). There was a focus on resources often at risk post-fire: protecting soil came up in 85% of the table discussions and watershed functions in 70%.

How successful are management practices that attempt to rebuild resilience or critical ecosystem functions following large disturbances?

Next, the tables delved into the success of attempts to rebuild resilience or critical ecosystem function after large disturbances. Some took a very pessimistic view ("nothing is working") while others highlighted specific measures that are helping ecosystems recover from significant disturbances. Others focused on successes such as

- Soil burn severity mapping,
- Sensitive area mapping,
- Culverts to divert water from human-values,
- Property protection, and
- Hazard tree removal.

At some level, the success or failure of an intervention is determined by nature; the timing and amounts of precipitation can be the determining factor in the success of BEAR treatments. Even defining what should be considered a successful intervention after fire is difficult. Participants mentioned that success should be defined by scale, thresholds, or tipping points.

The conversation about failures to rebuild resilience after fire highlighted that many practices have a double edge and can cause additional problems. For example, although some felt post-fire thinning or salvage harvests can help reduce fuel loads and bolster local economies, participants also discussed the potential to remove habitat, damage soils, and generate negative reactions from the public. While participants saw BAER treatments as successful in achieving short term goals, BAER implementation with untrained staff or staff with poorly suited expertise is not successful. Other problems can arise because putting fire crews on BAER project is often seen as punishment. Some felt planting trees was successful at least in revegetating areas, if not for erosion control. Others pointed to specific failures with replanting corkbark fir and Engelmann spruce.

Perhaps the most controversial post-fire intervention was seeding. Some felt seeding was not effective ecologically, but was useful in demonstrating to the public that something was being done. Many of the arguments about seeding are familiar (e.g., Foltz et al. 2009, Peppin et al. 2010). Participants were concerned that seeding:

- Spread invasive plants,
- Was expensive (particularly hydro-seeding),
- Lacked a sufficient seed bank,
- Impeded native plant re-establishment, and
- Was ineffective because of high intensity rains common in the southwest.

Perceptions of mulching and mastication were similar to perceptions of seeding.

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Participant concerns looked beyond the utility of specific practices, to the larger policy environment. A key issue is the lack of a long-term focus on rebuilding resiliency. The chief mechanism for implementing post fire projects is BAER, which, by definition, has short term goals. Since the chief mechanism for post-fire recovery is short term, funding and vision for long-term rehabilitation is lacking. Participants highlighted some implications of this short-term bias. There is a lack of monitoring and analysis of intervention effectiveness. Practices tend to be based on a hoped for climate not realistic predictions for future climate.

What are suggested post-fire management practices/strategies to improve post-disturbance outcomes and resiliency?

Some practices participants suggestions included:
- Start planting with species that are from downslope or slightly warmer climate but that are still native to the general area,
- Conduct salvage harvests to reduce fuels but leave pockets for wildlife habitat,
- Prioritize areas for re-seeding,
- Plan reforestation to re-introduce seed, not to re-introduce stands,
- Utilize the opportunity to observe and learn from the naked landscape: arch sites, springs, landscape features, and
- Use dedicated, more specialized crews to perform work intended to support resiliency (conservation crew, fuels crew) as opposed to simply using on scene suppression crews for recovery work.

Since the core of many concerns about post-fire practices were in the policy and planning realm, many of the preferred strategies to improve post-disturbance resiliency also focused on this larger context. Participants made a strong call for better planning to guide post-fire response even before the fire starts. This pre-planning for the post fire environment could include risk analyses, reforestation, and anticipating a changing climate. Another planning element suggested is development of a fast track situation to get through NEPA for areas of high concern or to allow the regulatory exemptions in place during incident to carrier over to post-fire activities.

Since funding was identified as a limitation for rehabilitation, participants suggested new approaches to funding which included:
- increase funding and staffing,
- create long-term funding mechanisms,
- couple funding for post-fire rehab with fire suppression costs,
- find partners,
- build agency 'rainy-day' funds for emergencies,
- determine more cost-effective measures,
- seek out investors and philanthropists,
- partner with non-governmental organizations and non-profits.

Much of the strategizing aimed at moving to a more long-term incident management response, which includes post-fire. Part of the long-term strategy should include monitoring and evaluations. For example, participants felt inserting climate experiments and hydrological modeling into landscape analysis and NEPA alternatives would be useful. Participants also

called for further review of both post-fire evaluation of previous management as well as the long-term effectiveness of BAER and other post-fire treatments. Other topics that participants flagged as needing more study are how soon grazing and public travel should be allowed after a fire.

Communication, both within agency and with the public, was the third strategic theme that emerged. Participants called for cohesive inter-agency coordination, working beyond federal lands post-fire, engaging specialists when necessary, sharing across more boundaries, and making databases accessible by having directories to help route people to the right data. Improving communication with the public would include outreach and education to engage the affected community.

One discussion table framed the long-term goal well by calling for the creation of heterogeneous and resilient landscapes by using post-fire burn severity mosaics. This would include leaving unburned "mosaic" patches on landscape to foster heterogeneity and biodiversity and in some burned areas doing nothing. Other participants emphasized the need to allow time for nature to run its course in order to effectively target restoration efforts. This would be a shift to thinking about using the post-fire landscape to get ready for the next fire or other disturbance (e.g., beetle outbreaks). The long-term resilience goal may require a change to the definition of success and a shift in public perception of healthy ecosystems.

Accelerating the Development of Fire Adapted Communities (roundtable 5)

Who needs to be involved in creating fire adapted communities and how?

The result was a long list that demonstrates how inclusive fire adapted communities need to be:
- Local leaders who can unify, keep things focused, and build consensus;
- Homeowners can be ready set go, create defensible space, develop an acceptance of living with fire, tolerance of smoke, and lower their expectations for full suppression;
- Youth can educate their parents and changing the status quo;
- Visitors and tourists can learn about fire adapted ecosystems and acclimate to smoke;
- Realtors can support fire wise activities and communicating risks to buyers;
- Homeowners' associations can set policies and exert influence;
- Large landowners can allow fire people onto their land to do the work and conduct burning on their own land;
- Local businesses can provide funding and influence decision makers;
- Chamber of Commerce can foster support for a fire-adapted community by articulating threats in the context of local economics, including effects on tourism;
- Forest products industry can develop ways to utilize small diameter material;
- Fire departments, especially local, can provide inspections, tours, and a reality checks;
- Insurance companies can provide financial incentives for taking proactive measures;
- Universities and schools provide information and transfer knowledge;
- Extension agent can be liaisons because they are seen as trustworthy;
- Nonprofits and interest groups can share info with their constituents;
- Fire safe councils can build support for fire and sway public opinion;
- Tribes can provide local knowledge on caring for the land;
- Media can help educate, set agendas, and influence opinions;
- Local government can create building ordinances, codes, and zoning rule; they can help get people involved in the process through field trips and meetings;
- Municipal water suppliers can fund upstream management of watersheds;
- Utilities can identify and reduce infrastructure at risk;
- State government can provide funding and oversight;
- Federal land management agencies can treat areas contiguous to communities and share science;
- Public information officers can share information during or right after an event;
- A number of government agencies (e.g., NRCS, US and State forest services) can make grants to homeowners for thinning; and
- Federal legislators can provide incentives for fire protection like they do for renewable energy.

How can we encourage better communication and sustained engagement amongst all these stakeholders, before, during, and after fires?

The next task for participants was to discuss how to encourage communication and engagement amongst all these stakeholders. Participants recommended that communication be transparent,

direct, and respectful at all times. All opinions should be heard and no one excluded from the discussion. Participants emphasized that face-to-face communication is paramount. Assessments of individual house risk can be a good opportunity for face-to-face discussions of threats and personal responsibility. Outreach needs to be sensitive to real impacts on people. For example, air quality concerns should be taken seriously and the risk to vulnerable populations honestly acknowledged.

Getting over preconceived notions and biases is a good step towards finding common ground. Developing or updating a community wildfire protection plan (CWPP) can spark dialogue and conversation between and across groups. On-going communication is important, so even after the CWPP is completed or other goal is met, regular meetings, even if infrequent, should continue. Where possible, having someone who is paid to keep the momentum going is a big help. This individual can be an agency / community liaison or be in a position shared between two organizations.

To share information, participants recommended using the communities' pre-existing social networks. In fact, a lot of successful community changes depend on one local champion, one personality. Homeowners' associations and other organized groups can be a great way to reach many people at once through a trusted intermediary. People often implement actions on their own property due to what their neighbors have done. Participants suggested tailoring the message to the local community's concerns, while also making sure the message is consistent and comes from multiple, varied sources.

Participants suggested establishing relationships before doing any pre-fire treatments. This can happen by identifying a core group of key leaders who are committed to meet and work regularly. Pre-fire relationships should include the media. Other strategies include:
- Hold local field trips to show impacts of treatments including prescribed fire and how systems recover;
- Use visual aids such as Google earth maps or sandbox fire simulators;
- Share real life success stories;
- Use social media and other new technology to share information and images;
- Get information on watersheds and fire via utility water bills;
- Post information on recreation trails;
- Get involved in local conservation or discovery day events;
- Have local firefighters explain exactly what they can and can't do during a fire event;
- Provide opportunities for researchers to directly convey their findings to the public; and
- Make fire science part of the school science curriculum.

Large fires are an opportunity to get the message out, so there should be a communications plan in place to take advantage of the teachable moment. During a wildfire event or prescribed fire, pictures and detailed communication can help build support. In sum, participants urged for constant, consistent communication via a wide variety of media to share information on fire and resilience. Partnering with public information staff would minimize duplication of efforts and ensure consistent communication.

Strategy Development (roundtable 6)

Roundtable 6 discussions were set up differently from earlier roundtables: participants could choose which roundtables to attend. The topics were drawn from earlier discussions and meant to focus on implementable solutions. The roundtables at which each topic came up are listed in parentheses. Note that most roundtables discussed multiple strategies.

Seeding and Planting (Table A)

Participants advocated for seeding in certain circumstances and for more thoughtful application of grass seed. They called for local cost-benefit analyses prior to any seeding, particularly broad-scale aerial seeding. Participants also recommended development of programs to research and grow the most appropriate seed for areas where seeding or grass planting is deemed the most appropriate post-fire management action. Participants called for additional research, such as common garden experiments, in the Southwest to help managers understand if they should plant at higher elevations because of climate change.

Monitoring (Tables A, B, C and G)

Participants felt that monitoring was not a high enough priority in the planning or implementation of post-fire projects. Without 'real-time' data on post-fire ecological response it becomes difficult to make evidence based management decisions. Monitoring of any kind is seriously lacking in most forests, mainly due to monitoring being viewed a low priority and the first thing cut when budgets shrink. Their suggestions included:

- Incorporate monitoring into individual forest plans (in cases where it is not already included);
- Engage scientists and managers to establish appropriate monitoring protocols and strategies that can provide feedback on management actions and identify other potential ecological trends;
- Develop both short- and long-term protocols and work to capture trends at multiple scales;
- Develop monitoring protocols that are simple enough to teach volunteers and use volunteer labor to complete some of the post-fire monitoring;
- Design monitoring specifically to address barriers, to show agencies/funders the effectiveness;
- Create one directory that will route people through all the data sources;
- Share data, including analyzed data that might not be considered "science" or publishable;
- Incorporate remote sensing to multiply the effectiveness of monitoring;
- Use existing, monumented ecological monitoring plots already established in forests, most with long-term baseline data; and
- Change the culture to be more supportive of monitoring/maintenance and to appreciate its value.

One group of participants highlighted the power of robust monitoring and rapid feedback to inspire confidence; the confidence needed to increase treatment size and move forward in the face of uncertainty.

NEPA (Table B)

Participants highlighted that NEPA does not fit well with hypothetical situations, or pre-planning in general for events that have not occurred because of its site-specific nature. However,

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participants pointed to a potential to include some of the more general post-fire management actions into more landscape scale or programmatic plans. Participants had a strong perception of inefficiency with the planning process using current NEPA guidelines and they had several suggestions on how to improve the efficiency and outcomes of post-fire management plans:

- Increase pre-fire coordination between the federal government and local, state, and tribal governments;
- Incorporate local knowledge into post-fire actions, particularly BAER;
- Use pre-fire planning to help make decisions based on vegetation, climate, biophysical setting, fire severity, etc. for post-fire treatments; and
- Engage research to help solve post fire-response (e.g., a symposia about post-fire response involving agencies and scientists).

Risk: perceptions, personnel, liability, and leadership (Table C)
In this final roundtable participants discussed risk: perceptions of risk, legal ramifications, and personnel issues. Participants identified that there are perceptions about constraints such as species recovery plans that may not be real constraints. In other words, managers perceive activities such as thinning or fire use as risky because of misperceptions about rules and requirements. In these cases, collaboration and communication can help dispel misperceptions, and increase area treated. Participants suggested that improving trust between agencies, stakeholders, and resource managers would also reduce the misperceptions of risk.

In other cases, managers face real risks when taking actions to improve long term resilience and, at the same time, no action carries little personal risk. Participants called for leaders to be stronger and for incentives to encourage well thought out risk-taking to benefit long term resilience. For example, there should be incentives for managers to take advantage of large-scale fires rather than react to them in fear, with full suppression.

Many of the risks have a legal element. Participants called for agencies to stand behind their people, and provide immediate support if something goes wrong. This support should be coupled with education programs about legal issues, litigation, and personal liability insurance.

A related issue that participants highlighted was the challenge of experienced, skilled people leaving or retiring. This is particularly difficult when replacements are not as effective. To counter act this problem, participants suggested:

- Make more opportunities for advancement locally so skilled people don't move away;
- Import people with needed knowledge;
- Visit other regions and bring back knowledge gained there; and
- Fire people who are not meeting performance standards.

Use fire to increase resiliency at ecologically meaningful scales (Table D)
While participants recognized the importance of expanding the scale at which fire is used or managed, there were no easy answers. Participants did note that managers should accept large fires, and even start to depend on them as a treatment. A related idea was to start valuing treatments in other terms, such as their resiliency benefits. Participants called for coordinated *actions* via pooled resources not just coordination meetings. Non-governmental organizations

such as The Nature Conservancy were mentioned as an important part of this active coordination. Many of the strategies from this roundtable mirrored those from other tables such as increasing collaboration across disciplines.

Spatial fire management plans, WFDSS, and teams / resource advisor communication (Table E)

During this roundtable, participants discussed spatial fire management plans and WFDSS. Both of these tools house pre-fire planning information and data. Participants mentioned that spatial management plans improve communication during an emerging incident and bring all the relevant data together in one place. However, these plans are limited by data layer quality concerns, person power required to build them, the difficulty of matching data across jurisdictional lines, and worry about access to sensitive cultural or endangered species information. Participants suggested that in many cases operations teams only need generalized data such as where not to use retardant or where to access water. More generally, the participants' recommendation was to provide more information and meta-data in spatial management plans to make them more useful.

Many of the challenges participants identified around WFDSS were related to getting more people to use it. Participants mentioned additional training, particularly for local resources, and making it easier to use for decision makers. Because of WFDSS's rapid pace of change it can be difficult to keep up with. One solution suggested was to have a coordinator who works with decision makers on pulling the necessary information from WFDSS for them to make educated decisions.

The other topic this table discussed was integrating resource management concerns with suppression teams. Participants quickly identified that there are often communication problems between teams and resources advisors (READs). These problems can crop up if fire suppression leadership do not appear interested in taking input from local resource advisors. In other cases, READs may not understand suppression operations. Some potential strategic solutions participants identified include:
- Conduct better team self-evaluation after an event;
- Make a resource advisor an official title on a team with Incident Qualification and Certification System (ICQS) qualifications;
- Increase rapport between suppression technicians and ecologists, including preseason fire meetings;
- Create a "planning and communication resource advisor" who can translate between the local knowledge and the operations/planning; and
- Incorporate fire ecology into firefighter training early

More generally, participants called for a shift to a new paradigm where resource objectives drive fire management. Encouragingly, some participants felt this was already beginning to happen.

Fire Operations (Table G)

The strategies discussed at the fire operations table echoed issued raised throughout the conference. For example, participants discussed the need to increase public acceptance of smoke. In the context of fire operations, community tolerance for smoke is related to allowing

suppression teams more time. Participants said that suppression teams are willing to be patient but not sure they are allowed to be patient. Another pressure to move quickly comes from the budget constraints.

Participants explored the possibilities of improving the interactions between researchers and suppression teams by:
- Getting researchers certified to be on the fire perimeter so they can learn about research needs firsthand, from suppression teams;
- Involving operations people in research project development;
- Encouraging suppression teams to document fire behavior and effects with photos linked to specific locations and times;
- Helping operations people see the benefits of Fuels Treatment Effects Monitoring so it is not just another end of the year burden;
- Incorporating suppression teams who were on a particular fire into a BAER team for that same area; and
- Conducting ecological after-action reviews.

Sharing fire knowledge with the public (Table H)
During this roundtable participants focused in on the need to bring science-based information to the public about fire. They suggested involving public officials in presenting the key messages such as:
- Fire is nature's resource recycler;
- Ancient Forests come from wildfires; and
- Fire is beneficial.

Social media can be a good tool for sharing these positive messages if handled professionally. Participants saw social media as a way to expand the public message to embrace wildfire and still be Fire Wise in the WUI. Visuals (photos, maps, and movies) and field tours may help the public better understand the variability of fire. Participants noted the importance of hearing the public's concerns and working directly with landowners when trying to share information on post-fire risks.

Increasing resources for community wildfire preparedness (Table I)
Participants acknowledge that there are no easy answers to increase resources to help communities to prepare for wildfire (see roundtable 5 above). A local champion is crucial for the success of many efforts such as the development of CWPPs. A champion can help build enthusiasm within the community through success stories and create linkages with agencies. Engaging a board group of stakeholders including emergency management, air quality departments, local fire departments, federal agencies, and others, is important for uncovering resources and securing grant funding. Once a wide group of stakeholders is engaged it is important to make sure they stay engaged, and face-to-face meetings are an important tool for maintaining engagement. Participants mentioned that celebrating victories can help keep the momentum and reduce burn out. Similarly, concrete actions, such as chipper days or forest treatments, also help keep communities moving towards wildfire preparedness.

Catalyze community collaborations to support fire-adapted communities (Table J)

Community champions, or 'sparkplugs', were also the first element identified by this group of participants. These champions are able to interact well with the public and know how to engage people. Participants went on to highlight the importance of building trust with the community by:

- Asking questions and understanding people's values;
- Uncovering existing networks in communities;
- Holding meetings in places people are comfortable;
- Using local examples and photos; and
- Providing resources for people to start working on community preparedness.

It is also important to identify possible detractors and get them involved early. Sometimes getting skeptical community members outside to talk about specifics can help diffuse opposition. Participants also highlight the importance of getting people thinking about fire in the same way as other disasters like hurricanes or tornadoes. This may help people understand the inevitability of fire.

Lessons Learned during this workshop – participant feedback

There was an overwhelming level of interest in the topic of resilience. Rather than a proposed workshop with 50, over 180 participants, facilitators, notetakers and speakers attended the workshop. Because of the breadth of the workshop and backgrounds of participants, the SWFSC was pleased by the overall response. Participant evaluations suggest that the workshop tackled the right topics and participants really enjoyed the opportunity to interact and share their experiences.
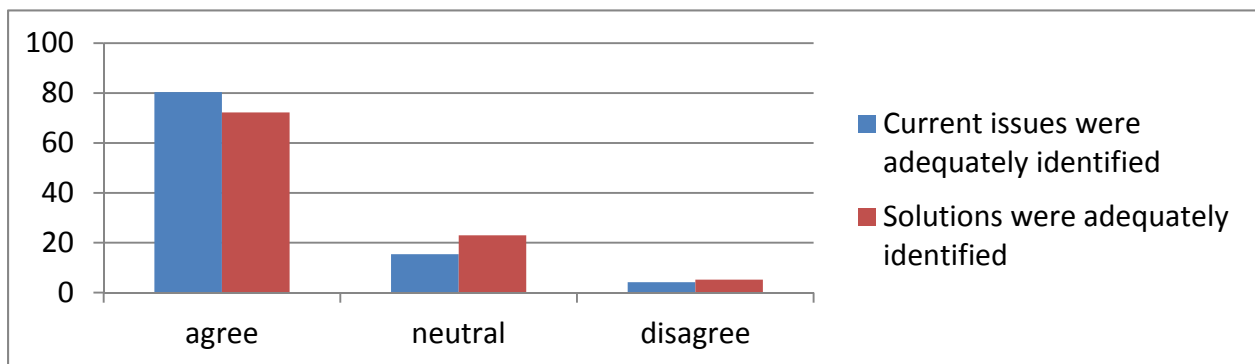
Participant evaluations

The SWFSC invited a diverse audience, so participants came with very different levels of experience in the topical areas. Reframing resilience concepts, i.e., helping managers plan for changes in disturbance regimes and system responses under uncertainty, needs more research. Most attendees found their stride in sharing challenges and potential solutions within current fire management and had a harder time planning for conditions several decades out. Having managers speak about their local success stories was important and gave managers hope that they too could come up with creative solutions.

The SWFSC will integrate some of the workshop's lessons learned into its future work:

- Managers continue to struggle with increasing the pace and scale of fuel management. They support more strategies to advance cross-jurisdictional fuels treatment including Rx fire. They want a landscape approach which may be across jurisdictions or across ecosystems.
- Participants want to integrate suppression activities into our ecological fire objectives. Better training for suppression crews and resource advisors, better use of WFDSS, and other preplanning, clear communication between IC Teams and local resource managers are needed.
- With the expansion and severity of wildfires, the SWFSC wants to address both short and long-term post-fire outcomes. Needs include: more understanding of post-fire ecological trajectories, clarifying the difference between immediate post-fire stabilization and resilience building, and understanding how and where management interventions should take place.
- Managers want to work more effectively with local communities. The workshop introduced many to the concept of <u>social</u> resilience. Managing fire and fuels requires community support. Recent efforts to network communities and help them become truly fire adapted are relevant and useful.

For all themes, solutions lie in improvements in: on-the ground practice, scientific understanding, external policy development, and internal agency policies.

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References

Foltz, R. B., P. R. Robichaud, and H. Rhee. 2009. *A synthesis of post-fire road treatments for BAER teams: methods, treatment effectiveness, and decisionmaking tools for rehabilitation*. RMRS-GTR-228, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Millar, C., N. Stephenson, and S. Stephens. 2007. Climate change and forests of the future: Managing in the face of uncertainty. *Ecological Applications* 17(8):2145–2151.

Peppin, D., P. Z. Fulé, C. H. Sieg, J. L. Beyers, and M. E. Hunter. 2010. Post-wildfire seeding in forests of the western United States: An evidence-based review. *Forest Ecology and Management* 260(5):573-586.

Peterson, D. L., C. I. Millar, L. A. Joyce, M. J. Furniss, J. E. Halofsky, et al. 2011. *Responding to climate change in national forests: a guidebook for developing adaptation options*. PNW-GTR-855, USDA Forest Service, Pacific Northwest Research Station, Portland, OR.

Reynolds, R. T., A. J. S. Meador, J. A. Youtz, T. Nicolet, M. S. Matonis, et al. 2013. *Restoring Composition and Structure in Southwestern Frequent-Fire Forests*. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Meeting Agenda

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Fostering Resilience in Southwestern Ecosystems:
A problem-solving workshop
February 25-27, 2014 - Tucson, Arizona
Radisson Inn & Suites, 6555 E. Speedway Blvd

AGENDA

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Workshop Objectives

- Bring together scientists and natural resource managers to reframe the concept of *resilience* in a time of changing climate and changing fire regimes
- Identify and evaluate current and potential resilience-building practices, including in large burned landscapes, in light of changing circumstances. Identify critical management goals and objectives for improving practice
- Identify and prioritize future research needs
- Collaboratively develop a set of key recommendations and next steps
- Improve natural resource managers' ability to help communities become fire adapted

Day 1 (February 25, 8:00am – 5:30pm)	
8:00am – 8:20	**Welcome and Introductions** – *Andi Thode, Northern Arizona University*
8:20 – 8:45	**How agencies can and need to adapt -** *Gilbert Zepeda, Deputy Regional Forester, Southwest Region*
8:45 – 9:15	**A framework for discussing resilience in the Southwest -** *Don Falk, University of Arizona*
9:15 – 9:45	**Linking science and management** - *Connie Millar, USFS PSW Research Station*
9:45 – 10:00	**Overview of Roundtables**
10:00 – 10:15	**BREAK**
10:15 – 11:15	ROUNDTABLE 1: **Defining Resiliency**
11:15 – 11:30	Sharing back
11:30 – 11:40	Overview of Roundtable 2
11:40 – 12:45	ROUNDTABLE 2: **Building landscape resilience**
12:45 – 1:45	**LUNCH**
1:45 – 2:10	**Wildland Fire Management: Perspectives on national policy, public safety and resource protection and ecosystem resilience** – *Tim Sexton, Wildland Fire Management Research Development & Application Program*
2:10 – 2:20	**Wildfire Suppression and Ecology: Barriers and Successes** – *Clay Templin, Tonto National Forest*
2:30 – 2:40	Overview of Roundtable 3

2:40 – 3:45	ROUNDTABLE 3: **Using Wildfire as a Resiliency Tool: Tactics, Strategies and Communication**
3:45 – 3:50	Overview of Roundtable 4
3:50- 4:10	**BREAK**
4:10 – 5:15	ROUNDTABLE 4: **Post-fire management options for building resiliency**
5:15 – 5:30	**Closing and overview of Day 2 -** *Anne Bradley, The Nature Conservancy*
5:30 – 6:30	**Social Hour** - Cash bar and snacks, Reddington Room

Day 2 (February 26, 8:00am – 4:30pm)	
8:00am – 8:15	**Welcome and introductions** - *Anne Bradley, The Nature Conservancy*
8:15 – 8:45	**Ecological and Social Tipping Points** - *Tom Sisk, Northern Arizona University*
8:45-9:45	**Successful local examples of building resilience** • Flagstaff Bond Measure - *Mark Brehl, Flagstaff Fire Department* • Managing Wildland Fire to Create and Maintain Resilient - *Chris Marks, GRCA* • Fire Adapted Communities - *Alexander Evans, Forest Guild*
9:45 – 9:55	Overview of Roundtable 5
9:55 – 10:10	**BREAK**
10:10-11:40	ROUNDTABLE 5: **Collaborative problem-solving: Accelerating the development of fire adapted communities**
11:40-12:00	Share back – Brief highlights from each group
12:00-1:30	**LUNCH**
1:30-1:45	Overview of Roundtable 6
1:45-3:30	ROUNDTABLE 6: **Strategy development**
3:30-3:45	**BREAK**
3:45-4:15	**How do we prevent being a deer in the headlights? Ideas for future collaborations** - *Andi Thode, Northern Arizona University*
4:15 – 4:30	**Closing comments –** *Anne Bradley, The Nature Conservancy*

Day 3 (February 27, 8:00am – 12:00pm)	
9:00am -12:00pm	Arizona Prescribed Fire Council Meeting- all are welcome
8:00am-10:00am	SWFSC Focus Group - Cholla Room
8:00am – 12:00pm	Workshop publication organization