# 2021 STATEWIDE FOREST SCIENCE RESEARCH COORDINATION MEETING

*Summary Report*

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## Purpose and Background

Coordination meeting among major new and returning statewide forest science research grantees and government scientists to better understand: 1) data requirements to support research; 2) research deliverables/products; 3) intended user group(s); 4) geographic focus(es); 5) timelines; etc.

In addition, the meeting:

- ✓ Developed common awareness of the extensive forest science work underway;
- ✓ Delineated differences and areas of alignment or overlap across projects;
- ✓ Identified possible knowledge and data gaps; and
- ✓ Forged or expand collaboration among focal research project developers, and between government science work and research project

## Attendees

Over 90 attendees from various, statewide forest science focused organizations attended the coordination meeting. Represented organizations included:

## Research Presentations

Detailed presentations were delivered by the lead researcher of each of eight statewide forest science research initiatives; four of these research groups were newly funded and included information on the research focus, scope of work, analysis, expected deliverables, timelines, and other relevant information. The other four research initiatives were returning from the 2019 meeting and provided a brief review of the above content as well as showcased progress to date. Notes on each presentation are included in the next section and PowerPoint slides of each can be found in the "Presentations 2021 Statewide Forest Science Coordination Meeting" file.

### Summary and Discussion

The following groups presented:

1. Assessment and mitigation of wildfire induced air pollution; UC Davis, presented by M. Barbato; funded by UC Lab Fees
2. Transforming prescribed fire practices for California; UC Irvine, presented by T. Banerjee; funded by UC Lab Fees
3. Mitigating and managing extreme wildfire risk in California; UC Santa Barbara, presented by C. Jones; funded by UC Lab Fees
4. California Foresite: Spatial assessment and priority planning; UC ANR, presented by S. Khan; funded by the Department of Conservation and CNRA
5. The future of California drought, fire, and forest dieback; UC Los Angeles, presented by A. Hall; funded by UC Lab Fees

6. Comprehensive open source development of next generation wildfire models for grid resiliency; Spatial Informatics Group, presented by D. Saah; funded by the Energy Commission
7. High-resolution, dynamic mapping of forest fuels and wildfire hazard; Salo Sciences, presented by C. Anderson and D. Marvin; funded by Gordon and Betty Moore Foundation
8. Innovation center for advancing ecosystem climate solutions; UC Irvine, presented by M. Goulden; funded by Strategic Growth Council

Of the newly presented research projects, the first two (Barbato and Banerjee) both address aspects of emissions and air quality concerns and advance our strategies for mitigating wildfire risk. The third project (Jones) considers how climate change is influencing wildfire risk, with an emphasis on implications for the electric grid, while the fourth (Khan) assesses current watershed conditions and prioritizes investments, in part by leveraging geospatial data produced by these 8 research projects.

The progress of the returning four research projects included, but was not limited to, successful downscaling of climatic models and advancing fire models to consider implications for carbon storage and larger diameter trees (Hall and Saah), launching a near-term wildfire forecast system (Saah) and an online platform with high resolution forest structure vegetation data (Anderson), and generating novel geospatial layers to support existing platforms (Goulden).

The returning four research projects have developed multiple cross-project collaborations to model fire, drought, and tree mortality. All 8 research groups recognized the opportunity to further expand sharing data and analysis to more rapidly and comprehensively achieve outcomes.

**Discussion on Overlap, Opportunities, Gaps**

Open discussion on research synergies and complementarities.

Attendees recognized that a lot of high quality and useful data is being produced from these projects, but there are few resources to exchange, update, or sustain data production in the long-term. However, they noted that data privacy and possible sanitization protocols would need to be developed before sharing. Addressing how to exchange, update, and sustain data from these projects is a real issue but also a great opportunity.

The group noted that stakeholder engagement efforts from multiple projects are targeting similar or the same groups of people; there may be an opportunity to at least compare notes or even consider and develop an integrated approach.

Attendees agreed both of these topics are worth revisiting during a quarterly call.

## Detail on Newly funded Research Projects

The information below is listed in order of presentations delivered, and it should be paired with a review of the accompanying PowerPoint slides.
*Though the authors of these notes attempted to accurately capture the detailed information discussed throughout the event, given the technical and extensive nature of these projects, please excuse any inadvertent errors or omissions. Please contact the project leads with any questions; corrections can be submitted to the report authors.*

1. **Assessment and Mitigation of Wildfire Induced Air Pollution; UC Davis, presented by M. Barbato; funded by UC Lab Fees**

Focus:

Interdisciplinary collaborative focused on five Wildfire Research Areas (WRAs): 1) modeling and forecast (not real time) of wildfire spread, 2) wildfire emissions and air quality, 3) health effects assessment, 4) mitigation strategies, and 5) visualization.

Key research questions:

1. Modeling wildfire spread in the WUI at individual building scale
2. Bridging the gap between scales of wildfire models
3. Identifying the appropriate spatial and temporal scales for different modeling components for assessment of air quality and population level health effects
4. Measuring physiochemical, optical, and toxicological properties of fire emissions from heterogeneous fuels
5. Developing an emission database for urban/WUI materials
6. Developing baseline data to assess effectiveness of different existing and innovative mitigation strategies
7. Developing the scientific visualization framework to support knowledge dissemination, community engagement, and policy development
8. Preparing the groundwork for future investigations of other wildfire-related issues

Geographic Scope(s):

California vegetation and climate

Research Team:

UC Davis lead, LLNL, UC Merced, UC Irvine, UCLA, UC Berkeley, LANL, Electric Power Research Institute.

Analysis:

A combination of modeling and lab-based experiments.

- Wildfire Modeling and Forecast – data inputs include LANDFIRE, LANDSAT products, and climate predictions. This goes into a semi-dynamic fuel model (vegetation productivity, mortality, and response to disturbances), which feeds physics-based (explicit fire flame/front tracking; two-way meteorological coupling) and statistics-based (empirically trained machine learning; computationally efficient) fire models. The outputs include burn area and smoke emissions at 30-meter resolution.
- Emission Prediction and Air Quality Assessment – atmospheric modeling and CMAQ model (UC Irvine)
- Development and assessment of wildfire mitigation strategies – including prescribed burns and vegetation management, urban growth and land use policy, fireproofing homes.
- Assessment of individual and population-level health outcomes from wildfire smoke (UCLA, UCD, LANL).
- Visualizations – working with Cal-Adapt to collect data and make them available to the public.

Planned Deliverables: the project will develop a methodology and framework and an online data visualization tool.

2. **Transforming prescribed fire practices for California; UC Irvine, presented by T. Banerjee; funded by UC Lab Fees**

Focus:

Prescribed fires can reduce fuel loading. Need to increase pace and scale of prescribed fires in California but narrow burn windows and impacts to air quality and public safety present challenges. The goal is to develop tools to facilitate more prescribed burning; i.e., safe and efficient prescribed fire strategies and decision support system tools for prescribed fire monitoring, stakeholder engagement, and training students and researchers

Geographic Scope(s):

The fire behavior modeling and IT decision support will focus on small scales, while the air quality modeling will focus on intermediate scales.

Research Team:

- Fire behavior modeling – UC Irvine and Los Alamos
- Air quality modeling – UC Riverside
- IT decision support – UC Irvine and UC Riverside
- Field measurements - Berkeley

Analysis

They will collect high resolution data on fuel, etc. Feed into models on fire behavior, feed back into models on air quality, which will feed into IT decision support system, which will then feed back into the data to sharpen the models further.

1. Modeling of wildland fire/prescribed fire behavior (collaboration with LANL). Using a high-performance processing computer to run rapid simulations of fuel treatments and fire ignition scenarios. In addition, they are working to develop tools capable of running ensembles even faster to identify thresholds to inform which scenarios should be investigated further in the HPCC simulations. Simulating different hypothetical wildfires allows them to capture different facets of fire behavior. Analyses will focus on the interaction of fire and atmosphere, and the development of new smoke production models that account for interactions between atmosphere, plume, and the fire.
2. Air Quality Modeling: chemical transport models can extend modeled fire behavior into a representation of pollution impacts. CTMs solve for chemical and physical evolution of assumed emissions over time, based on meteorology and other conditions. They will compare the influence of prescribed vs. wildland fires on pollutants and human exposure. Finally, they seek to improve understanding of emissions speciation and plume dynamics to turn them into a fast-running model for high speed prediction and projections.
3. Enabling smart and connected information technologies for prescribed fire: Goal is to enable situational awareness at burn site to monitor progress and or detect anomalies. They will create platform for sensing, networking, analytics and data management technologies at burn site that is suited for limited budgeted constraints. This includes sensors at the burn site. Vision based analytics that leverage machine learning could detect anomalies and support development of a data management system that continuously returns updated data for real-time use.
4. Pyrosilviculture treatments – part of this project includes implementing prescribed fires for research. These are not very common and they are open for collaborators. Blodgett Forest may be ideal location for prescribed fire education center in California. Currently they plan to do prescribed burns in spring, fall and winter of 2021 and 2022.

Models:

- Fire behavior: Multi-fidelity modeling approach
- Air quality - Chemical transport models (CTMs)

Planned Deliverables:

Outputs -

- fire behavior modeling
- air quality modeling
- IT based sensing systems for decision support and situational awareness
- pyrosilviculture practices
- Decision support tool for prescribed burning
- Sharing data from prescribed fires

3. **Mitigating and managing extreme wildfire risk in California; UC Santa Barbara, presented by C. Jones; funded by UC Lab Fees**

Focus:

This project investigates the complex interactions among four research themes – climate change and fire-weather, vegetation management, the electric power grid and associated policies - and their influences on wildfires.

The goal is to understand how climate change modifies extreme fire weather conditions and behavior in CA, which factors interact with electric power grid infrastructure to increase wildfire risk, how trade-offs between reliability of energy supply and wildfire risk vary across alterative PSPS protocols, and what cost-effective investments in vegetation management can minimize wildfire risks in the electric grid infrastructure. All of these questions interact.

Climate change happens on many scales, and there are robust relationships showing increases in wildfire sizes/frequency and warming trends. Extreme fire weather behavior involves complex relationships among vegetation types, fuel moisture, topography, and weather. Further complicating these relationships are the varied geography and fuels in California.

Geographic Scope(s):

Statewide

Research Team:

UCSB, UCB, LBL, LLNL, UCSD

Analysis:

- Develop fire risk assessments across California with emphasis on the wildland urban interface (WUI) and electric grid infrastructure
- Observational and multi models analyses (global reanalysis of ERA5 data; weather station data; remote sensing data; downscaling of WRF high resolution climate model; fire spread models (couple and uncoupled)

    - Example: There is a clear statistical change in surface winds in some regions of state, which may be changing fire weather conditions
    - Case Study: Using DOE fire in Aug-Sep 2020 to study fire behavior sensitivity to weather and fuels conditions
- Use machine learning methods to construct databases of:
    - Extreme fire weather, wind gusts
    - Wildfire risks, with an emphasis on electric power grid and WUI
- Risk model to predict power-grid-induced wildfire probability to inform better de-energization strategies. Methods:
    - Use machine learning tools to leverage enormous data sets on weather and infrastructure.
    - Create a decision-making approach to balance maximizing electricity delivery with minimizing network upgrade costs and risk
    - Develop optimization models to capture wildfire ignition risks and complexities of infrastructure investment
- Using the Camp Fire as a case study, create vegetation treatment scenarios near powerlines and town of Paradise to assess impacts.

Models:

- High-resolution climate model downscaling (WRF model; 30-yr, 1.6km grid, hourly outputs). Only downscaling for current climate, not future projections
- Fire spread models (coupled and uncoupled) - Prometheus

Planned Deliverables:

- High res WRF downscaling, 30-year, 1.6 k, hourly outputs, statewide
- Databases of extreme fire weather/wind gusts, and wildfire risks
- Fire spread model studies
- Workshops with stakeholders and agencies

Timeframe:

March 2020 - Feb. 2023

4. **California Foresite: Spatial assessment and priority planning; UC ANR, presented by S. Khan; funded by the Department of Conservation and CNRA**

Focus:

This project is jointly funded by CNRA and CalEPA through AB2551 to establish a comprehensive understanding of forest management and restoration needs, and to provide transparent and defensible data and analysis in support of prioritization of investment opportunities to improve watershed function and resilience.

The spatial analysis complements the statewide monitoring efforts outlined in AB1492 for integrated data ecosystem. The FORESITE project is focused on prioritization, geospatial tools and data to allocate resources for watershed restoration.

4 main tasks:

- Stakeholder Engagement
- Assessing baseline and current potential conditions
- Climate vulnerability and risk assessment
- Visualization and priority planning
-

Geographic Scope(s):

California watersheds – starting with five: McCloud, Trinity, Upper Sacramento, Pit, and Feather.

Research Team:

UCANR (Lead), UC Berkeley, UC Merced, UC Davis, University of New Mexico, USFS

Analysis:

Assessing current conditions, potentials, and climate risks/vulnerabilities:

- To describe baseline conditions, they will pool and synthesize geospatial data (physical settings such as soil, climate, regolith depth, topography, roads, etc.). This will integrate existing statewide layers as much as possible and only develop new layers as necessary. The projects will include ground verification as needed and will emphasize data updatability. The accumulated data will need to be aggregated and homogenized.
- The current potential of an area is defined as the upper limit values; what is possible in a location, given the current climate and physical conditions. This effort will require building a multivariate approach to measure current potential and identify its dominant controlling factor.
- The climate vulnerability and risk analysis will utilize an IPCC approach that combines resource value with climate exposure and sensitivity. This informs the potential consequences and impacts, which in turn informs vulnerability and adaptive capacity. Together, this will allow the creation of risk classes.

Visualization and Priority Planning Tool:

- This tool will inform prioritization of investments based on scenarios to reduce vulnerability and or risk, improve baseline conditions, or a combination of both objectives. It will provide access to maps and graphics that are driven by transparent and defensible data, that is both scalable and updateable. The tool will be user-friendly for a variety of potential audiences, provide flexible management criteria/objective formulation, and flexible weighting of assets.

Planned Deliverables:

- Online prioritization tool for restoration efforts
- Geospatial layers describing current and potential asset conditions and future risks in an interactive online platform.

Timeframe:

Two years, done by end of 2022 for stakeholder input/feedback.

## Detail on Returning Research Groups

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### 5. The future of California drought, fire, and forest dieback; UC Los Angeles, presented by A. Hall; funded by UC Lab Fees

Focus:
Understanding the sensitivity of tree mortality and wildfire risk and behavior to climate change over time
Research Team: UCI, UCD, UCSB, UCLA, UCB and LB Natl Lab, Los Alamos

Analysis:

- Detect tree mortality and create high resolution maps of these areas
- Model spatial patterns and temporal dynamics of human vs. lightning caused ignition probability.
- Analyzing the relative importance of fuels, weather, and topography on fire behavior (severity and spread rate) across ecoregions
- Intensification of fire severity by hot and drier climate and fuel build-up in North Coast
- The impact of drought- induced tree die-offs on fire rate of spread
- Live fuel moisture estimates: goal is to look at different metrics of vegetation conditions and come up with estimates of live fuel moisture, which is a key parameter to predict fire behavior.
- Attribution study of causes of increasing warm season fire weather
    - Vapor Pressure Deficit (VPD), a leading climate variable that influences fire weather, has increased at the rate of 0.70hPa (0.50 standard deviation) per decade during warm season (May-Sep) of 1979-2020 in California. VPD changes induced by the variation of the atmospheric circulation (the flow analogue trend), largely due to natural climate

variability, can only explain about half (54%) of the VPD trend observed over California. The remaining half of the VPD trend is likely due to anthropogenic warming because it cannot be explained by changes of cloudiness and vegetation types.

Modeling components of project:

- Dynamically downscaling CMIP6 GCMs across CA and weather US. They are also modeling forest sensitivity to water availability and drought (vegetation models tailored to CA ecosystems).
- Working to adjust FATES-HYRO to account for root distributions of key CA plants; root distributions are important for water use, and resulting impacts on tree physiology.
- Fire behavior modeling – demonstrated that FATES-SPITFIRE correctly simulates fire's influence on forest community composition, and that it is able to correctly simulate chaparral live fuel moisture. Evaluated importance of different climate drivers to future live fuel moisture dynamics.
    - Near future – link live fuel moisture to fire risk in FATES-HYDRO-SPITFIRE, evaluate the importance of live fuel moisture on fire dynamics, and evaluate fire behavior across mixed conifer, chaparral, oak woodland/savannah regions.
- Anthropogenic warming effects on bark beetles and tree mortality

Modeling/synthesis: climate-driven limits to future carbon storage in CA's ecosystems. Used statistical models to find that both moderate and extreme climate warming will drive large carbon losses. Rising temperatures drive carbon loss, while uncertainty in future precipitation adds large uncertainty to the magnitude of that carbon loss. Climate warming favors hardwood tree species at the expense of conifers. The most vulnerable locations are low/mid-elevation and North Coast. Forest carbon offsets are located disproportionately in these vulnerable areas – Northern Coast and Southern Cascade. The project team combined historical analyses with future projections to make statistical projections of future change. They will be doing a lot more of this in the coming year.

<u>Models:</u>

- CMIP6 GCMs
- FATES-HYDRO
- FATES-SPITFIRE
- IMAP
- TDIA (insect attack)

<u>Timeframe:</u>

- Started in March 2018
- Ending in about a year (expecting no cost extension)

6. **Comprehensive open source development of next generation wildfire models for grid resiliency; Spatial Informatics Group, presented by D. Saah; funded by the Energy Commission**

Focus:

Pyregence is creating a consortium of many collaborators to build free, open access tools and datasets for the next generation of wildfire models.

Key user groups – Investor-owned utilities, as well as state/federal land and fire management agencies, state planning agencies, tribes, interested stakeholder and public

Analysis

Extreme weather (basic research)

- cluster analysis of State fire weather zones (develop algorithm to identify archetypal weather conditions associated with rapid fire growth). Then historic wildfire analysis, then where are we blind for weather data? Then Tech-test – pilot testing of upper air profiler for situational awareness.

Fire behavior (basic research)

- LAB MEASURE: Predict heat release rates across the range of fuel structures and environmental conditions found in wildland areas (small-scale burn experiments were conducted to test the effect of wind speed on the smoldering burning rate of wooden cribs. Prepping for large-scale burn experiments)
- FIELD MEASURE: New fuel measurement and mapping system
- SCALE: Map current and projected future fuel conditions in areas of elevated tree mortality
- MODEL: Develop fire model that includes large fuels (> 3 inches diameter), solid phase combustion, and buoyancy

Forecast tools (applied to operational)

- near-term wildfire forecast system. UP and running for the last wildfire season. Beta version models and forecast tools are up and functional at pyregence.org/forecast. They are planning 2021 updates for the near-term forecasting tools.

Scenario analyses (applied to operational)

- long-term wildfire projections. Goals are to develop coupled statistical/dynamical fire-climate-vegetation models to run long-term (end of century) wildfire risk projections. This will support the CA Fifth Climate Change

Assessment by running models for long-term wildfire projections. They will develop a planning support tool for IOUs and stakeholders relying on the grid to visualize the impacts of wildfire under a changing climate.

Collaboration with UCLA/Alex Hall on downscaled historical climate data.

Coordination with CECS on Fire perimeter data, Harvest Data, and Surface fuels

Landscape models: A full version of LUCAS now running over the conterminous and western U.S. On-going assessment and validation of LANDIS-II re- parameterizations for Klamath, Sierra Nevada and North Coast Forests

Models:

- CAWF
- 2 uncoupled models: ELMFIRE developed by REAX engineering and GRIDFIRE developed by SIG
- Long term models: LUCAS, LANDIS
- 2 statistical modeling approaches

Planned Deliverables:

- Open access tools and datasets for wildfire modeling
- Cluster analysis to identify extreme weather types for large daily fire growth – Nature Paper, data will be available
- Integrated data for consumption by other groups

7. **High-resolution, dynamic mapping of forest fuels and wildfire hazard; Salo Sciences, presented by C. Anderson and D. Marvin; funded by Gordon and Betty Moore Foundation**

Focus:

Development of a forest monitoring system with high-resolution (3 – 10 m) forest structure vegetation data (updated every year), as well as weather and wind, active wildfires, and wildfire exposure (collaboration with Pyregence).

Research Team: SALO Sciences, work from Vibrant Planet

Analysis:

In partnership with Pyregence, working to map drought and insect driven tree mortality. Also working with utilities on fire risk. Aiming to use this data in the future for rapid post-fire response and developing an annualized fire hazard at 10 m resolution – which will be useful for simulating treatments and their effect on fire hazards.

Planned Deliverables:

- forestobservatory.com
- Open to sharing data with new teams
- API available for free and open non-commercial use, cloud data storage

The Observatory can provide raw data layers to all initiatives, integrate data from them and use them to inform models, provide data/expertise to improve models by initiatives, and can conduct collaborative science together.

8. **Innovation center for advancing ecosystem climate solutions; UC Irvine, presented by M. Goulden; funded by Strategic Growth Council**

Focus:
Terrestrial ecosystem conditions, function, and vulnerabilities with an emphasis on carbon, drought stress and tree die off, fire and water. Effects of past and future management actions and disturbance over a 10-30-year time horizon for a stationary climate. The entire effort includes geospatial data analytics, disturbance analyses, decisions support tools, and ecosystem services valuation.

Analysis

Geospatial work update: creating data layers that play nicely with existing software (Pyregence, Eco Futures, Salo).

- Geospatial data layer creation and analysis using full Landsat stack (since 1984)
    - Biogeochemistry model, CASA based
- Dead pools C in detritus (1-1000 hour) – completely new dataset which provides dynamic component and fine focus
    - Closer comparison, Wildland Fuels database of coarse fuel
- Refined management history from agencies – identifying scale of actual treatment (not just what was proposed), incorporating private lands, all in one data layer by doing a comparison to LANDSAT
    - Relatively easily updatable
- Forest health data layer – forest stress for a given drought, probability of die off
    - Can use to assess effect of management on forest stress, for every year over the last 35 years. Also, predictive ability based on past recovery
- Chronosequences of past disturbance: looking at past disturbance like fire and recovery of photosynthetic capacity, or other metrics – generates recovery curves for ecosystems. Can look at management and other disturbance too

Timeframe:

About 45% of the way through the project. About 14 months to go plus a 1-year NCE (end date proposed ~22 months.

## Government Agency Scientist Lightning Talks

Following the major research presentations, government scientists delivered an overview each department or agency's major research and data collection efforts related to statewide forest science analysis (e.g., wildfire, tree mortality, forest structure, ecosystem service quantification, monitoring and assessment, etc.).

### CALFIRE, Fire and Resource Assessment Program (Chris Keithley)

- FRAP has multiple research and monitoring programs.
- Recent effort focused on updating the Fire Hazard Severity Zone mapping; incorporates downscaled climate data.
- FRAP also has a forest health research grant program; anticipate grant solicitation in March and many of the topics discussed this morning would be applicable.

### Air Resources Board (Alan Talhelm)

- CARB research division serves the agency broadly in public health and climate missions. Currently have a contract on smoke health impacts, including one on natural and working lands' health scenarios modeling.
- Air quality monitoring division is closely involved in burn permitting. Look to improve blue-sky smoke modeling for CA and Nevada.
- The research division also maintains a greenhouse gas emissions monitoring and inventory system.
- Industrial Strategies Division works on forest offsets – looking into remote sensing tools to monitor and evaluate offset projects.
- Sustainable Transportation and Communities Division (CCI Program) is involved in project level GHG quantification related to forestry.

### Sierra Nevada Conservancy (John Tangenberg)

- The Conservancy plays more of a data consumer role than a data producer role, but they are developing a "data lake" to compare data from different research projects and to bring data together for policy and reporting. Last year they built a 30m operational DEMO database, based on the Land fire and the USGS ARD framework. The coding scripts from this database are being scaled to a statewide level. The goal is to run queries rapidly at scale; the database is integrated in the Snowflake data cloud, ArcGIS, Jupiter notebooks, etc.

### CA Energy Commission (Alex Horangic, R&D Division)

- Projects funded by EPIC and PIER. Two projects are led by Dan Cayan at UCSD's Scripps Institution of Oceanography; the first is "Advanced statistical downscaling methods and products for ca electricity system climate planning" and is focused on techniques for downscaling climate projections to provide improved resolution of CA's highly varied meteorological conditions. The second, "Development and evaluation of high-resolution

historical climate dataset over CA" is focused on improving the spatial/temporal resolution of historical climate data, and enhancing prediction of the risk of compound climate events.
- Two additional projects will start in the next few months. "Development of climate projections for CA and identification of priority projections" will provide projections with high spatiotemporal resolution and point projections to meteorological weather stations of interest. It's utilizing novel bias correction and downscaling techniques, and the project will support of the 6th state climate change assessment (these are in collaboration with Alex Hall's group). Finally, the Commission has funded Eagle Rock Analytics to develop a stakeholder informed, co-produced, climate data and analytics platform, which will support CA's electricity sector resilience investments. The results will include tools to help users select the most appropriate model and interpret the outcomes.

### Tahoe Conservancy (Jason Vasquez)

- Focused on understanding the implications of climate change impacts on forest and watershed management. Just completed some work to downscale climate projections to the Tahoe basin, and to determine impacts of these climate projections (drought stress, precipitation, peak runoff, etc.) on upland water/lake resources for the Tahoe basin.
- Their involvement with Tahoe Sierra Central Initiative includes collaborating with PSW to look at habitat connectivity as it pertains to different climate models, scenarios, and management scenarios.
- Working with the Nature Conservancy on smoke emissions modeling for the TCSI landscape.

### Department of Conservation (Nate Roth)

- Upcoming coordinator grants for watershed planning
- Regional Forest and Fire Collaboration programs (focus on treatment applications).
- Geologic Hazards Program is involved in post fire geologic stability and hazards analyses.
- Tracking carbon capture and storage activities

### CA Department of Fish and Wildlife (Melanie Gogol-Prokurat)

- Data are publicly available in BIOS system, can be viewed or downloaded. The system houses more than 2500 spatial datasets developed by CDFW scientists and partnerships. Includes vegetation classification and mapping program - CA version of National program. Have a new map of Modoc region, and southern sierra foothills and southeastern CA are in progress. These will add nearly 4 million acres of fine scale mapping for the State. These could be useful for field validation or data inputs. Also have associated field plot data.
- Conservation Analysis Unit conducts landscape scale spatial analysis and maintains data on species distributions and statewide biodiversity metrics.

- Areas of conservation (ACE) emphasis project compiles species habitat models, etc. to develop statewide maps of biodiversity, specific habitats and connectivity and climate resilience. ACE brings together best information into standard framework for use in conservation decision-making.
- CA Natural Diversity Database is subscription-based service on rare animals, has a separate database entirely for spotted owls

### CA State Water Board (Greg Gearheart)

- Fieldwork on water quality board functions include overseeing the surface water ambient water monitoring (SWAMP) program, which is a statewide data collection effort, and includes stream pollution and bio assessment programs, which includes an emerging interest in fire response, and synthesizes data and prompts new data collection.
- Opportunity to help refine some of the work and define the need for developing catalogues of data.
- Data Dashboards: all SWAMP data, fire GIS mapping tool which includes BMP performance and water quality data.
- Statewide freshwater harmful algal bloom (HAB) program, which includes monitoring, event response, risk communication and standards development work.

### USFS Region 5 Remote Sensing Lab (Lee Tarnay)

- F3 is the central platform being used as an imputation framework. Supports forest wellness management and operations. F3 also uses standard tools like FIA and FPS, which are plot-based monitoring programs that are mature and peer-reviewed. But F3 adds higher spatiotemporal resolution for all of the attributes from an FIA plot and spreads to any pixel on landscape.
- Merges FIA and the FASTEE map program, which uses LANDSAT, and produces outputs in FCS format that is readily available for modeling and scenario planning (format that can be used by forest management agencies).
- Working on building out platform for forest treatment prioritization for fire treatments, carbon sequestration, etc. (also looking into biodiversity and other elements)
- 30 m resolution, some metrics are updated daily. Includes forests, shrublands, and other parts of wildlands
- Integrated with secure FIA plot data so F3 has to be on secure computing environments so it's a bit of a bottleneck but they are working to moving to a federal cloud computing environment.
- Currently collaborating with CARB and CalFire FRAP to support emissions and carbon mapping needs.

### USFS PSW Research Station (Peter Stine and Pat Manley)

Peter Stine – ForSYS

- Testing ForSys, a scenario planning tool, on a 117,000-acre test area in the Stanislaus National Forest. They've delineated polygons within the test area and defined the objectives and associated metrics
- Test area is done now and are in the process of scaling up statewide over next several months

Pat Manley – Tahoe Central Sierra Initiative

- TCSI is co-led by PSW and TNC. 4 key products:
  (1) Framework for resilience – completed
  (2) Assessment of current conditions that addresses 7/10 pillars from Framework – completed, will be available in next two weeks
  (3) Currently modeling future resilience conditions based on 6 different management scenarios under 5 different climate models. Preliminary results – beetles are a big driver and are quite hard to control via management – mgmt. is more effective at influencing mortality from fire. Their results are seemingly quite similar to Alex Hall's group results.
  (4) Blueprint: very similar to the headwater's project Loretta is leading.

## Distillation of Knowledge Gaps Exercises

Prior to the meeting, invitees were asked to provide a list of existing knowledge gaps in forest and fire science. Meeting coordinators grouped the responses into 7 categories (wildfire, restoration and reforestation, monitoring, wildlife and habitat, climate change, prescribed fire, and forest management).

After the research presentations and lightning talks from researchers and state scientists, all attendees participated in small group discussions about the generated list of possible knowledge gaps. Each small group assessed the list associated with 2 -3 of the categories and determined whether they were true (meaning no scientific research has been done and nothing is known about the topic) or partial knowledge gaps (meaning scientific research is in progress but few conclusions are currently available), or not actually a gap.

Please review the following list of identified knowledge gaps.

## Knowledge gaps

Questions with an * were considered partial knowledge gaps. Research addressing these questions may be underway but few conclusions are currently available, or knowledge is limited to narrow geographic or temporal scales.

### Forest Management

a) What are soil carbon impacts from forest mgmt. in each vegetation type?
b) What are WUI appropriate management strategies that effectively mitigate wildfire across diverse ownerships? *
c) How many forgotten burn piles exist on the landscape and do they have a different decay rate than dead wood in a natural configuration?

### Prescribed Fire

a) How will climate change shift prescribed fire burn windows? *
b) What are effective mitigation strategies for smoke exposure?

### Climate Change *

*These questions were considered partial because they have been partially answered via extrapolated modeling; ground-truthing is needed but is expensive.*

a) What is the end fate and life cycle of carbon under various forest management actions?
b) How does forest management (e.g., fuel reduction) and harvested wood product utilization influence carbon pool dynamics as compared to their fate with wildfire?
c) What is the tradeoff between CO2 fertilization and drought and temp stress on future CA biomass carrying capacity?
d) Should new soil organic carbon inventories be performed in CA forests?
e) How are post-fire forest recovery rates changing due to climate change?
f) What are appropriate reforestation approaches in areas affected by catastrophic wildfire/tree mortality, accounting for future climate conditions, to avoid type conversion?

### Carbon

a) What are soil carbon impacts from forest management disaggregated from by forest type?

b) Who many forgotten burn piles exist on the landscape and do they have a different decay rate than dead wood in a natural configuration?
c) What are WUI appropriate management strategies that effectively mitigate wildfire across diverse ownerships?

### Wildlife and habitat

*Questions in this category were often recognized as partial gaps because they are studied but often only for a small subset of species.*

a) How do species respond to landscape restoration?

### Wildfire

a) What are fuels and other burning materials and/or emissions factors from WUI specific fuels and fire characteristics (e.g., cars, modern homes, etc.)? *

### Reforestation and restoration

*Many of these questions are answered for specific places or events, but generally are true knowledge gaps.*

a) What are the most effective forest management approaches to maintain healthy riparian areas w/in shrublands?
b) What are the most effective strategies for restoration of all aspects of heterogeneity across spatiotemporal scales?
c) How long does soil carbon storage take to recover from major disturbance and or type conversion?
d) How do forest economics drive management decisions – particularly for gasification and other emerging markets *

## Next Steps and Action Items

1. Research teams will consider issues of long-term data exchange and update, as well as opportunities to integrate stakeholder engagement approaches at a future quarterly meeting.

2. Meeting hosts will create and distribute a Google Doc of the identified knowledge gaps for research project teams to supplement with literature, links to existing data sources, etc.