California Wildfire Resilience Core Metrics Rating Process and Results

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Prepared for the California Wildfire & Forest Resilience Task Force

by

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Photos: Top row, left to right: Fire in the Wildland-Urban Interface (CALFIRE), Giant Sequoia Emergency Response USFS crew (USFS Region 5), Little Lakes Valley, Eastern Sierra (Jeff Pang); Bottom row, left to right: interagency archeology and cultural fire workshop with tribal members near Mariposa, CA (CALFIRE), Sequoia Kings grove (National Park Service, nps.gov).

Context and Purpose

At the request of the California Wildfire & Forest Resilience Task Force (Task Force) leadership, the Science Advisory Panel (SAP) developed an approach to provide timely science support for the Task Force's effort to identify a set of core reporting metrics. These core reporting metrics will be used for measuring progress towards achieving three broad goals related to wildfire resilience: reducing risk of wildfire, improving ecological integrity, and supporting social and cultural wellbeing. Such reporting will support the Task Force's understanding and communication of the impacts of implemented projects and investments.

This briefing provides a high-level overview of the process, results, and conclusions. A more detailed assessment and interpretation of the results is available here: https://doi.org/10.58076/C6MW2P

Process

The project team developed a structured process for eliciting scientific input on identifying core reporting metrics, which centered on two sequential rounds of surveys. The surveys were open to members of the Science Advisory Panel, as well as additional invited academic or agency scientists with relevant expertise, such as hydrology, vegetation management, fire ecology, or social science. In both rounds, respondents reviewed only those metrics relevant to their self-identified expertise(s).

The Round 1 survey sought feedback on proposed criteria for core reporting metrics, and a cursory review of the suitability for inclusion of each candidate metric. The set of candidate metrics was derived from the existing Task Force Regional Resource Kits (RRK), which each include approximately 100 management-relevant metrics curated and compiled by an interagency team of scientists. The project team used a simplified comprehensive list of metrics from all four RRKs in Round 1, and requested respondents rate the suitability of each metric (from 1 (low) to 5 (high)). Respondents were also invited to suggest additional (i.e., absent from the RRK-derived set) candidate core reporting metrics.

In preparation for the Round 2 survey, the project team removed metrics with an average suitability rating of less than 3 (out of 5) and added suggested metrics from Round 1 to the candidate list.

The Round 2 survey sought relative rankings of the importance of the three resilience goals and of the attributes for core reporting metrics, as well as a more detailed evaluation of each metric. For the detailed evaluation, respondents were instructed to:

- rate the usefulness of each metric for measuring progress towards the three resilience goals on a scale of 1 to 5 (low to high);

- rate each metric's feasibility (i.e., how realistic it is to remeasure), understandability (i.e., how easy it is to explain to wider audiences), and sensitivity to the process of interest, each on a scale of 1 to 5 (low to high);
- indicate for which Task Force regions of California each metric was relevant

Key Results

Round 1 Survey

- Respondents generally agreed on criteria for core metrics. Core metrics should:
    - Be feasible to re-measure periodically using consistent and validated methods
    - Be relatively easy to understand and explain to non-scientific audiences
    - Be able to be reasonably aggregated from local scales to a statewide scale
    - Be able to capture a range of variation necessary for demonstrating changes in resilience
    - Be relevant to a range of both ecological and social values
    - Not be overly redundant or correlated with each other

- Respondents proposed an additional 40 candidate core reporting metrics, which varied in terms of current application readiness.

Round 2 survey

Relative rankings

- On average, respondents rated reducing wildfire risk as the most important resilience goal, followed closely by ecological integrity; social/cultural wellbeing was rated as more important than neutral, but lower than the other two goals.

- Respondents rated sensitivity of a core reporting metric as the most important attribute, followed closely by feasibility; understandability was slightly more important than neutral.

Metric evaluation

- Out of 115 metrics, 72 were rated highly useful for reporting on progress toward one or more of the three resilience goals. 15 metrics were rated highly useful for reporting on progress toward two or more of the three resilience goals. **Probability of high severity fire** was the only metric rated highly useful (average > 4.0) for reporting on progress towards all 3 resilience goals (Table 1).

    - Many, but not all, metrics were *not* considered useful for measuring progress towards supporting sociocultural wellbeing. Generally, more metrics were rated highly useful for reporting on progress towards goals of improving ecological integrity and reducing wildfire risk.

- Candidate metrics rated most useful for reporting on progress towards resilience goals were *not necessarily* the same metrics rated most feasible or sensitive to the process of interest (Tables 2 - 7).

    - Although **probability of high severity fire** was the only metric rated highly useful (average > 4.0) for reporting on progress towards all 3 resilience goal, this metric was rated moderately feasible and sensitive (average 3.76 and 3.81, respectively).
    - **Cumulative Tree Cover Lost, Recent Fire Severity, Time Since Last Fire, and Tree Mortality** were all rated highly useful (average > 4.0) for reporting on progress towards reducing wildfire risk and increasing ecological integrity, they were rated moderately useful (average > 3.0) for reporting on improving social and cultural well-being, and all four metrics were also rated highly feasible and sensitive (average > 4.0).

- The project team compared metric ratings when weighted by the relative rankings of the three goals and by the relative rankings of the three attributes.16 metrics currently available in the RRKs fell within the top 10 scores of either the weighted by relative goal ratings or the weighted by relative attribute ratings; of those metrics, four (**Recent Fire Severity, Time Since Last Fire, Tree Density, and Tree Mortality**) fell within both top 10 lists (Table 8).

Conclusions and Considerations

The core reporting metrics are intended to measure progress towards achieving three broad goals related to wildfire resilience: reducing risk of wildfire, improving ecological integrity, and supporting social and cultural wellbeing. However, few of the considered metrics are strong candidates for measuring progress towards *all three goals*. This emphasizes the need to decide if every metric within the core reporting subset must be useful for reporting on all three broad resilience goals, or if it is sufficient that the core reporting metrics as a whole address all three goals.

Furthermore, the survey results emphasize that there are tradeoffs for most metrics in their usefulness for reporting on progress towards a goal, with their sensitivity to changes as a result of management action, their feasibility to measure, and or their understandability. These tradeoffs complicate selecting a set of core reporting metrics. For example, accurate reporting on progress towards goals may favor metrics with high sensitivity and usefulness to multiple goals; however, demonstrating value of investments to legislators may favor metrics with higher understandability. Decisions about balancing these tradeoffs should be made transparently.

Finally, in both surveys used in this project, more respondents indicated their expertise was related to vegetation and fire ecology or management, than hydrology or sociology.

To report on progress towards increasing socio-cultural well-being, the Task Force may need to explore and or invest in metrics not included in the RRK that are not currently application ready.

Appendices

Table 1. Metrics that were rated highly useful (average score ≤ 4 out of 5) for at least two of the three goals.

Metric	Goal		
	Reducing wildfire risk	Improving ecological integrity	Supporting social and cultural wellbeing
1. Probability of High Severity Fire	X	X	X
2. Tree Density	X	X	
3. Proportion of Max Stand Density Index	X	X	
4. Vegetative Stress During Extreme Drought	X	X	
5. Tree Mortality	X	X	
6. Time Since Last Fire	X	X	
7. Mean Percent FRID since 1970	X	X	
8. FRID Condition Class for Departure	X	X	
9. Recent Fire Severity	X	X	
10. Probability of Moderate Severity Fire	X	X	
11. Duration of effect of management action	X	X	
12. Evacuation capacity	X		X
13. Damage Potential in WUI	X		X
14. Structure Exposure Score In WUI	X		X
15. Firewise approved communities or communities with Community Wildfire Protection Plans	X		X
16. Insurance availability price	X		X

Table 2. The metrics with top 10 highest ratings for sensitivity to the process of interest.

In RRK?	Metric	Avg. Sensitivity Rating
No	Insurance availability price	**4.29**
Yes	Tree Mortality	**4.23**
No	Repeated High Severity Fire	**4.14**
Yes	Density (Trees Per Acre)	**4.08**
Yes	Time Since Last Fire	**4.00**
Yes	Recent Fire Severity	**4.00**
Yes	Cumulative Tree Cover Lost	**4.00**
Yes	FRID Condition Class for Departure	**4.00**
Yes	Mean Percent FRID since 1970	**4.00**
Yes	Vegetative Stress During Extreme Drought	**4.00**

Table 3. The metrics with top 10 highest ratings for feasibility to measure.

In RRK?	Metric	Avg. Feasibility Rating
No	Repeated High Severity Fire	**4.76**
Yes	Time Since Last Fire	**4.72**
Yes	Housing Burden	**4.60**
Yes	Current FRI since 1970	**4.57**
No	Climatic Water Deficit	**4.53**
Yes	Recent Fire Severity	**4.50**
Yes	Poverty	**4.50**
Yes	Unemployment	**4.50**
Yes	Low Income Populations Proportion	**4.50**
Yes	Annual Mean Runoff	**4.40**

Table 4. The 10 metrics rated as most useful for measuring progress towards the wildfire risk goal.

In RKK?	Metric	Avg. rating of usefulness for Wildfire Risk goal
Yes	Wildfire Hazard Potential	**4.82**
Yes	Probability Of High Severity Fire	**4.82**
Yes	Damage Potential in WUI	**4.67**
Yes	Standing Dead and Ladder Fuels	**4.65**
Yes	Total Fuel Exposed to Fire	**4.57**
Yes	Total Dead Down Fuels	**4.52**
No	Built Environment Domain Hardening	**4.45**
Yes	Probability Of Ignition from humans or lightning	**4.41**
Yes	Density (Trees Per Acre)	**4.38**
Yes	Tree Mortality	**4.36**

Table 5. The 10 metrics rated as most useful for measuring progress towards the ecological integrity goal.

In RRK?	Metric	Avg. rating of usefulness for Ecological Integrity goal
Yes	Tree Mortality	**4.68**
No	Ratio of high to low moderate severity wildfire	**4.60**
Yes	Shrub Resiliency	**4.54**
Yes	Vegetative Stress During Extreme Drought	**4.50**
No	Repeated High Severity Fire	**4.50**
Yes	Recent Fire Severity	**4.44**
No	Areas of low potential shrub regeneration	**4.42**
No	Beetle Sensitivity	**4.42**
Yes	Meadow Sensitivity Index	**4.38**
Yes	Multi stressor Refugia	**4.38**

Table 6. The 10 metrics rated as most useful for measuring progress towards the sociocultural well-being goal.

In RRK?	Metric	Avg. rating of usefulness for Sociocultural Well-being goal
Yes	Damage Potential in WUI	**4.87**
No	Health outcomes related to air quality	**4.87**
Yes	Poverty	**4.83**
Yes	Tribal Lands	**4.71**
Yes	Low Income Populations Proportion	**4.67**
Yes	Structure Exposure Score In WUI	**4.64**
Yes	Housing Burden	**4.60**
No	Insurance availability price	**4.57**
Yes	Unemployment	**4.50**
No	CalEviroscreen score	**4.50**

Table 7. Metrics included in more than one of the top 10 ratings for: usefulness for wildfire risk goal, usefulness for ecological integrity goal, usefulness for sociocultural well-being goal, sensitivity to the process of interest, or feasibility to measure the metric; and whether the metric is currently included in an RRK.

In RRK?	Metric	Top 10 Lists
Y	Damage Potential in WUI	• usefulness for measuring progress towards **wildfire risk goal** • usefulness for measuring progress towards **sociocultural well-being goa**l
Y	Density Trees Per Acre	• **sensitivity t**o the process of interest • usefulness for measuring progress towards **wildfire risk goal**
Y	Housing Burden	• **feasibility** of measuring • usefulness for measuring progress towards **sociocultural well-being goa**l
N	Insurance availability price	• **sensitivity t**o the process of interest • usefulness for measuring progress towards **sociocultural well-being goa**l
Y	Low Income Populations Proportion	• **feasibility** of measuring • usefulness for measuring progress towards **sociocultural well-being goa**l
Y	Poverty	• **feasibility** of measuring • usefulness for measuring progress towards **sociocultural well-being goa**l
Y	Recent Fire Severity	• **sensitivity t**o the process of interest • **feasibility** of measuring • usefulness for measuring progress towards **ecological integrity goal**
N	Repeated High Severity Fire	• **sensitivity t**o the process of interest • **feasibility** of measuring
Y	Time Since Last Fire	• **sensitivity t**o the process of interest • **feasibility** of measuring
Y	Tree Mortality	• **sensitivity t**o the process of interest

		• usefulness for measuring progress towards **wildfire risk goal** • usefulness for measuring progress towards **ecological integrity goal**
Y	Unemployment	• **feasibility** of measuring • usefulness for measuring progress towards **sociocultural well-being goa**l

Table 8. Metrics included in the top 10 scores when weighted by either the relative goal rankings or the relative attribute rankings. The four metrics bolded and shaded in gray fell within both weighted values' top 10 scores.

Metric	**Weighted Score by Relative Goal Rankings**	**Weighted Score by Relative Attribute Rankings**
Probability Of High Severity Fire	53.56	
Wildfire Hazard Potential	50.05	
Vegetative Stress During Extreme Drought	48.09	
Risk of Tree Dieoff During A Drought	47.65	
Total Dead Down Fuels	46.97	
Damage Potential in WUI	46.55	
Tree Density	46.52	49.50
Recent Fire Severity	49.03	49.37
Time Since Last Fire	47.64	52.05
Tree Mortality	51.52	50.50
Cumulative Tree Cover Lost		48.78
Poverty		50.27
Housing Burden		50.17
Unemployment		49.54
Urban Canopy Cover		48.76
Low Income Populations Proportion		47.89