Notes: Planning for the next big one: managing the post-fire environment in a time of change; April 16-17, 2015

Presentation: The Concept of a Burned Area Learning Network. Anne Bradley, The Nature Conservancy

- Why a Burned Area Learning Network? (1) Fires are becoming larger, and their impacts last for decades; (2) Under a changing climatic regime we may need to change our assumptions and tools; (3) Current policy and funding typically only address the short-term impacts; and (4) Many different organizations and agencies conduct post-fire work making coordination difficult
- A Learning Network relies on people *sharing* what they know and *learning* from others to meet its goals; it provides linkages between people and supports a community of practice.
- This workshop is a kickoff for BANL; workshop objectives: listen and learn from participants with diverse skills and expertise; share both strengths and needs for improvement in our practice; recommendations from the workshop will be used to plan the next steps for the network.
- Anne reviewed questionnaire results re. short- and long-term objectives for burned area response.
  Short Term Objectives: stabilize soils, watersheds, and cultural resources; protect public safety and property; reduce flood potential; give the public the science, techniques, and funding sources they need to understand and recover; and reduce/prepare for impacts on all lands (cross boundary).
  Long Term Objectives: *Plan ahead and act* instead of reacting to fire and floods;
  - *Return areas so they are resilient to future disturbances* including natural fire regimes;
  - *Bring together affected parties in a coordinated effort* to manage before, during and after fire;
  - *Public understands the connection* between ecosystem health and ecosystem services;
  - *Allow natural recovery processes to occur* without impairment from short term treatments;
  - *Learn from large fires* and understand *why* we are undertaking rehab/restoration; are we choosing to restore areas only to protect human interests? Would recovery happen naturally over a longer time scale that humans are not willing to accept?

Presentation: Introduction to Pre-planning for Post-fire Action. Marie Rodriguez, Valles Caldera Preserve

- Cost of BAER is on average 5% of the cost of suppression, although a look a recent fires shows that total rehabilitation costs are 25% to 872% of suppression costs.
- For wildland fire, we have effective tools for cross-jurisdictional fire management such as LANDFIRE and the Wildland Fire Decision Support System (WFDSS) that allow complex planning and analysis to be completed in less than 24 hours and link long-term and short-term ecological goals; in contrast, few resources have been invested in post-fire rehabilitation.
- *Pre-fire Planning for Post-fire Action – Goal: Improve scientific understanding, policy, and management practices for burned areas to enhance long-term resilience of ecological systems and provide for human safety.*
- Pre-fire Planning for Post-fire Action—Objectives:
  - Improve the efficiency and accuracy of short- and long-term post-fire risk assessments for soil loss, flooding, debris flow, sedimentation, invasive species, long-term vegetative change and potential for re-vegetation, and identified values (e.g., human safety, biological, cultural, watershed, economic). *What if agencies provide standards for pre-fire assessments?*

- Improve inter- and intra-agency relationships and develop more cohesive interagency strategies for post fire response during cross-jurisdictional fires. *Should BAER teams/practitioners be involved in pre-suppression planning?*
- Expand the range of immediate post-fire rehabilitation and longer term restoration tools and improve their execution. *Do we consider impacts of BAER tools on long term recovery and restoration costs?*
- Integrate short-term and long-term objectives for burned area management. *Are there examples from land management plans that managers believe have worked well?*
- Engage the public in pre-fire planning for post-fire action. *What tools and resources do we hear communities asking for that don't yet exist? Do we need a team that deals with people and communities the way BAER teams assess soils and re-vegetation?*
- Create an adaptive feedback mechanism to incorporative existing and new information into pre-fire planning and post-fire actions. *How are the findings of recent JFSP-sponsored studies being incorporated into actions? Have there been near misses that need to be brought to people's attention to prevent these incidents in the future?*

Session: Watershed Assessment Tools. Moderators: Lauren Jaramillo & Mark Stone, UNM

Goal of this session is to review existing tools for assessment of burn severity, flooding, geochemistry and ash runoff, and post-fire debris flow hazard/potential. The following presentations will summarize the state of practice, identify needs, and discuss emerging tools that will improve our ability to assess the post-fire environment.

Presentation: Characterizing Burn Severity (Making More Than a Pretty Picture). Andrea Thode, Northern Arizona University

- Landsat Thematic Mapper Imagery (Landsat 5 & 7 with TM & ETM+), 30 m pixel resolution; available from 1984 – present; both have 7 bands of imagery, ETM+ actually has 8, the last band is panchromatic with 15m resolution
- Bands 4 and 7, near infrared (NIR) and middle infrared (MIR) are important for Burn Severity mapping; healthy green vegetation reflects near infrared light strongly; bare ground and soil are dark in the near-infrared, and bare burned areas tend to be relatively bright in the MIR.
- 3 things need to know about a burn severity map: timing of imagery, burn severity method, and classification definition.
- Imagery timing: initial vs. extended assessments. Initial and extended assessments require imagery from different periods before and after fire; the timing significantly affects what the Normalized Burn Ratio (NBR) is measuring. Initial assessments use imagery from after the fire (1-2 months) and compare with imagery taken 12 months before the post-fire imagery; an extended assessment uses imagery from before the fire (1-3 months) and compares this to imagery taken 12 months after the pre-fire imagery.
- Burn Severity Methods: there are 5 methods for determining burn severity; all require pre- and post-burn imagery. The methods include: the Normalized Burn Ratio (dNBR), Relative Normalized Burn Ratio (RdNBR), Relative Burn Ratio (RBR), the Normalized Differenced Vegetation Index (dNDVI) and Relative NDVI (RdNDVI). *Important to know if the method is relativized or not.*
- Large patches of high severity are more consistent between methods, but it's harder to distinguish moderate from high severity, and moderate severity vs. low.

- Field data is taken to determine classification; look at different strata and calculate an average Composite Burn Index (CBI); severity measure (RdNBR) is plotted against CBI to develop classification (high, moderate, low, unchanged); anything above CBI = 2.5 is High Severity.
- Burn severity maps can look quite different depending on what you mapping: soil burn severity, vegetation change, or tree mortality.
- How do we pick one method over the other? RdNBR better when comparing multiple fires as it is on a relative scale; dNBR, RdNBR, dNDVI, and RdNDVI all pretty similar when looking at one fire, except in open vegetation types like pinyon-juniper, where RdNBR and RdNDVI perform better.
- Burned Area Reflectance Category (BARC) supports BAER program, immediate assessment, uses dNBR, focus is on soil burn severity.
- BARC data distributed to BAER teams: BARC4, classified into 4 classes with no field data to support classification; BARC256, unclassified continuous data, provides the basis for soil severity maps, classified using local knowledge and field data.
- Monitoring Trends in Burn Severity (MTBS) maps all fires in the west ≥ 1,000 acres; uses dNBR and RdNBR; focus is on vegetation response. Gives you fire perimeter, continuous value dNBR/RdNBR images (16-bit), five-class burn severity maps classified by technicians using available field data (not always); technicians have professional experience and familiarity with the fire regime/vegetation type. *However, never take this classification to heart.*
- Rapid Assessment of Vegetation Condition after Wildfire (RAVG) maps all fires > 1,000 acres; immediate assessment; uses RdNBR; classified by basal area loss, expressed as % change in basal area or tree cover from the pre-fire condition; basal area loss may not be permanent, just what is measured post-fire; classification is based on plots in CA,
- *Conclusions: know why you want to map, know how it was produced, know how it was classified, and use local knowledge and data to assess its accuracy.*

Questions:
Q. How often does the BAER team make changes to the BARC map? Darryl (BIA): well over 90% of the time, the team is changing the burn severity breaks from the raw output map.

Andi: Don't trust RAVG maps because the burn severity categories are not calibrated for the Southwest.

Burn severity and fire intensity are two different things in the BAER world; fire intensity affects vegetation mortality, burn severity is from the ground surface down.

<u>Presentation:</u> Post-wildfire Flooding with Examples From the Las Conchas Fire and Some Implications for Aquatic Ecosystems. Steve Scissons and Justin Reale, USACE

- Current tools: HEC-hydrological modeling systems, TR-55 and Wildcat models; almost any hydrologic model will give you a flood.
- Large Floods: Start with an existing model or delineate a watershed; apply runoff factors and start manipulating them; apply rainfall amount and run the models for different scenarios.
- Data needs for predicting large floods: topography, soils information, rainfall intensity, burn severity, and estimate of future conditions; the last two are the unknowns. But if 50% or more of the watershed has burned at moderate-high severity, then you *know* there will be large floods.
- Impacts on aquatic systems are episodic, hard to catch; it rains and the impact occurs; large impacts occur in the monsoon season. Large post-fire DO sags propagate 50 km downstream.

- Post fire, the amplitude of the diurnal dissolved oxygen change increases; see spikes in turbidity that correspond temporally with drops in dissolved oxygen, moving nutrients into these systems that are causing increases in respiration.
- *How long do these impacts to water quality persist?* Depends on a number of factors including climate change, watershed resilience, degree of aquatic impacts, whether mass wasting is occurring—see this a lot; and amount of sediment movement. *Where do we put all the sediment? Timescales: 5—100 years? Data collection—what do we do with the water quality data that we collect, and how does it influence management?*

Presentation: Post-fire Geochemistry of Ash and Runoff for the Burned Area Learning Network. Danny Katzman, Los Alamos National Laboratory

- Big uncertainty after Cerro Grande fire of what was going to happen, e.g. runoff, radionuclide concentration and radionuclide mobilization; collected a lot of data, and learned a lot. Had monitoring and sampling methods worked out so could do a better job after the Las Conchas fire.
- Where do fire-related constituents come from? 10 cm of duff is reduced to 2 cm of ash; sharp contact w/ the underlying soil. Organic content (duff) stores radionuclide and metals, duff burns, and concentrates metals/radionuclides in the 2 cm of duff. Sampled radionuclides and metals in ash: cesium, strontium, plutonium as well as barium, calcium, and manganese. Compared background levels to samples collect in Cerro Grande and Vivash fires. Burned areas had elevated radionuclides and metals; the two burned areas had similar concentrations for all radionuclides except plutonium was higher in Cerro Grande and higher than background levels. A comparison with northern Rocky sites showed similar values to Cerro Grande values for cesium and plutonium.
- Normalized post-fire runoff was higher immediately after Cerro Grande fire but returned to pre-fire levels after 3 years; sediment transport persists beyond 3 years. Ash is moved out of the system after about 2 years ash, using cesium and strontium as assays.
- After Cerro Grande put together Interagency Flood Risk Assessment Team; consortium of organizations established to deliver information to the general public and interested organizations on chemical risks related to flooding in the aftermath of the Cerro Grande fire; issued a report; information on slide says ingestion of plants grown in ash-containing sediments may be associated with long-term health risks, but the study found no increase in chronic health concerns related to ash in the environment (and on agricultural crops) and no evidence of bioaccumulation in plants.

Q. Indicated earlier in the talk that you learned from Cerro Grande, resulting in improved outcomes after the Las Conchas fire. Could you expand on this? Danny: After Las Conchas, partners from across the landscape met and we shared results and lessons-learned from Cerro Grande; partners went off and did their separate things, although the Cerro Grande experience helped LANL with a better sampling and data analysis plan.

Presentation: Evaluating Potential Natural Hazard Risks – Identifying Their Potential and Magnitude. Jason Kean, U.S. Geological Survey

- Debris flows are triggered by garden variety storm over recently burned areas; initiate rapidly during high-intensity rainfall; and events progressively entrain sediments from the hill slope, e.g. gullies and rills.

- A suite of tools have been developed for *rapid* assessment of post-fire debris flow hazard; maps identify which drainage basins are most *vulnerable* to debris flows; empirical models predict the probability and magnitude of debris flows; debris flow hazard is a function of basin morphometry, burn severity, soil characteristics, and rainfall intensity.
- Maps and rainfall thresholds for triggering a debris flow event are used by BAER teams, National Weather Service, and other stakeholders for emergency planning and warning.
- *Feedback from stakeholders:* need digital geo-spatial data that can be downloaded by BAER teams and others for planning, not just a paper map; need maps *faster* (days after a fire, not months); and want assessments for more than just a handful of fires every year.
- USGS automated the process, can produce a map and spatial data 1-2 days after they obtain a burn severity map. In addition: use the web infrastructure developed by Earthquake Hazards Program to enhance delivery of map and spatial data. USGS hazard assessments are now a standard and free product of the USGS Landslide Hazards Program. In 2014, completed 18 post-fire assessments—more assessments done in more states than any other year.
- *Future Directions* include: identify and correct weaknesses of current models; verify accuracy of assessments made in new areas—there's been a lot of work done in southern CA, but not much in the Southwest; and develop new models if necessary. Also want to expand "library" of rainfall thresholds—same data collected for model verification can be used to develop rainfall thresholds for debris flows.

Questions:
Q. What about teaching BAER teams to run the models. Answer: BAER teams can get debris flow hazard output in 1-2 days, so not much need to teach BAER teams to run models.

Q. Does local knowledge provide better inputs and result in improved maps? Answer: USGS just provides the modeled results, no interpretation, that's the BAER team's responsibility.

Q. What factors could local knowledge provide input on? Answer: models are unable to answer the question: if we put a treatment here what is the reduction in debris flow probability or volume? However, Anne Tillery and colleagues modeled fire behavior (pre-fire) and then looking at differential debris flow risk (probability and volume). This approach can be used in pre-fire planning to place fuel treatments or to think about post-fire mitigation priority.

Q. Is USGS attempting to calibrate the debris flow models? How well do model predict debris flows after particular rainfall events? Answer: Yes, this is a priority for USGS. USGS effort is primarily focused on debris flows which are different than floods; a debris flow pulse can be embedded in a longer flood pulse.

Q. Are you looking for sites to test physical models? Answer: Yes.

Group Discussion: the following three questions (in bold) were posed by the section presenters for discussion.

Q. Is there an identifiable threshold point that marks the transition of a watershed from a more chaotic post-wildfire hydrologic condition to a more organized, dynamic hydrologic system where long-term planning is feasible? Does fire severity assessment provide a reliable key to when this threshold might be crossed?

Q. to presenters: What key processes determine the sediment balance? Do you track these thresholds before you begin mitigation actions? Answer: In order to determine whether sediment dynamics in a

particular system are approaching a more stable state or pre-fire conditions, you would have to have pre-fire data on sediment dynamics in channel.

Andi (NAU): Sedimentation effects that you see downstream are the result of post-fire vegetation dynamics and thresholds on the slope (upstream) where sediments are coming from. To better understand sediment balance thresholds, you can look for vegetation thresholds upslope, because this is where the sediment is coming from and why it's moving.

Q. Does crossing that stability threshold mean that it is now time to begin mitigation actions? If the threshold is not reached for decades, where does that leave managers? Is there a sequence of actions to be taken during unstable states and different ones during stable states?

Zander (Forest Guild): I'm struggling with the idea of a threshold because it assumes that there's a single event and then a trajectory to recovery. Consider vegetation recovery, vegetation can recover post-fire and then, after a number of years, there is a fire-risk situation and perhaps another fire. So instead of a single event you have a series of events, each resulting in change—thresholds are not evident, there is continual change, and new states are emerging.

Participant: Stability is misleading concept, change is likely, for example, some stream systems will aggrade, and others will down-cut. We should consider throwing out the word stability, we probably won't see stability in our lifetimes and we're going to have something new.

Participant: Huge issue with the word threshold, there is a range of different thresholds depending on who is the stakeholder, end-user or audience; the reservoir manager has a different threshold than a community living downstream of a burned watershed. We do not have a common set of issues and thresholds.

Bob Parmenter: can look at the "stability threshold" in a probabilistic way; can look at the distribution of weather events, and can assign probabilities of another future event of specific magnitude, and then ask, given the observed vegetation regrowth, what is the predicted response of a specific rainfall event on soil erosion. A threshold for action may be a 70% probability that subsequent storms will not result in sediment movement. Given this threshold, can select places on the landscape that will have a lower probability of not being affected by subsequent storms, floods, and soil movement and target these areas for restoration actions. Can look at look at this question of identifying where managers can put resources to achieve the best outcomes as a Markovian process.

Q. As timescales of post-fire hydrology and climate change converge, will an identifiable threshold continue to exist?

Craig (USGS): Challenge is that, as humans, we get used to what we've seen, e.g., forested watersheds. With the 10x increase in density of trees, vegetation-hydrology-disturbance relationships have changed over the last century. We are experiencing more extreme fires and post-fire floods, affecting communities in different ways than it has for a long, long time. We have a lot of infrastructure in places that it shouldn't be, making us more vulnerable to changed conditions.

We also have a frame of reference based on our past experience of what merits treatment.

Participant: Should have a social scientist represented on BAER teams—how fast do people adjust to changed conditions and what are the social components that affect a change in attitudes or behavior. Are there social thresholds regarding what people expect from post-fire mitigation? Lots of BAER funds

were invested after the Cerro Grande fire, but these actions did absolutely nothing in terms of getting people out of the canyons or developing measures to protect infrastructure.

Phoebe (Cochiti Pueblo): Watching the Las Conchas fire migrate north, areas that burned in Cerro Grande re-burned in the Las Conchas fire, but the fire stopped at the Lab in response to fuel treatments implemented there after the Cerro Grande fire.

Tamara (Massong Group): Responding to the expectations of the public is what is driving a lot of the post-fire response. How do you tell Santa Clara pueblo that they will never get their forest back? This is what the community wants, resources will be spent, but the will the restoration efforts be successful? Approximately $7M is needed to protect the community from post-fire flooding; keep moving the discussion up the political ladder because the community is not going to get a functioning watershed back.

Panel Discussion: Improving Inter- and Intra-Agency Relationships. Panelists: Anna Jaramillo, USFS; Marie Rodriguez, VCP; Penny Luehring, USFS; Darryl Martinez, BIA-DOI, Dave Repass, BLM; and Steve Scissons (USACE). Moderator: Jeremy Kreuger, BLM-NM.

Penny Luehring (USFS) presented a brief overview of **post-fire rehabilitation activities including the BAER Program** on federal lands.

- She distributed a table/matrix of 4 types of fire recovery activities that are common to all USDA/DOI programs. These programs are suppression activity damage repair, emergency stabilization (BAER), rehabilitation (BAR), and restoration. Each program has different objectives, timelines, responsibilities, and funding sources, e.g., different programs are paid for out of different pots of federal money.
- **BAER Program** identifies *imminent* post-wildfire threats to human life and safety, property and critical natural or cultural resources and takes *immediate actions to manage unacceptable risks*. Actions taken are immediate, preventative, effective and minimal (e.g., the minimum needed to manage risks); they are implemented within the first year post-fire. Funding comes from the same pot of money as suppression operations.
- BAER Program is all about values, threats and resultant risks: critical BAER values are identified, they are assessed for threats; risk is determined, and a treatment strategy and prescription is developed. Probability of damage or loss w/in 1-2 years and the magnitude of consequences that would result from loss are considered and only those values that rank as high or very high will warrant BAER attention.

Dave Repass (BLM) provided a brief overview of the **Burned Area Rehabilitation (BAR) Program**; the program targets lands that are unlikely to recover on their own. The 3-year cycle is tied to federal budget cycle, since they are doing budgets 3 years ahead. BLM deals more with post-fire invasive species issues than floods and sediments coming off of burned areas.

- Suggested taking a look at and commenting on planning documents that will result from Secretary Jewell's Executive Order 3336, Rangeland Fire Prevention, Management, and Restoration. http://www.forestsandrangelands.gov/rangeland/index.shtml

Kris Graham Chavez (NRCS) provided a brief overview of the **Emergency Watershed Protection (EWP) Program**

- Emergency Watershed Protection (EWP) program is one of many NRCS assistance programs. EWP provides technical and financial assistance to resolve imminent hazards to life and property

caused by floods, fires, and other natural disasters. All EWP work must be sound and defensible economically, environmentally, and from an engineering standpoint (technically).

- Following a case-by-case assessment of the work needed, EWP funds may be used to remove debris from stream channels; stabilize road culverts and bridges if life or property is threatened; reshape and protect eroded banks; correct damaged drainage facilities; stabilize levees and structures; re-vegetate damaged areas; and purchase floodplain easements on lands subject to frequent flooding. *The goal is to restore the area to pre-disaster conditions.*
- NRCS' first task is to assess the damage to the watershed including threat of flooding, burn severity and condition of vegetation cover, the watershed's capacity to generate large volumes of water (slope, climate), and soil permeability and depth.
- EWP work must be sponsored by a public agency of the state, tribal, county, or city government or a conservation district; public and private landowners are eligible for assistance providing the proposed work is part of the sponsor's project. NRCS can typically pay up to 75 % of construction costs of eligible emergency treatments; the remaining 25% must come from local sources in the form of cash or in-kind services. Up to 90% cost share is allowed in "limited resource" counties.

Anna Jaramillo (USFS Region 3) gave a brief overview on **Forming a Local BAER Team**.

- BAER personnel are identified before fire season and attend a pre-season meeting to identify additional resource needs and make local contacts. Forest Service Policy Requires a BAER assessment on fires that are > 500 acres or on smaller fires if threats are likely.
- Agency Administrator coordinates between IMT and BAER team; BAER Team Leader communicates with federal, state, county, and local emergency response agencies; Team determines if emergency exists and reviews treatment alternatives. Team Leader recommends treatments to Agency Administrator.
- As an example of the time constraints that BAER teams work under, Anna presented a hypothetical time line for post-fire assessment and action.
  - Fire starts on June 1 and burns for 9 days;
  - Assessment team starts five days after fire starts (June 5)
  - Implementation needs to be completed before first damaging storm; first damaging storm is expected on July 10; implementation of recommended treatments is assumed to take 10 days, could be shorter or longer; must begin treatments by July 1;
  - Contracting Process is assumed to take 10 days (includes preparation of contract documents, advertising, and awarding); could be shorter or longer.
  - WO review and approval can be up to 3 business days; RO review and approval can be up to 3 business days; total contracting and review period is approx. 16 days.
  - Fire is contained on June 8 (burns for 9 days); *this gives the assessment team 10 days to complete their work if they want treatments implemented before the first damaging storm.*
  - Take-home message: the timeline is extremely tight and the time for assessment and determining treatments is short.
- The benefits of having a local BAER Team include: (1) familiar with the local landscape, resources and know the critical values at risk; (2) have local contacts with communities and partners; and (3) "ownership" in implementation and monitoring. But the challenges can be great—fatigue, compressed timeline, complexity, and "it's in their backyard".

Darryl Martinez (BIA) gave a brief overview of the **BAER Program on Tribal Lands**.

- In contrast to the past, now BIA doesn't wait for certain criteria to be met in order to mobilize their National BAER Team; instead, scale up the National Team's involvement with increasing local need; additional staff and expertise augment the local team; over 60 BAER experts are spread across the country and are available to assist local teams.

Steven Scissons (USACE) gave a brief overview of the **NM Silver Jackets Program**.

- NM Silver Jackets are part of the National Silver Jackets Program, http://silverjackets.nfrmp.us Signatories for the NM Team are NM Department of Homeland Security and Emergency Management, USACE Albuquerque District, and FEMA Region VI. Other participating federal and state agencies include National Park Service, US Forest Service, NM State University, Earth Data Analysis Center (UNM), USGS, National Weather Service, Bureau of Indian Affairs, NM State Forestry, and NM Floodplain Managers Association.
- The Silver Jackets are state-led interagency teams that provide networking opportunities and facilitate collaborative work among federal and state agencies involved in flood risk and floodplain management. These interagency teams leverage resources to address flood risk as cost-effectively as possible.
- NM Silver Jackets first project was the installation of a rain gage network in the Las Conchas burn area; the project involved coordination with 14 agencies, 2 Pueblos (Cochiti and Santa Clara). The rain gage network served Peralta, Peralta/Bland, Cochiti Mesa, Cochiti/Capulin, Santa Clara/Valles Caldera; the network transmits near real-time rain gage and pressure transducer stage data via satellite; information is available to authorized users via a browser and web-enabled devices.
- Current project is: Afterwildfire-a guide for NM communities, http://afterwildfirenm.org/; the project team is led by NM State Forestry and involves multiple agencies. Phase I is complete; Phase II is underway and will involve website updates, a pamphlet, and infographics.

Questions for the Panel:

Q. Are BAER Teams asked for things that you can't deliver? If so what are these? Answer: BAER teams can't work off of federal lands but can enter into an agreement and do a treatment on private land if the upstream threat on federal land will impact downstream land owners. Have 10 days to 2 weeks to conduct their assessments, so can't use the whole tool box of potential assessment tools in planning mitigation actions.

Q. BAER teams are under pressure to do something and some things just don't work or their effects are limited. How do teams address this issue? Answer: BAER teams must assess whether the threats and values are significant enough to raise the issue to first response; focus on asking the question what are the values at risk and then design a solution; in designing a solution, BAER policy requires an analysis of potential actions that can be taken and how effective these actions have been in the past. For example, they take into consideration studies on treatment effectiveness by Pete Fulé and Peter Robichaud and teams won't implement treatments that have shaky outcomes.

Marie: the timeline is so tight, there's almost not enough time for BAER teams to do anything effective, e.g., seeding may help, but seeds won't germinate before the monsoon rains arrive; our ability to be effective is limited but everyone is watching. Anna: if treatments are deemed ineffective, BAER teams won't implement them.

The timeline to act is very different between federal agencies and the NRCS. EWP are discretionary funds, and NRCS doesn't get money as quickly as other federal agencies. To have NRCS walk into a post-fire meeting with actual funds would be huge.

Q. What does it take to change federal policy? Answer: need to elevate policy issues to the Cabinet/Secretary level; getting USFS and NRCS funding lined up should be easier. Commenting on Secretarial Order and/or working with the congressional delegation are good ways to affect policy changes.

Q. Why don't we put a hydrologist on the Incidence Command Team? This expertise is a post-fire risk component that is missing on the ICT and in WFDSS decision making. Penny has proposed this in the past, but the discussion didn't go as far as needed to affect a change; she is willing to re-initiate this discussion because it's an important component of WFDSS decision-making.

Q. How soon can BAER treatments be implemented? Darryl: that depends on the fire; before BAER plan was done for Las Conchas, they were already placing treatments to protect Cochiti Pueblo.

Break-Out Group Discussion. Participants divided themselves up into small groups to address the following two questions:

- *How can BAER teams engage communities? And what can be done before the fire?*
- *How can pre-fire planning assist with post-fire recovery actions with regards to the role of BAER program?*

Ideas from the break-out groups were posted on the sheets around the room; each sheet was devoted to a specific objective of pre-fire planning for post-fire action that Marie Rodriguez described in her presentation.

<u>Case Study Presentation:</u> Las Conchas Fire Case Study and Discussion—Interagency Coordination and Lessons Learned from a Community Perspective. Phoebe Suina, Cochiti Pueblo; Tamara Massong, The Massong Group

Pueblo de Cochiti Las Conchas Fire and Post-Fire Response, Phoebe Suina

- Las Conchas burned 17,600 acres or 60% of the Peralta watershed (29,000 ac.) fire also burned in Cochiti and Bland Canyons and affected roads, people and cultural sites in these two watersheds. Pueblo had a number of challenges, including analytical and data issues, following Las Conchas: (1) the upper Peralta Canyon watershed was beyond their jurisdictional boundary but this land is an important ancestral/cultural area; (2) there was a lack of historical precipitation and flow data for all 3 watersheds and a lack of precipitation and flow measurement tools; and (3) burn severity maps were developed before the fire was out in Peralta watershed.
- To address these challenges, the Pueblo and collaborating federal and state agencies used anecdotal information and knowledge from the community to assess precipitation events and predict flow volume and response time. In addition, they installed T-post flood gages, made on-the-ground flow measurements and post-flood flow estimates, and used Nexrad data.
- Flood estimates in Peralta Canyon 2011: in the *initial* BAER report (e.g., the burn severity map completed before fire was out) flows of approximately 1,000 cubic feet per second were estimated for a 10-year precipitation event. In fact, six flood events > 1,000 cfs in Peralta

occurred with 0.75 inches or more of rainfall in 6 hours and a ~5, 000 cfs flood occurred after 1.5 inches of rainfall over 6 hours.

- Pueblo used a watershed approach to flood mitigation based upon the experience of post-fire erosion and flood mitigation efforts at LANL after Cerro Grande fire; minimal funding (approx. $200,000) was available from the tribe. Berms and levees were constructed on Cochiti Pueblo Reservation above the housing area that directed flows to southern part of the floodplain and reduced pinch points in the system. Pueblo governors brought an impressive number of federal, state, and local entities to the table in 2011 and 2012 to collaborate on post-fire flood mitigation measures. Funds from the collaboration were used to reinforce and reconfigure berms; re-establish capacity behind berms by removing over 30,000 cubic yards of sediment and debris; repair Highway 85 crossing area using gabions and removal of sediment and debris; remove culverts at Highway 85; and remove sediment and debris from channel.
- Flooding in September 2013 (est. 9,290 cfs) caused further damage but the berms and levees held. Phoebe presented an amazing graphic showing modeled impact of flood inundation with and without berms and levees on Cochiti Pueblo.
- Was the effort a success? On the plus, side no lives were lost in post-fire flooding, collaborative relationships were improved, and damages were minimized during the Disaster Period associated with DR 4197 as a result of mitigation funding sources. On the negative side, cultural and ancestral areas are still impacted, post-fire flooding is still a threat, and over $3 million of infrastructure and road damages remain with no funding source to repair the damage.

FEMA—National Disaster Recovery Framework, Santa Clara Pueblo Implementation. Tamara Massong

- National Disaster Recovery Framework (NDRF) provides recovery support to states, tribes, territorial and local jurisdictions; it is a collection or team of interagency partners working together with affected communities to develop recovery goals, objectives, strategies, and partnerships. Program provides technical support in developing the recovery framework and the team focuses on how best to restore, re-develop and revitalize the health, social, economic, and environmental fabric of the community.
- The team can have six Recovery Support Functions (RSF) each with a designated federal coordinating agency; Santa Clara Pueblo took advantage of the following three support functions: *Community Planning and Capacity Building* (Federal Emergency Management Agency); *Infrastructure Systems* (U.S. Army Corps of Engineers), and *Natural and Cultural Resources* (U.S. Department of Interior).
- The federal team for Santa Clara implementation included: *Federal Disaster Recovery Coordinator*– Nancy Casper (FEMA); *Tribal Disaster Recovery Coordinator*—Regis Chavarria (SCP); *RSF Coordination Manager*—Phil Hoge (FEMA); *Infrastructure Systems RSF Team*—Tamara Massong (USACE), Tomas Gonzales (USDA-NRCS), Viola Sanchez (BOR), Tom Gerhardt (BIA), Pat Schafer (FEMA); *Natural and Cultural Resources RSF Team*—Rubin Montes (USFS), Barbara Judy (NPS), Kevin Jaynes (FEMA); and *Community Planning and Capacity Building Team*—composed of FEMA personnel. These teams developed a Recovery Support Strategy, led by Pueblo and supported and written by the NDRF teams; the Strategy identified a list of recovery activities, the timeframe for activities, and agencies involved in each activity.

Group Discussion:

Tamara: Who else has had an experience like this?

Jeremy (BLM): Our technical specialists worked with Cochiti Pueblo specialists; tough problem to solve but we worked well together.

Phoebe: one owner or manager does not have jurisdiction over the entire watershed. The collaborative effort meant Cochiti could affect more mitigation higher up in watershed on BLM land. In fact, activities high up on BLM land shad a positive impact.

Participant: I am struck by how much money was spent after the fire—$10 million! What if you spent that on upfront management of forests before they burned? That story should be told to communities so they might realize benefits from the better investment.

Phoebe: Yes, but there are very few resources for communities to be proactive before the disaster. It's the disaster that triggers the availability of funds.

Laura (TNC): National Disaster Resilience Competition could provide resources for communities and counties to fill the gaps and needs that federal programs don't meet.

Eliza (NMDF): What advice do you have for communities?

Tamara: Need to have right person from community leading the effort; need someone who has multiple areas of expertise and skills (technical competence, communication skills, trusted in community, knowledge of government agencies at multiple levels, etc.).

Phoebe: Also good to know the language, whether its engineering speak or government acronyms. And prior experience with programs like FEMA, NEPA, the federal procurement process, and knowledge that federal funding comes with strings attached.

Tamara: Need personnel who have TIME. There are so many details, very time consuming, can't be a second job for someone.

Are you publishing this? Phoebe: it's on my to-do list; some of this information can be found in the BIA BAER report and Smoke Signals publication.

Anne: What kind of time lag?

Tamara: In the case of Santa Clara Pueblo, they have been working on the ground since the fire but the damages are getting worse; and gains were undone by the next flood; after the 2013 floods, the Pueblo decided the problem was too big for them to handle on their own. A team formed in spring 2014 and a draft strategy was developed in November 2014. Cochiti path is the better/faster path; good team started work right away, didn't wait for FEMA.

Phoebe: All potential stakeholders in the community or Pueblo need to be on board before you start. With the NDRF process, we worked to build this consensus, not only in the community but also among the federal agencies; problems can develop when agencies or community members have different ideas about what to do.

Presentation: The Importance of Connecting Short and Long Term Outcomes after Fire. Peter Robichaud, Rocky Mountain Research Station

- Summarized results of a number of studies including: (1) a BAER monitoring study—mulching, seeding, etc. (3 yr); (2) long term studies following the Hayman fire (12 yr), School fire (6 yr) and High Park fire (3 yr and ongoing); and (3) salvage logging studies in WA, MT, & CO (3-7 yr).
- Elevated risk of erosion 3 years post-fire, ground cover is increasing but has not reached threshold of 60-70% cover needed to prevent/reduce erosion. When will cover exceed 70%?

May take a while (more than 12 years) until a canopy becomes established. First seven years seeing a lot of sediment coming off burned area; however, haven't produced any sediment in five subsequent years (8-12 yrs post-fire). Grasses responded well in all sites that were seeded; forb cover less on (grass) seeded and wood straw sites, forb cover greater on hydromulch, wheat straw and control; shrubs increased on all sites, except where seeded; wood and wheat mulch produced high canopy cover. Conclusions: straw mulch worked best; hydromulch expensive but didn't work very well; maybe 7 years is what it takes for stable conditions to re-establish.

- *School Fire Results for Salvage Logging (6 yrs.)*
  Effect of Burn Severity—Low/moderate severity plots had greater canopy and species richness than high severity plots; very few nonnative species were found overall
  Effect of Treatments:
  - *Short-Term:* wood straw = agricultural straw > native seeded;
  - *Mulch: Long-term:* wood straw > agricultural straw > seeding > hydromulch;
  - *Mulch:* resulted in higher soil N;
  - *Native Seed:* lower ponderosa pine seedling density; forb and shrub growth hindered.

  Effect of Salvage Logging—Delayed vegetation response about 1-2 years; affects natural regeneration of grasses, forbs, and shrubs.
- *High Park Fire Results for Treatments (3 yrs. so far)*
  - *Mulch* increased soil moisture and promoted seedling establishment in year 2;
  - *Wheat straw* yielded high plant cover initially compared to other mulches and controls but declining in year 2;
  - *Wheat & wood shreds* supports microbial immobilization of soil N, possibly affecting recovering vegetation
- *Salvage Logging (Hayman, Eagle, & Tripod fires)* increases spatial heterogeneity of properties: "slash" increases surface cover and removes burned canopy. Heavy equipment traffic compacts the soil and disturbs understory vegetation and surface cover. Additional variability results from traffic levels, routing, and best management practices. Results: soil compaction due to skidders and feller bunchers; sediment production 10-100 times greater due to skidders; adding slash to skid trails reduces erosion; compaction reduces/delays vegetation regrowth 1-2 yrs.
- *Impact of Prescribed Fire and Wildfires on Soils.* Studied 3 prescribed fires—Bumblebee Fire (Spring), Buckskin II Fire (Summer), and Buckskin I Fire (Fall)—and one wildfire, Bitterroot Valley Fire (Summer).
  - Results: Erodibility (sediment yield) much less from prescribed fires than wildfires; five years after wildfire, erodibility (sediment yield) similar to controls.
  - In addition, looked at impact of fuel treatments (green timber sale) following BMPs on sediment yields, little erosion resulted from treatments implemented w/ BMPs. Transportation system, as part of fuel treatments, is a chronic erosion problem.

Questions:
Pete Fulé: Does leaving fuels in place, instead of salvage logging, increase fire risk? Pete R.: doesn't think this is an issue. Pete Fulé agreed, fuel loads were not high in burned areas in a post-fire study they did.

Mary (NMDF): What if we conduct salvage logging immediately after a burn? Pete: his shouldn't matter, it's all about the skid trails and the impact they have on vegetation recovery, e.g. delayed by 1-2 years. Mary disagreed; she didn't notice big differences in vegetation recovery after salvage logging in Rodeo-Chediski.

Pete R.: now experimenting with wheat straw vs. rice straw; wheat straw moves in a 13 mph wind, rice straw is stickier takes more wind to move it. However, to distribute rice straw you need to chop it up. Is chopped up rice straw less vulnerable to moving by the wind than wheat straw? Providing straw stays on the ground, the performance of wheat and rice straw is similar in facilitating vegetation recovery.

Erosion is reduced when have 60-70% ground cover—reach that target cover quickly when mulch, cover recovers even faster with seeding. However, if you put too much mulch down, this can retard vegetation regeneration and recovery.

USFS is planning to re-burn Rodeo-Chediski, 12 years after fire, to address shrub and tree regeneration issues.

Day 2, April 17th

Recap of Day 1. Marie Rodriguez, VCP

- The morning session was devoted to an introduction to the tools of assessment, followed by a group discussion on thresholds. Here are some high-points from the latter discussion.
- Stability is a slippery slope—the system is always dynamic and never stable, how do we judge when we restoration actions can be effective and not be lost to the next storm?
- There is a need to look at the post-fire environment as a new state with a novel successional trajectory that is outside our current point of reference. This likely incorporates a new disturbance regime. *How to begin that campaign of shifting baselines and paradigms with the public/community stakeholders?*
- Need better tools for estimating the probability of success over time; can use a Markhoff chain process to model/estimate the probability of possible outcomes and alternatives as future events occur, e.g., outcomes and alternatives may narrow in response to future events.
- Using past information for the probability and magnitude of floods, e.g. 20-year, 50-year, 100-year floods, is no longer valid.
- *Goal of BALN: Improve scientific understanding, policy, and management practices for burned areas to enhance long-term resilience of ecological systems and provide for human safety.*
- There were a lot of comments on BANL objectives, all of them legible! Diverse—today use your dots to vote, or comment on each other's comments so the comments reflect a discussion; this will help us identify what the group thinks is most salient and important to address in future workshops.
- Highlights: BAER Decision Support System (BDSS aka Badass); Wnimy (Why not in my back yard)
- Establish a pilot project for pre-fire community engagement; incorporate case studies like Cochiti, Santa Clara, and Raton.
- *Need:* larger, higher severity wildfires translate into larger, more complex workloads for staff; need to increase capacity to respond to the post-fire environment.
- As partners, we work together on fire management issues covering the spectrum from safety and planning, to science, preparedness, operations, strategy development, logistics, intelligence, emergency response, and more. We also collaborate on interagency strategies to manage wildfires, not only for single incidents but as a matter of policy:
  - WDFSS is a powerful decision-making system;
  - Incorporate BAER information into WFDSS, train BAER teams in use of WFDSS.
- There were a number of good suggestions for tools that can be used for pre-fire assessment, let's vote on those and flesh that topic out.

- BAER-BAR Restoration could be integrated and iterative with BAER having greater consideration of long-term restoration.
- Community engagement—living with post-fire environment is part of living with fire; build on existing campaigns such as Community Wildlife Protection Plans and Fire Adapted Communities that have already established roots.
- Interagency/intra-agency coordination—a lot of small actions that make sense, such as:
  - An interagency pre-season meeting that would facilitate communication in lieu of an actual declaration of policy;
  - Associate a BAER meeting with the next national or regional wildland fire conference;
  - Integrate BAER into wildland fire pre-season readiness, phase I risk management assessment.
- *Issue:* in contrast to fire management, there is no "BAER organization" or BAER funding for training or pre-season preparation. Currently we rely on good people, good will and a little luck rather than a good system.

Presentation: On-line BALN Forum. Mary Steuver, NM Forestry Dept.

- Set up a ZetaBoards forum for the Burned Area Learning Network; this will allow continued conversation by participants on a variety of topics. You can register and sign-in *or* remain a guest if you want your comments to remain anonymous. Check it out! The link to the forum is: http://s15.zetaboards.com/SW_Burn_Area_Network/index/

Session 3: Evaluating Long-term Upland Ecological Consequences and Managerial Options.
Moderator: Don Falk, University of Arizona.

Presentation: Natural Patterns of Post-Fire Recovery. Jose Iniguez, RMRS, and Collin Haffey, USGS.

- Post-fire high severity patches can recover to 5 different community types: (1) shrublands (oak); (2) grasslands; (3) grass-forb-small shrubs; (4) aspen; and (5) post-fire bare lands; the last is uncommon. These recovery types are not new; inspection of older fire scars shows they are coming back as oak shrublands, grasslands, and aspen.
- Potential drivers and feedbacks: Kerry Kemp (University of Idaho) showed that distance to a seed source may be the primary mechanism determining post-fire regeneration in mixed conifer forest http://nrfirescience.org/event/resilience-and-regeneration-after-wildfire-dry-mixed-conifer-forests-us-northern-rockies;
- A consequence of bigger fires and large high-severity patches is that many areas are farther away from a potential seed source; don't find regeneration more than 250 m away from seed source; the same pattern holds in AZ and for Collin's work in NM. This "regeneration" distance is affected by microclimate and whether an area lays upslope or downslope from a potential seed source (climatically favorable sites).
- Loss or alteration of a process that's key to the system, like regeneration, is how Pepe defines type conversion. Adult conifers that survived the Dome fire were adjacent to a high-severity burn patch; this patch could have could have come back with conifers given the proximity of a seed source; however, these large trees were killed in the Las Conchas fire and now there is no proximal conifer seed source that could potentially contribute seeds to the oak-locust that is recovering post-Las Conchas.
- *Ponderosa pine historical regeneration pattern*: historically, ponderosa pine had a very consistent decadal establishment pattern, that is, at least a few trees established in most decades. However, there were regeneration peaks that were not necessarily synchronized across sites, suggesting age-peaks were a function of local (fire) rather than regional (climate) processes.

- Historically, regeneration in conifer forests hasn't been a problem, but it's become an issue with increasing size of high-severity burn patches. In wildfires, get a mix of burn severities; small high-severity patches are not a problem. In the Pumpkin fire, stem-mapped a 4-ha/10-acre (200 X 200 meter) area that burned at low-moderate severity; within the plot, there was a small high severity patch (all trees were killed) and that is where found most of the new regeneration.
- Looked at wildfires (1984-2011); since 1984, high-severity patches larger than 1,000 ha. are not common (n=62); however these 62 patches cover almost 300,000 ha.
- Are we seeing regeneration in these patches? Some of these >1,000 ha patches include mixed conifer with aspen and aspen is regenerating/re-sprouting and conifer regeneration is occurring at the edges of these patches. In the Pumpkin fire (2000), 400 m away from edge, ponderosa pine is regenerating. In high-severity patches in Rodeo-Chediski (2002), see a lot of juniper regenerating and re-sprouting, with ponderosa pine as a minor component. It took 12 years for pines to come in amongst the oaks in the Aspen Fire in the Catalina's.
- *Management Strategies:* Scale of disturbances is increasing, and with it, the scale of intervention and the potential for undesired outcomes, e.g. slide showing straw mulching and a post-fire monoculture of invasive weeds.
- Monitor landscape and trends in vegetation recovery and then when there is an opportunity, apply management actions. The Pacific Decadal Oscillation warm phase (wet phase) gives us an opportunity to do more fire and more planting. We need to acknowledge that ecosystems are new, and we have little control on how they land up. A consideration of historical conditions may not be appropriate for managing areas that have undergone a type-conversion; need a new management paradigm for these areas. However, recent wildfires have resulted in patchy landscapes and historic conditions may apply in areas with surviving forest.

Questions:
Darryl: What is the definition of high severity—did you use burn severity maps based on soil burn severity; response from Collin, Pepe—defined burn severity based on tree mortality and crown loss, not based on soil severity.

Anne (TNC): Having a lot of small trees in a high-severity burn patch doesn't tell me what recovery will look like in the future. Pepe: we are planning a new study, funding permitting, that will document regeneration trajectories in older fires, using historic aerial photographs to identify them on the landscape; still need to know more about the effects of re-burns in these recovering burn patches.

Presentation: Post-fire Restoration Based on the Target Plant Concept. Owen Burney, NM State University, John T. Harrington Forestry Research Center.

- After severe wildfires, what factors influence natural post-fire regeneration? Soils: post-fire there is a decrease in organic material, change in soil structure/porosity, volatilization and leaching of nutrients, and erosion. Plants: seed bank is depleted, decrease in plant cover, and reduced seed dispersal based on the size of the burn area. (Certini, G. 2005. Effects of fire on properties of forest soils: a review. Oecologia 143: 1–10)
- Restoration may require artificial planting. Target Plant Concept: fitness for purpose—plant has characteristics that allow seedling to survive and grow after outplanting. Target Plant Concept has a number of steps: (1) *identify specific objectives for planting*; (2) *conduct a site evaluation* (soil, climate, vegetation, other factors, e.g. slope, aspect elevation, animals, pathogens; (3) *consider limiting factors* including soil moisture, nutrients, pH, soil microbial community (e.g.,

forest fires result in a loss of microbial populations), exotic vs. native vegetation, animal herbivores, and pathogens.

- (4) *Consider mitigating measures* to deal with limiting factors including soil amendments (enhance nutrients, microbes, water holding capacity), vegetation control, and animal damage protection (fencing, trapping). Municipal biosolids significantly increase plant production up to 3 yrs. post-fire.
- (5) *Consider genetics*: species selection based on objectives. Genetic selection—consider locally adapted seed sources and seed transfer guidelines e.g. how far can seed be moved without adverse effects—requires a lot of information; seed transfer guidelines have been developed for OR but not NM; also consider mixture of male/female for cuttings, characteristics of source plants, genetic diversity, and assisted migration options.
- (6) *Consider plant material*: (i) seed, cuttings, or seedlings, depending on species; (ii) stock type (bare root vs. container); (iii) seedling morphology (root-shoot ratios); and (iv) physiological conditioning.
- (7) *Consider outplanting techniques*—grid vs. nucleation grouping or natural regeneration patterns; *outplanting windows*—plant when soil moisture is highest, that is, in the spring and fall; spring usually has more predictable soil moisture conditions, but fall gives transplants a longer period for root growth before first summer/dry season.
- (8) *Assess performance through monitoring* and make adjustments.
- *Assisted migration:* climate is changing faster than some native species can migrate naturally. Trees can move 0-15 km/decade; forbs/grasses move 0-30 km/decade; climate is changing at an average rate of 30 km/decade; climate is changing faster than some native plants can adapt or migrate. To address this issue, can move seed sources within ranges and to leading edges of range (assisted population migration) or move seed sources into anticipated ranges (assisted range expansion). There are ecological and economic risks to assisted migration; costs increase with migration distance; effects on receiving ecosystem (genetics, competition w/ other species); effects on donor ecosystem (removal of genetic resources, loss of function/structure); and establishment failure.
- Assisted migration (AM) is a possible climate change adaption strategy for forested ecosystems; need to make informed decisions which require collaboration and communication. AM can be used w/ other practices including: maintaining genetic diversity within populations—provides populations with increased capacity to adapt; maintain landscape connections to facilitate natural migration; promote gene flow (pollen and seed migration); create seed banks, emphasizing diversity and long term storage; select and breed for future climates by targeting adaptive traits such as bud break, bud set, drought resistance (e.g. xylem water potential); growth and performance.

Questions:

Q. When is the best time to plant in ponderosa forest? Owen: Ideally, if you have the right material, planting as soon as possible is best; competition w/ invasive species is at a minimum. If it's a smaller area may want to wait to see how the area recovers naturally.

Nucleation grouping techniques may be a strategy for sites where the objective is to increase/improve seed dispersal within sites or in sites that will be favorable for growth; this will take a long time.

Mary: Following the Rodeo-Chediski fire, 1.5 million trees were planted; looked for favorable microsites, also planted in sites that could play an important role in seed dispersal and sites where it was critical to

maintain forests; places that are good places to plant for dispersal may not be favorable for immediate planting.

Bob: will be doing an experiment with ponderosa pine on the VCP, looking at a diversity of local seed sources and assisted migration.

Presentation: Climate Change and Severe Fire. Peter Fulé, Northern Arizona University

- Climate, fire and forest relationships are changing—will treatments be effective in the future?
- Transition to a more arid climate is projected (Seager et al. 2007); increasing temperature will result in vegetation changes, e.g., compare vegetation in Flagstaff vs. Prescott (+7^{o}F) vs. Sedonna (+14^{o}F).
- *Fire patterns are changin*g: climatic variables associated with "big fire years" include high temperatures and low precipitation, but patterns varied by region. Only the SW region showed an increase in annual area burned and area burned severely. Southern Rockies ecoregion showed trend in increasing severity.
- Williams et al. 2014 projected the dry conditions in 2011, which was a particularly severe fire season, into the 2050s; vapor pressure deficit will be greater by mid-century suggesting even more severe fire seasons than we've experienced in the recent past.
- *Do fuel treatments still make sense?* A number of studies show that fuel treatments are effective in reducing burn severity but climate change will affect treatment effectiveness. To date, forest restoration projects, including 4-FRI, have not considered the implications of climate change in treatment planning.
- *Climate-Forest Vegetation Simulator:* Forest Vegetation Simulator (FVS) most widely used model in USA; modified by Crookston & Rehfeldt based on analysis of climate-forest relationships from Forest Inventory and Analysis data; calculates species viability score, used to adjust growth, mortality, and regeneration. Bioclimatic envelopes fit presence/absence from FIA data to current climate, then see where suitable conditions occur under future climate. Advantages: huge data sets, highly precise models. Disadvantages: suitable climatic conditions are necessary but other factors are important. Can a species move to a new site? How will disturbances change at the site?
- Bioclimatic envelopes can be looked at as a minimum rather than a maximum because there will be competing species; also don't know exactly what the future climate will be, e.g., different greenhouse gas emissions scenarios.
- Rodeo-Chediski fire (2002) burned over treated and untreated sites. In 2003, staff from the Apache-Sitgreaves National Forest and RMRS selected 7 paired sites, treated and untreated, 10 acres each; on White Mountain Apache Tribal lands, randomly selected plots; all sites measured in 2004 and re-measured in 2011.
- Pete's project (Shive et al. 2014): re-visit post-wildfire projections using C-FVS. Do fuel treatments have persistent effects? How might forests change? Used 7 GCM-emissions scenario combinations to derive temperature projections; also considered a No Climate Change scenario. *Results:* species respond differently, so vegetation communities change. Moderate climate change improved performance of non-pine species (e.g. Gambel's oak) suggesting a reassessment of management is needed; severe climate change leads to complete forest loss (A2 emissions scenario).
- *Scenario: No Climate Change/Prescribed Fire*. Restoration of historical surface fire regime (5 yr return interval) would maintain open pine forest/savannah. This conclusion is the underlying assumption of current management.

- *Scenario: Moderate Climate Change/Prescribed Fire.* Restoring historical fire frequency leads to long-term forest decline, but fire at longer intervals could be used (20 yr.). Thus, moderate climate change requires an adjusted management regime.
- *Scenario: Severe Climate Change/Any Treatment.* All scenarios lead to elimination of pine forest; prescribed fire treatments result in complete forest loss; non-burning treatments result in oak/juniper savannah; and current fuel treatments have no persistent effect. Thus, severe climate change would result in a different ecosystem and management regime.
- *Conclusions:* (1) models of climate and forest are uncertain, but the potential magnitude of change is extremely high; (2) species respond individually so forest composition will change; (3) even moderate climate change requires reassessment of management; and (4) severe climate change completely alters native forest ecosystem. *C-FVS suits managers' data and training; we should use it.*
- Will Flatley, NAU, is adapting LANDIS model for SW forests and incorporating climate change effects. LANDIS II allows dynamic interactions among forest vegetation, climate, and fire; study area is Kaibab Plateau, n. Arizona.

Questions:
Q. What are the error bars on the C-FVS modeling estimates. Pete: FVS is built on large data sets; model performs retrospectively very well; climate part attempts to adjust those regression equations that underlie FVS.

Marie: There are many small experiments going on; is there some data that we should be collecting that would contribute to answering the sorts of questions that Pete and Owen talked about, or Owen?
Owen: Wariables that we typically measure on a site are species, growth rates, fuels, physio-phenological characteristics such as timing of bud break and bud set, recruitment patterns, and microclimate characteristics of these recruitment sites, e.g., spatial distribution of species and correlated micro-climate variables.

Pepe: Does C-FVS take tree age into effect? Pete: no it doesn't, so can't look at how young vs. old tree respond to drought.

Paula (RMRS): 80% of grass-forb species have recovered post-Hayman fire, however, they have not reached their pre-burn cover e.g. legacy species are present; not a lot of weed invasion. Also, there are many early successional species which contribute to the overall plant diversity. Andi has consistent results, took 3 years for the species to come back but their site was seeded and invasive weeds were introduced.

Post-fire studies show places with and without invasive species coming in; the prediction is that nonnatives will increase, but the empirical results show both outcomes.

Can shift the discussion by asking what are your undesired conditions instead of what are your desired conditions?

Break-out Group Discussion: the following questions were posed by Session organizers:

- *Should we always strive to return landscapes to their pre-fire configuration, or in some cases should we accept change as inevitable?*
- *What research is needed to help us understand unique post-fire landscape trajectories and our influence on it?*

- *How should we engage community members to understand their attitudes toward post-fire landscapes that have been altered from the pre-fire condition? How are they responding to such abrupt and drastic change?*

Session: Advancing Community Engagement in Pre-fire Planning for Post-fire Action. Moderator: Doug Cram, New Mexico State University

Presentation: Lessons Learned During the Development of www.afterwildfirenm.org. Eliza Kretzman, New Mexico State Forestry

- New Tool: AfterWildfire.org. The guide was written for community leaders and individuals in fire-affected areas; also useful as a planning tool. NM State Forestry led the project teams; the team researched other existing guides first; partners and volunteers contributed a lot of expertise, time and talent. Wildfire survivors critiqued draft; product funded through USFS grant.
- Eliza gave a tour of the website; there are seven sections: Immediate Safety, Mobilizing Your Community, Who Can Help, Post-fire Treatments, Financial Tips, Flood Information, and Additional Resources. Participants are encouraged to check the website out.
- *Mobilizing your community:* who do you need at the table when we think about post-fire readiness and response? Sometimes non-traditional partners can contribute significantly to this effort.
- *Lessons Learned:* website is used far beyond NM; the "Financial Tips" and "Mobilize Your Community" sections of the site can be useful for pre-fire planning for post-fire action; the Fire Adapted Communities Learning Network has planning guides and lessons-learned too. Key lesson learned since May 2014 when the site was completed: *The people you have sitting at the table before a fire may not be the ones you need post-fire. For example, you need food banks, schools, water utilities, community groups, banks, etc. This is your working group for recovery.*
- *Nest Steps:* Website updates, ongoing; short printed version of the guide, available in the next few months; and integrating feedback from users.
- There are a lot of gaps in assistance after a destructive wildfire; limitations to agency funding and strong sidebars on how the funding can be used can create challenges for agencies working with communities. Long-term needs of communities post-fire typically exceed the 3-year window of most of the emergency funding sources.

Presentation: The Fire Adapted Community Learning Network—Opportunities to Engage the Public in Pre-fire Planning for Post-fire Action. Eytan Krasilovsky, Forest Guild.

- A fire adapted community acknowledges *and takes responsibility for its wildfire risk*, and implements appropriate actions at all levels. Actions address resident safety, homes, neighborhoods, businesses, and infrastructure, forests, parks, open spaces and other community assets. Every community *has a unique set of circumstances and capacities*, so the kinds of actions they undertake will vary. Further, *there is no end-point in becoming fire adapted.* Sustaining, growing and adapting strategies, partnerships, and capacity through time are key; visit www.facnetwork.org for more information.
- Wildland-Urban Interface—we want management, restoration and maintenance, including the use of prescribed fire, to be community supported actions that are "normalized".
- A fire-adapted community involves home preparedness which includes home owners, home-owner associations, acequia associations, water boards, landscapers, and architects. Building from the home, we have, collaborative partnerships, community groups and boards, fire

departments, town and county planning departments, and businesses. Finally, there are ecosystems and land manager that steward them. There are a number of elements of a fire-adapted community (FAC), however, these elements do not include planning for the post-fire action. Planning for post-fire action should consider preparedness in the context of resilience, that is, be relationship-based, involve the whole community, be long-term and ongoing, and involve sustainable development.

- There are a number of online resources for FAC: www.facnetwork.org. Also a NM webpage that can be useful: http://www.fireadaptednewmexico.org/. In addition, In Santa Fe County, there is a home-site risk assessment website that displays wildfire risk ratings; this is an important tool and a good resource locally. But moving to pre-planning for post-fire, we need to look to new partners and resources and learn from others. For example, after the Carlton Complex Fire in 2014, this appeared in the Methow Valley newspaper: http://issuu.com/methowvalleypublishing/docs/2014trialbyfire_methowvalleynews. Another free tool for pre-fire planning: https://weed.recovers.org/
- Eytan connected with other FACLN hubs; this led to a conference call with other hub leaders that have recently experienced WUI fires. Here is a summary of the conversation:
  - Long-term cultural and community impacts and needs are an ongoing challenge to meet.
  - Need to pre-plan for fires and the people you have sitting at the table now are not the ones you need to be sitting at the table during and after the fire. For example, after the fire the recovery needed food banks, schools, water utilities, hospitals, community groups, technical assistance providers, and banks; this is your working group for recovery; “non-fire" and non-traditional partners have a lot to offer. Also, incorporate post-fire planning into CWPP updates.
  - Incident management teams can play an important role in communicating post-fire information and messaging during the fire when the public meetings are jammed packed. Waiting till the end of the incident is too late. Then everyone is exhausted and attendance for public meetings has dropped. *Do we need community liaisons pre-identified that go beyond our volunteer fire departments to do this work?*
  - Do we need BAER teams that deal with people and communities the way BAER teams assess soils and revegetation?
  - FAC learning network has the opportunity to connect burned communities to help recovery.

Presentation: Community Engagement in Post-fire Restoration—Front Range Fire-Adapted Communities. Jonathan Bruno, Coalition for the Upper South Platte

- Fires are a part of the CO Front Range ecosystem, whether we like it or not.
- The Front-Range Fire Adapted Communities are using a watershed planning tool that considers agriculture, forest health, fire, invasive species, land use and development, mining, recreation, transportation, water system operations and local/regional economies.
- When discussing fire and education with community members, it is important to discuss the challenge at all levels—fire impacts everyone and fire risk can be explained in the context of what the community cares about, their common interests and goals. The costs of wildfire can be large; consider that the average cost of post-Waldo restoration work was over $25,000/acre; fuel treatments cost about $1,700/acre.
- The big challenge related to pre- and post-fire work is that often we have disparate, compartmentalized agencies and organizations at all levels of government that don’t communicate well with each other, or with the general public.

- What is a community? A community is not a place or a collection of dwellings defined by geographical boundaries, streets and intersections. A community is a social system of human connection and communication; people within the community have common values, and experience a feeling of fellowship with others as a result of sharing their commonality. A community then is about people and relationships, and the *adaptation that is called for is found within their shared values, interests and goals.* The most fundamental adaptation required is not a change in the building code, or roofing materials, or the complex of brush and forest fuels, nor the type of landscaping or deck materials. *The most fundamental adaptation required in addressing the threat of wildfire is to change the way people think about the place where they live. The vulnerability to the devastation caused by wildfire must be incorporated into the culture of the community.*
- Some useful resources for post-fire restoration: the Phoenix Guide http://www.nacdnet.org/resources/reports/phoenix_guide.pdf . Also, see the Wildfire Restoration Guide http://cusp.ws/wp-content/uploads/2014/05/Fire-Restoration-HandbookDraft5.7_FINAL.compressed.pdf. CUSP had 6,500 volunteers and needed a tool to direct and educate those volunteers.
- Collaborative Wildfire Protection Plans are ways to educate and build support around post-fire action.
- What if we do nothing? Not only do these fires devastate the environment, they also cost communities a great deal in lost revenue, reduced visitation, loss of property and lives; as an example, after the Waldo Canyon Fire, insurance claims alone were over $453.7 million; this doesn't include costs associated with loss of tourism, recreation opportunities or restoration; this works out to be over $24,825/acre burned.

Questions, Discussion and Next Steps:
Q. How did you work with agencies and communities to do post-fire restoration? Jonathan: Trust is key, CUSP focused on building relationships with agencies and demonstrating the value they provided; because of agency turnover, it's difficult to maintain relationships, but it's key so it has to be a priority. CUSP has done a good job raising funds for work that wouldn't occur otherwise and so we come to the USFS with money.

Q. You spoke of the lack of youth involvement and volunteers; what are you doing about this? Jonathan: A lot of youth and university students *are* involved. The difference is that the older demographic listens and is usually concerned with their safety; this makes them easier to work with.

Eytan: Youth Conservation Corp in NM had fire adapted communities training and then put them to work on post-fire restoration.

Collin: Valles Caldera Preserve brings in youth to assist with monitoring; what is happening elsewhere? Eytan: Forest Guild uses YCC kids to do monitoring. Mary says she involved volunteers in collecting data for her thesis research; this group of volunteers became BEMP; we can take what we learned with BEMP and apply it elsewhere. NM is a good place to build a monitoring network because of BEMP and other successes. If we correlate monitoring and restoration work with state education standards, we can work directly with teachers and schools.

Jonathan talked about a teacher training in Durango, CO, on fire ecology and healthy forests. In addition, he cautioned that when youth are involved in data collection, sometimes the data isn't reliable; however the experience engages youth and educates them about a potential career path; so it depends

on your objectiv. Bus transportation is the big cost to get kids out to a site. Also, need to have the monitoring and restoration protocols well specified.

Q. What are our strategies for making communities comfortable living with fire? Jonathan: Education is a key. Pete: Flagstaff is getting there; good to have a little smoke in the air at all the time; managers are careful initially and, over time, build trust that smoke doesn't mean disaster. Also, acknowledge fire managers that have had good fire results that year.

When broadcast burns occur, the public normally just gets a notification; CUSP is using broadcast burns to educate the community to the values of burning. Can involve the community in pre-season planning of prescribed burns, and bring the public to see the effects of prescribed burns, especially complicated ones, and interpret the results.

Post-fire funding is not available soon enough or for long enough. Also there is a gap in knowledge and communication; the IMT talks about BAER activities on public lands and tells private landowners that the NRCS or FEMA can help them, when in fact they can't. Advice to communities: rally your forces and assume you're not getting additional resources—you are on your own.

Q. What about interactions and responses from the insurance companies? Fire and risk management is increasingly being driven by insurance companies; companies come out, assess fire risk, and tell owners that they need to do treatments or their insurance will be dropped. We can use the CWPP to set standards for treatment prescriptions.

United Policyholders is a non-profit advocate group that can help you deal with insurance companies before and especially after wildfires.

Educating line officers of what their responsibilities are to communities may assist in building productive relationships; also, although agency staff turn-over is high, there are many staff that have been in one place for a long time.

Ana (USFS): Having a printed guide that summarizes information on the BAER website *and* training BAER personnel so they don't "promise the world" to the public would be extremely useful. When will the printed guide be ready? In June, said Ariana Pinzon.

Communications can be tiered—first step, identify organizations and their constituencies in communities; second, engage these organizations to assist in the outreach of post-fire effects and actions.

If needs come up in BAER team meetings with the community, then volunteer Public Information Officers can address these needs in follow-up meetings.

Q. What really great idea stands out in your mind as a logical next step that we can tackle collaboratively?

Jonathan: Develop a deeper connection with other implementers that are kicking the dirt and doing things through the FAC Learning Network and other organizations; these entities could benefit from coming to a workshop like this.

Don: interactions between scientists, NGOs and managers are key to this effort of pre-fire planning for post-fire action. There is no line of communication to the Joint Fire Sciences Program that the science is

an important part of this effort; this link between the science and building post-fire resilience needs to be communicated to JFSP to build support for continued research funding around fire.

Need to integrate the post-fire planning into CWPPs and fire management plans. Money is limited so we need to include this in the existing work we do.

Tony Cheng (CSU) is leading a field trip to the West Fork fire. Anne will send out an announcement for this event. Also, we talked about pre-fire planning for post-fire action, is there an interested landscape, collaborative group, or watershed association that's willing to experiment with this idea?

Marie: Valles Caldera has a large number of monitoring plots that have pre-fire data and that burned in a recent wildfire; all burn-severity categories are represented; if there is some research question that can make use of these plots, contact Bob Parmenter.

Are there meetings, symposium or some other event coming up where we can communicate about the BALN and perhaps hook up with other people?

Eytan: FAC.org would be a good venue for posting a piece.

Zander: New Mexico WUI summit may be a way to get some of these post-fire issues in front of interested folks; also, we can organize a special symposium at the Tucson SFE meeting in 2016.

Jonathan: what kind of documents will come out of these meeting? Anne: we will collate all the things that are posted on the walls and distribute the workshop notes. If you can think of other ways to package this information and transfer it in a useful way to the others, please let me know.