Statewide Forest Science Coordination Meeting
Summary Report

Contents

Purpose and Background

On November 15, 2019 the California Natural Resources Agency and the Strategic Growth Council convened a forest science coordination meeting to support improved understanding of major statewide forest science research underway. The day-long meeting included state and federal scientists as well as research partners, and it focused on four recently funded, major statewide forest science research projects that have commenced work in the past year, to better connect the researchers to one another and with government scientists.

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 data or knowledge gaps;
- Forged and expanded collaboration among focal research project developers, and between government science efforts and research projects.

Attendees

Over 45 attendees from various organizations focused on statewide forest science attended the coordination meeting (see Appendix 1 for photos).

- CA Natural Resources Agency (HQ)- Timber Regulation and Forest Restoration Program; Monitoring and Stewardship Unit
- CA Energy Commission
- CA State Water Resource Control Board- Surface Water Ambient Monitoring Program
- CA Department of Fish and Wildlife – Vegetation Classification and Mapping, Aquatic Bioassessment Lab
- CA Air Resources Board – California Climate Investments; Natural and Working Lands Carbon Inventory; Research; Prescribed Fire and Agricultural Burning
- CA Strategic Growth Council
- CAL FIRE – Climate and Energy; Fire and Resource Assessment Program (FRAP)
- Sierra Nevada Conservancy
- Tahoe Conservancy
- Forest Service – Pacific SW Research Station; Remote Sensing Lab
- USDA Climate Hub
- Spatial Informatics Group
- Laurence Berkeley National Laboratory
- University of California: Berkeley, Irvine, Merced, Los Angeles
- Salo Sciences and Stanford

Research Presentations

Detailed presentations were delivered by the lead researcher of each of the four statewide forest science research initiatives. These presentations included summarizing the research questions, scope of work, data requirements, expected deliverables and data format, user group(s), reporting timelines, and other relevant information. Notes on each presentation are included in the next section, and PowerPoint slides of each can be found in Appendix 2.

Summary and Discussion

The following groups presented:

1. Comprehensive open source development of next generation wildfire models for grid resiliency; **Spatial Informatics Group**, presented by David Saah. (Funded by California Energy Commission EPIC Program)

2. The Future of California Drought, Fire, and Forest Dieback; **UCLA**, presented by Alex Hall. (Funded by University of California Laboratory Fees Research Program)

3. Wildfire Risk Mapping and Early Detection; **Salo**, presented by David Marvin and Christopher Anderson. (Funded by Gordon and Betty Moore Foundation Research Grants)

4. Innovation Center for Advancing Ecosystem Climate Solutions; **UC Irvine**, presented by Michael Goulden. (Funded by CA Strategic Growth Council Climate Change Research Program)

The first two research projects (Saah and Hall, respectively) focus on near and long-term projections of fire behavior and impacts, while the third project (Salo) seeks to improve data quality and availability. The last project (Goulden) focuses on a more holistic assessment of forest ecosystem condition and dynamics as it relates to fire, water quality/supply, biodiversity and otherwise. Taken together, all four projects may complement one another and leverage shared data and analysis to achieve greater outcomes as a collective force.

Discussion, Overlap, Opportunities, Gaps:

- Major areas of research overlap: All four projects cover vegetation dynamics, hydrology, fire spread, fuels, tree mortality, large trees, management.
- Recommendation from discussion: For developing projections, group should think about developing common/consistent scenarios so that across projects we can compare information at different scales.
- In developing future management scenarios, there ought to be research community consensus on what management strategies should be.
    - There will be some emphasis on management from past 35 years as that is what is included in experimental design.

- The group agreed that coordinating models and data is desirable, but all agree that diverse approaches may be beneficial (rather than one approach for all).
- Suggestion: Collaborate on one design that works best to present data in common repository

- Hall Lab is interested in Goulden group's collection of past management/harvest data (to support model run using historical climate data) since Hall Lab does not have this expertise. Ideally 100 years back datasets sought.
    - Degree to which current vegetation state depends on what happened 70-80 years ago is unknown.
    - Timber harvest data/grazing data- lacking emergencies / exemptions spatial information.

- Gap: Need to address sensitive wildlife habitat in modelling: wildlife and biodiversity as element for forest health. Maintaining native biota and communities integrated into analysis. Identify intersection of habitat value and burn probability.
- Gap/action: Better meteorology data should be shared.
- Gap: Determining intensity and frequency of treatment. How can projects inform each other? Orchestrate – what happens if you increase pace, intensity, where, and differential effects?
- Gap: Soil moisture data improvements.

Detail on 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 in Appendix 2.

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. Spatial Informatics Group, David Saah

Project title: **Comprehensive open source development of next generation wildfire models for grid resiliency**

Focus:

Building the Next Generation Near-term & Long-term Wildfire Risk Forecast Models for Enhanced Electricity Grid Resiliency & Public Safety: Given catastrophic wildfire, decreased stability of the electric grid, and rising costs, IOUs require better weather and fire forecasting to protect infrastructure now and into the future and mitigate for wildfire risks. This project seeks to improve near-time almost real-time forecasting for fire.

Geographic Scope:

Long term forecasting will encompass the extent of the Sierras; near-term forecasting will have statewide coverage (possible focus on southern California); historical analysis will be statewide; statistical burn area projections will be statewide.

Research Team:

Representation from various UC campuses, national Labs, national research institutes, federal partners, and private consultancies. Project team organization includes 4 working groups (e.g. group focused on quantifying extreme weather) with a full project integration team.

Analysis:
Integrate to "resilient grid" in form of tactical responses and strategic build out

Workflow:

- Start with end users—IOUs and stakeholders—review existing practices/needs assessment.
    - Documentation of user needs
    - Existing practices
    - Planned activities
    - ID long term scenarios
- Extreme weather—Ross Weather Station
    - weather patterns changed (blind spot)
    - technology has improved
- How to characterize at granular level extreme weather / fire events?
- Tree mortality:
    - Methods and mechanisms for characterizing those fuels
    - Field level understanding then scale this up—how to potentially use in operational setting
- Review of existing knowledge—match with fuel load. Analyze if capturing on-the-ground reality.
- Integrate existing studies
- External Research collaboration opportunities
    - Special team focused on those operations
    - Focus on scenarios—how to incorporate WUI
- Pull into common platform—near real-time of forecasting. Tactical tool/approach. When a fire does occur, what's the 0-7 day forecast?
- What resolution is most feasible?
- Spread/extent of specific fire emission.
- How does it work?
- Existing weather forecasts + operational fuels layers + topography layers
- Feed into operational model (uses two—CPUC and CAL FIRE)
- Real time fire location data (NASA / NOAA)
- Build fire spread forecast and distribute to a tool that's user friendly
- Outputs
- Forecast burn probabilities
- Long-term: statistical dynamics of fire climate change models to run analytics and support fifth assessment.

- Hybrid statistical dynamic weather model
- Use to inform near real-time monitoring
- Risk projections:
    - Partner with CAL ADAPT and improve upon existing data
    - Ensure data products are useable and available
- Short-term: fire probabilities
- Once steps are in place, "is this working?"
- User Engagement Workshops
- Operationalizing—stakeholder parties, put into setting for risk forecast
- Long-term projections
- Assumption: outputs we take will help develop outcomes and that will lead to impacts on the ground.
- Weather station siting framework
- Extreme weather historical analysis report and data archive
- State of wildfire science report
- Contemporary tree mortality report and data archive
- Near-term forecast modeling framework, data archive, decision support tool
- Long-term risk projection model framework, data archive planning support tool
- Cost benefit analysis
- Near-term integration
- Aggregation

Models:

- Seeking to develop automated near real time near-term fire forecasting (0-7 days). Models – ELMFIRE/GRIDFIRE (linked to WRF-Fire). Includes weather forecast, fuels and topography, real time fire location data, fire spread forecast generated by the model.
- Long term risk projections model assessment (~every 5 years) and refinement/development- statistical/dynamical fire-climate-vegetation models to run long-term to end of century wildfire risk projections. (input from downscaled climate data). LANDIS II, statistical burn area projection modelling, downscaled CMIP data
- CAWFE: Coupled Atmosphere-Wildland Fire Environment model
- WUI to be incorporated. Build predictability curves – based on all the simulations, and fire weather patterns.
- Integrate with Cal-Adapt and long-term risk projections. Fire behavior change, ignition change.
- Once those building blocks are complete – check in, is this working? If so, work with IOUS to use for risk forecasts and integrate long-term risk projections into the Fifth Climate Change Assessment.

Planned Deliverables:

- Weather station siting framework
- Extreme weather historical analysis
- State of wildfire science report
- Tree mortality report and data archive
- Near term forecast modelling framework/decision support tool

- Cost/benefit analysis and fact sheets
- Near- and long-term results integration open source code for all modelling
- Open, transparent, distributable platform.

Issues or Gaps Identified:

Possible tie in to SB 209, Cal OES, IOUs, CalFIRE and others working on fire prediction center. Operational by 2022. Short term analytics for forecasting for operations. David Saah is interested in being connected.

Timeframe:

Spring 2024

2. UCLA, Alex Hall

Project title: **The Future of California Drought, Fire, and Forest Dieback**

Focus:

Improve understanding of interactions among vegetation, climate change and fire. Focused on future projections: fire, climate, tree mortality.

Geographic Scope:

Sierra Nevada; extend analysis to coastal landscapes including Central/Southern California.

Research Team:
Representation from various UC campuses and National Labs

Analysis:
Historical analysis highlights: What has been the role of climate change, and how has it affected fire to date (relating to forest dieback and fire events)?

- Sierra Forest Die-off linked to multiyear deep soil drying
  - Death of trees linked with water balance changes over a few years
  - Landsat data to map tree mortality during drought—strong link between tree mortality and water balance
  - Way to predict tree mortality via metrics i.e. drought duration
- VIIRS Satellite data—high resolution (375m)
  - Develop metrics: burnt area increase
  - Rate of spread
  - Fire direction
  - Length of the fire line
  - Using satellite to measure how a particular fire behaves
  - Link to climate principles
    - Temperature vs burned area → number of fires
    - 1 degree C increase → increase in number of fires
- Group modeling historical fire dynamics—multiple climatic variables to relate fire behavior to climate.
  - PRISM/GridMET/TerraClimate (1984-2017)

- Ignition dynamics linked to heatwave events
    - Generate daily/monthly ignition probability
        - Human vs natural (more sensitive to heatwaves)
- Probability of fire

Models:
Working with dynamic climate and veg models. Goal to take vegetation and fire models and adapt to California-specific ecosystems.

- Dynamically downscaled CMIP+FATES (climate and vegetation model landscape projections) factoring in weather
- Model Activities
    - Climate modeling (historical/future 1990-2100)
    - 3km resolution climate simulations
    - Extended time series
    - Dynamical downscaling of CMIP6 GCMs
        - IPCC assessment
        - Downscaling 5 GCMs across and within models
    - Downscaling most extreme atmospheric river events paired with future events (underscores that wet extremes are likely to increase in future-affecting tree mortality and fire and build-up of fuels)
- Vegetation Modeling
    - Developed by global modeling community. FATES vegetation model is set up for global models, primarily tropical forests (it would have to be adapted to fit CA)
    - Patches of different vegetation states includes the dynamic between soil and atmosphere, rooting depth and growth of vegetation → applies to tree mortality work
    - Starting with Sierras, the scope focuses on mixed conifers with potential to expand, for example, by spinning up efforts to capture shrub regime in southern/coastal CA
- Fire Model (SPITFIRE) linked to FATES model
    - Simulation of fire behavior: impose fire ignition, rate of spread and intensity, interactions with vegetation model (i.e. tree mortality)
    - Has to be adapted for CA application
    - Working on improving simulation of Crown Fire
    - Fire alters forest structure and fuels which alter future fire behavior
    - Now adding crown fire and sensitivity to canopy moisture
    - Trying to capture dynamics when fire or disturbance, effect a dramatic change in vegetation and regrowth

Planned Deliverables:

- Projections
- Spatially explicit maps
- Data products
- High-spatial resolution simulations of climate, vegetation, wildfire through 21st century
- Key questions to be answered: How can vegetation and fire management alter/influence outcomes in the state?

Issues or Gaps Identified:
- LANDIS—drought is not captured realistically
- Important to include biology (i.e. bark beetle modeling)
    - Los Alamos partner is working on this critical component. Mountain pine beetle and western pine beetle modeling nested within PHASE are at very early stages.

Timeframe:

Spring 2021

3. Salo Sciences, David Marvin and Christopher Anderson

Project title: **Wildfire Risk Mapping and Early Detection;** dynamically mapping forest structure and wildfire hazards with deep learning.

Focus:

Develop a forest monitoring system that incorporates: ecosystem patterns, processes, services (how people benefit from nature/interact with natural systems); patterns (increase in temperatures) and drivers of change (emissions, climate change, land management) and management activities to derive analytical tools and mapping tools with the hope to support next generation of fire modeling.

Geographic Scope:
Statewide

Research Team:

Salo, Planet Labs, TNC

Analysis:
- Data Outputs:
    - Canopy fuels (cover, height, bulk density, base height, ladder fuels), surface fuels (using Anderson—18 classes or Scott & Burgan—40 classes), existing vegetation type (18 classes)
    - Real-time predictions of fire spread based on current ignitions
    - Can simulate how a fire will spread after ignition under different weather conditions
- Beta risk assessment:
    - WIFIRE
    - How do fire behavior models change with higher-resolution datasets? What are the differences? How to fire parameters shift?
    - Synthesize into metrics of exposure—intersecting fire and population data re ignition and spread. Still in process of defining exposure model.
- How:
    - Airborne LiDAR—existing; ESA Sentinel-2 (optical) 10 m resolution 6 bands 5-day frequency; ESA Sentinel-1; Main tool- Planet Labs—produce 3m resolution imagery every day.
    - Deep Convolutional Neural Networks—takes the context of an image into account by filtering across an entire area. These Networks can stack models

together (millions of parameters), learn about the structure of patterns, and scale across more general regions.
    - Tree height—LANDFIRE—30m resolution updated every 2 year
    - Scale: State and County
        - Landscape scale doesn't capture forest details particularly well.
        - It's possible to see the actual structure of forest and how fire interacts from one model to the next.
    - Tree height predictions ~ 4 m vertical.
    - Forest Cover—Modeling test data against 5-year old data
  - Developed new forest cover map in CA (differs from Forest Service)
    - Want to develop consistent internal dataset
    - Still need validation to compare

Models:

Parametric and non-parametric techniques/remote sensing models.

Planned Deliverables:

- A statewide map of tree mortality from high resolution satellite imagery for (existing; 2016)
- Individual tree mapping
- Planning tools (thinning/prescribed burn treatments, restoration planning, land-based carbon mitigation)
- Reporting and evaluation tools (risk assessments, emissions reporting)
- Assessment and response tools
- Earth Engine – models and publicly available, access assets
- Partnered with Vibrant Planet to make a better access point and front-end interface to visualize data, conduct analytics, and gather data from back end.
- Planet interface – decision support system for land managers, community collaboratives to use science to drive action on land.

Issues or Gaps Identified:

Validation of modelling work needed.

Data access and platform sharing of interest to entire science team across projects. Talk about possible data sharing platform that is linked moving forward.

Timeframe:

Next 6 months.

4. UC Irvine, Michael Goulden

Project title: **Innovation Center for Advancing Ecosystem Climate Solutions**

Focus:

Using spatially explicit datasets to assess how to manage forested ecosystems in a changing climate, with a focus on provision of water, wildfire hazard, carbon stocks, and overall forest health/condition.

Geographic Scope:

Sierra Nevada Mountain Range (to start)

Research Team:

Universities and US Forest Service

Analysis:

Tasks:

- Providing data and mapping
    - Assemble/create geospatial datasets of carbon stock, wildfire spread, water balance, and forest health over decades
    - Need: as many data layers as possible
    - Ecosystem service quantification: carbon, biomass, water, fire, die-off
    - Assessing management effects
        - Apply retrospective and ongoing observations of ecosystem function to past projects to learn what has and hasn't worked
        - Informing adaptive management
            - Exchange information with managers at demonstration scale in ongoing projects and through web tools
        - Valuing and financing
            - Quantify value of management on carbon, water, wildfire and other co-benefits
            - How to put into framework for comparing relative importance of carbon / water benefits?
- Strategy
    - Combine data layers and use as predictors of ecological function/ecosystem services
    - Predict how different controllers impact various ecosystem services
    - Create/display polygons of management type
- The strategy will consider past management regimes; create new datasets; and organize, project and homogenize existing datasets. Doing internally. If useful, UC is happy to share the strategy.
- What to trust and when to trust it?
    - Trying to identify strengths/weaknesses/caveats associated with each dataset.
- Ultimate goal: Understand the effects of a range of management options on key ecosystem services (business as usual/harvest/big trees). This information would be useful for informing management decisions.
- Moving forward:
    - Receive and incorporate input/ideas on the project direction, communication, and coordination
    - Identify and access GIS layers
    - Input, test, and use web tools
- User groups – higher level planners and managers across multiple scales

Models:

N/A

Planned Deliverables:

End tool to assess the impacts (possibly the cumulative impacts) of management on forested ecosystems of Sierra Nevada at watershed scale.

Issues or Gaps Identified:

Need help identifying and accessing existing GIS layers – especially historical management on non-USFS land (seconded by Alex Hall- need management data as far back as possible as current vegetation state depends on management practices a century ago)

Initial suggestions:

- Agricultural and Natural Resources hosting data (Extension services);
- RSL-CAL FIRE Change Detection Project- look at change/cause analysis. CAL FIRE can share THP data and CALMAPPER data

Timeframe:

Approximately Fall 2023.

California Agency Staff Lightning Talks

Following the major research presentations, government scientists delivered a high-level summary of their work focus/research to broadly inform the group of their focal work areas:

1. Loretta Moreno, CNRA - AB 1492 Ecological Performance Measures: Timberland Ecosystem Monitoring and Assessment

Statewide timberland ecosystem monitoring and assessment as an accountability measure for the multiple State programs that regulate timber management on nonfederal forestlands. *Reporting to Board of Forestry and Legislature.

- Harnessing data from existing monitoring programs across State and Federal resource agencies, establish a spatially explicit, consistent monitoring approach to track forest ecosystem condition over time at a regional scale.
- Results will be used to inform decision makers in their work to support adaptive management of timberlands and to help ensure the accountability of State-led forest management regulatory programs.
- Looking beyond the mandate of AB 1492, the EPM approach may also assist in the evaluation of State and Federal programs to invest in forest health and resilience.
- Appears to link very closely to Goulden et al. (SGC funded project).

2. Andy Rehn, Department of Fish and Wildlife - Aquatic Bioassessment Lab

Stream monitoring on a statewide scale in partnership with many federal, regional, and state agencies. Stream health measures include ecological indicators whereby

site conditions are scored to generate indices that allow for comparable analysis of stream health for bugs, algae, and physical habitat. CDFW maintains programs related to forest science research including perennial streams assessment, and statewide probabilistic survey with sampling sites chosen randomly.

3. Chris Keithley, CALFIRE - Fire & Resource Assessment Program (FRAP)

Forest carbon accounting, AB1504 need – annual forest carbon reporting for board of forestry and fire protection. How best to minimize loss from wildfire, pests, other disturbance. The report informs board members and public at large. CARB is a partner on this. Wildfire Hazard and Risk – mapping. Working on updated fire hazard severity zone mapping. Adding weather/wind data from climate profile into severity zone mapping. The FRAP Research Grant program is a new endeavor.

4. Tim Robards, CALFIRE - climate and energy program

Forest health grants and expanding wood products industry.

- Watershed program – (not represented at the meeting)
- Demonstration State forests – network of 70,000 acres around the state for research and demonstration. Long term datasets go back many decades for permanent plots (often tied into FRAP grants).
- Climate and Energy – forest health monitoring. Look at 10% of CCI projects for 10-year period. 60% of forest health grants going to federal lands to increase pace and scale for innovative wood product solutions. How did fuel loads change over a variety of different treatments? Starting next year to collect data as projects close out.

Additional data needs:

- Siting and facilities to expand pace and scale of private investment dollars.
- Investigate non-industrials.
    - Validation data sets – check State forests. Can combine Forest Service and UC Systems as well as redwood forests for gradients inland from the coast.

5. Diana Hickson, CA Fish and Game -Vegetation classification and mapping program

- Maintain CA expression of wildlife and map the state according to that system. Maps include structure and disturbance factors. 60% of the State is mapped; 40% is mostly non-forested areas.
- National vegetation classification system includes vegetation type data at species level, and plots height, class (plot size: ~100 m squared).
- Funders/Partners: CA Native Plants Society, BLM, Sierra Nevada Conservancy, DWR, SGC, Wildlife Conservation Board.

6. Melanie Gogol-Prokurat, Fish and Game - Vegetation classification and mapping program

- Develop, store, and distribute data for the Department. Spatial data goes into BIOS – biogeographic information and observation system. In house and by partners data sets. Viewer tool: users can view the (mostly downloadable). The system maintains over 2500 datasets.
- CA Natural Diversity Database – rare species observations throughout the state (similar database: spotted owl database). Subscription needed to obtain data.
- CWHR Wildlife Relations Program includes species information, and habitat suitability for terrestrial vertebrates. Free data are available to download in addition to GIS files of species ranges and habitat distribution models.
- Areas of Conservation Emphasis (ACE) – brings together all datasets, maps biodiversity, significant habitats, connectivity, and climate resilience statewide based on best available data.
- Wildlife information link – their tools could be useful

7. Peter Stine, USFS PSW – National Office of Forest Service

Emphasized consideration of a system developed by Alan Ager at Rocky Mountain Research Station. PSW pledge to Region 5 to evaluate tool or platform and consider how it might be used in CA. Forest managers are going to use some system to help decide where to put treatments. Up until now that has been called "expert opinion" – experience of a district ranger or a supervisor and staff. The pressure to increase efficiency is enormous, especially impacting USFS land on neighboring communities. R&D in USFS working with Forest System to evaluate a new system. It behooves us to figure out how to bridge that gap and communicate such findings to forest managers, for example, identifying suitable places for treatments. Regions in forest service are being encouraged to consider multi-objective spatial prioritization system.

8. Shuka Rastej, Water Board – Surface Water Ambient Monitoring Program, Healthy Watersheds Partnership

Watershed assessment tool for managers/planners to use to have a holistic approach. Looking to develop conceptual model, identify key metrics and indicators, gather data, create platform/interface for working product. Web based application for water boards statewide. CNRA, F&W, Regional Boards, TNC, EPA.

9. Pat Manley, USFS Research, PSW - TCSI Initiative

Have come up with 6 management scenarios. Linkages – work the researchers are doing can feed into a template to address a multimillion-acre landscape management options. Input data could also upgrade these models modeling in the future to inform management objectives. Forest growth, beetle dynamics- metrics of biodiversity, drought stress, smoke emissions, timber supply, other forest structure analytics. Management, frequency, type of disturbance.

10. Klaus Scott, Air Resources Board (CARB) - Natural Working Lands GHG Inventory group

Estimating geospatial explicit time series of ecosystem carbon stock and stock change with disturbance attribution across all land categories in CA. Tools built by UCB and SIG. Other partners – FRAP and USFS. Above and belowground carbon pools, soil, fluxes modeling conducted in house (i.e. Adam Moreno – forward projections of ecosystem carbon stocks and flows).

Linkages – forest structure, biomass, carbon, fuels and fire, processes. Wildland urban interface fuel models. Interest in fuel moisture.

11. Alan Talhelm, CARB - California Climate Investments overview

Quantifying benefits from forest work. Linkages – Michael and Roger's project on project level benefits.

Sean Pinnel- State policies that might lead to more carbon sequestration (levers to increase pace scale of restoration). Dar works on permitting for prescribed fire spatial reporting system; forest offset protocol quantifying projects.

12. Sarah Pittiglio, CARB - Research Division

Wildfire impacts on air quality and health. Measuring emissions from prescribed fire. Help air quality modeling group. Indoor air quality in evacuation shelters – equitable access to clean air. Project just starting – Mike Jerod, UCLA – quantify health co-benefits of strategies in NWL that will prescribe in scoping plan to reduce emissions in NWL sector. Reviewing literature to see health benefits of access to forests, urban green spaces. Mike Jarret- health co-benefits of strategies in NWL to reduce GHG emissions in NWL sector

13. Nic Enstice, Sierra Nevada Conservancy

Regional Resilience Dashboard and Investment Plan. Plumas Digital Random Access Memory (DRAM) project hazard tree threat map and special species habitat status map with a fire threat layer. Dr. North is coordinating with project managers at Plumas National Forest to improve resilience through products.

- CCI projects – Historic range of variation – TCSI. Forest structure that should have been there historically, to understand what it should be.
- El Dorado lidar acquisition
- Carbon accounting – landscape program. 2012 and 2017 lidar data sets for Tahoe National Forest. In discussions to leverage high resolution data from this to inform fuel modeling in FRAP, inventory work of frap and carb, and landscape carbon accounting of what has changed 2012-2017 and compare to inventories.

14. Elea Becker Lowe, CNRA Monitoring and Stewardship Unit

- Established Fall 2018, MSU is a relatively new unit of CNRA looking to develop a process to track the return on investment from bond-funded projects across the State.
- Projects of interest relate to forest science – habitat restoration and conservation, water supply, water quality, fuel load reduction, GHG sequestration, etc.
- Working to define metrics to track performance of projects and methodology.
- The team is currently developing stakeholder coordination process to determine monitoring protocols as a means of measuring the long-term performance of projects (determining the effectiveness and lasting benefit of work completed over a period of at least 10 years) and informing the development of an adaptive management process for CNRA-affiliated projects, starting with bond-funded work.

Distillation of World Café Exercise

After the series of presentations from researchers and State scientists, a collaborative "World Café" session was held with all participants. This session addressed two of the meeting's key objectives; to 1) Identify possible data or knowledge gaps; and 2) Forge or expand collaboration among focal research project developers, and between government science work and research projects.

Participants clustered in groups and engaged in discussion and diagramming to document data needs, data being produced by various efforts, and where that data could fill a need. The topics were organized around Carbon, Water, Wildlife/Biodiversity, and Fire.

The following outcomes were recorded and reported at the end of the meeting. **While which agency or organization can meet the data needs was not documented fully, we encourage participants to be in touch with each other to foster collaboration and data sharing.** Generally, it was noted that many data needs can be met by State agency programs; the organizers encourage communication and collaboration with and between State scientists.

The following list summarizes and provides examples of what was discussed. Overall, the exercise demonstrated there is a lot of information and data needed, a lot of information and data that already exist, and it allowed an opportunity for dialogue and to share resources.

CARBON

Data Needs Met:

- Management and disturbance maps (existing and new research)
- Structure Maps (SNC, CDFW)
- Vegetation Maps (CDFW)
- Spatial Informatics Group can provide: Lidar datasets (field-based carbon estimates)

Data Gaps:

- WUI fuel models (EPIC building)

Data Improvements Needed:

Project cost (per carbon acre)

WATER

Data Assets/Needs Met:

- LANDSAT
- LANDFIRE
- CA Forest Observatory
- VegCamp
- Gridded water balance dataset
- Space Station LIDR map for water (Jet Propulsion Laboratory—JPL)
- Snow particle level
- Site based water balance (soil, precipitation, ground water)
- Evapotranspiration data
- Basin-scale hydrologic observatory (upstream)
- JPL ECOSTRESS
- Snowpack Lidar (Harpold; Bales; JPL; NSF)
- Water—Co2 research (Bales; Tague Lab, UCSB)
- CA Ecosystem futures
    - Snowpack prediction
    - Precipitation extremes
    - Wildfire—watershed impacts

Data Gaps:

- Real-time dynamic monitoring of forest change
- Real-time dynamic monitoring of *water* change
    - Effects of Disturbance on snow, water supply and quality
        - Evapotranspiration
        - Soil moisture
        - Vegetation moisture
- Vegetation and soil moisture (wildfire drivers)
- More/Improved working precipitation monitors
- Flooding
    - Disturbance connection
- Water availability post water rights cashed in

  - National cap solutions scenario tools with disturbances
  - Need better water rights database

WILDLIFE

Data Needs Met:

- Timber harvest (spatial needs)
- High resolution vegetation data capable of fueling a wildlife habitat model for selected species
- Forest structure Lidar
- Past management scenarios spatial layer
- Find-scale heterogeneity of forest structure (tree distribution)
- Species observations
- Statewide roads layer
- Habitat models
- Empirical wildlife and plant data

Data Gaps:

- Climate resilience maps
  - Habitat resilience regarding fire scenarios
  - Habitat vs burn probability
- Habitat connectivity
- Grazing management affecting stream quality
- Large-scale high severity events
  - Impacts

Data Improvement Needed:

- Vegetation inventories
- Species observations
- Timber harvest
- Vegetation metrics are not necessarily comparable to fuel metrics
- Spatial scale variance

FIRE

Data Needs Met:

- Fire burn probability
- Management scenarios
- Development scenarios
- Forest Data (Salo can provide to VegCamp)

Data Gaps:

- Future ignitions scenarios
- Wind data
- Fuel management projects
- Post-fire conditions/recovery
- VegCamp needs forest data population density
- WUI fuels models

- Wildfire spread
- Annualized high intensity burn probabilities
- Fire Response function v-v fire intensity
- Fuel moisture/maps
- Forecasted short-term fire weather
- Surface fuels—understory/species
    - SNC/RSL—Tahoe El Dorado
- Species occurrence
- Fire severity maps

Data Improvement Needed:

- Wildfire perimeters
- Fire behavior fuel models
- High resolution climate stack
- Geospatial data on characterizing

Next Steps and Action Items

1. Research teams will set up quarterly meetings among 4 major research grantees.

2. Aim to hold an Annual Forest Science Coordination meeting to share products and build mechanism to refine RFPs, to address needs of the field and to avoid duplication and steer funding to needed research and/or data.

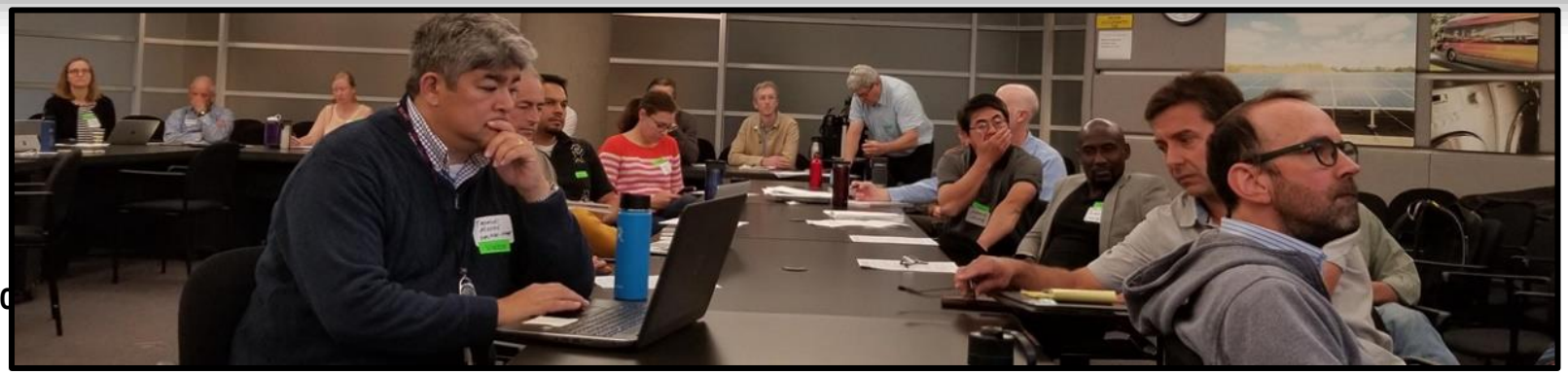
3. Seeking partners/volunteers to establish informal communication platform (Slack? Google group?) to continue notifying group of statewide forest science related news, data, publications, and project-related achievements/updates.

4. SGC can connect researchers to State staff/agencies as needed, for any program or agency who did not attend. For instance, David Saah with Fire Prediction Center efforts.

5. SGC and CNRA will use this report to update agency leadership.

Appendices

Appendix 1: Event Photos



Appendix 2: PowerPoint Slides Combined in Order Presented at Meeting

**Attached in email that accompanies this report.*