



A firefighter for the Upper Provo Wildfire washing his hands prior to getting dinner in Kamas, Utah on August 5, 2020. Photo: Charity Parks, USDA Forest Service.

Understanding Limits:

Wildland Fire Response and Pandemic Interactions in 2020

Nicholas McCarthy and David Calkin

Wildland fire management is a complex system with various scales, modes, plans, and operations. As with any system, fire management can be subject to stresses and strains that are, in some cases, easy to identify in isolation but highly challenging to diagnose at a system level. A suitable analogy is the homeostatic range in the human body—that is, the limits on levels such as body temperature, pH, and blood level. Modern medicine has a quantitative understanding of the normal, extreme, and fatal ranges of these indicators.

The 2020 fire year that unfolded concurrently with the COVID-19 pandemic was an exceptional example of interacting stresses on wildland fire

management as a system. As such, it is useful to examine the 2020 fire year in terms of the “homeostatic range” not of human bodies subject to the pandemic but of the equivalent range in wildland fire management.

It was known early on that the emergence of the COVID-19 pandemic in the spring of 2020 could have a significant impact on suppression resource availability and the capability to manage wildland fires in the United States. Led by the Northern Research Station, a rapidly facilitated futuring exercise with a number of fire management stakeholders illustrated four potential scenarios for the upcoming 2020 fire year (see the article by Westphal and others in

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this issue). The sidebar highlights the four scenarios; the objective of the analysis (see Westphal and others) was to characterize each scenario from a diverse set of perspectives and to understand the primary, secondary, and tertiary implications.

The scenarios represented unprecedented challenges. One scenario represented systemic failure defined by:

- COVID-19 transmission within fire camps and the associated health outcomes;
- The potential for transmission across fire camps as the fire year progressed;
- Transmission from infected first responders to communities at large, especially hazardous in remote and vulnerable communities; and
- Diminished responder capacity over time.

With the emerging severity of the COVID-19 pandemic and the bleak seasonal outlooks for the coming fire year, it became clear that a “high COVID, high fire year” scenario in some form was not only possible but likely, as was the need to prepare for it. A structure was needed for moving the interagency fire suppression capability through the five preparedness levels far more rapidly than usual. The implications and the risk of systemic failure called for addressing the corresponding issues as the signals first emerged. Specific triggers were needed for changes in strategic actions beyond the scope of the preparedness level system.

Four Potential Scenarios for the 2020 Fire Year

In a plausible fire year with [scenario # below], what might happen as a direct result?

Scenario 1:
HIGH COVID-19 impacts and **LOW** fire year severity

Scenario 2:
HIGH COVID-19 impacts and **HIGH** fire year severity

Scenario 3:
LOW COVID-19 impacts and **LOW** fire year severity

Scenario 4:
LOW COVID-19 impacts and **HIGH** fire year severity

THE DEGRADATION TREND ANALYSIS TOOL

The Degradation Trend Analysis Tool (DTAT) was developed in late March 2020 at the request of the Risk Management Assistance program.

Its purpose was to analyze and relay the status of interactions between the COVID-19 pandemic and wildland fire management. More specifically, the DTAT was designed to detect any degradation in the wildland fire response system nationwide while tracking its effects on COVID-19 spread and impacts.

The DTAT was to be used on a rolling basis to track status, predict short-term future status based on trend, and provide a rolling evaluation of predictions. The intended outcomes were to:

1. Bring focus to emergent dimensions/ issues at the geographic-area level;
2. Assess trends in the pandemic, incidents, and other factors at the geographic-area level; and
3. Provide a short-listed “menu” of strategies based on an aggregation of COVID-19 impacts (or “C level”), thereby furnishing a structured analysis.

The toolset was designed to inform strategic decision makers at the national and geographic-area levels, including the Geographic Area Multi-Agency Coordinating Group (GMAC), the National Multi-Agency Coordinating Group, senior agency leaders, forest/ district/county leaders, and local partners. Additional ad-hoc users were incident managers, in anticipation of constraints and changes that might be possible on a 2-week horizon. The second sidebar shows the outputs of the structured analysis by COVID (C) level.

Degradation Trend and Analysis Tool

COVID-19 impact/interaction level and associated triggers

Level	COVID Transmission Within the Wildland Fire Community in a Geographic Area	
C1 (level 1)	➤	Incident management teams and county health departments can manage the workload without significant degradation.
C2 (level 2)	➤	Incident management teams and county health departments are overloaded.
C3 (level 3)	➤	Widespread degradation and loss of capability.

The structured analysis had three focus areas:

1. Pandemic dimensions,
2. Incident dimensions, and
3. Geographic-area dimensions.

Figure 1 shows an early iteration of the analysis side of the tool.

DTAT USE IN 2020

Through the Risk Management Assistance program, the DTAT was recommended for trial use by GMAC and evolved considerably throughout 2020. Championed by the Southwest Area and later by the Great Basin Area and Northwest Area, two simple outputs emerged for use:

1. Consolidation of the pandemic category to intersect with the preparedness level system, and
2. Use as a communication tool.

An additional conceivable use was to influence the preparedness level system, but in practice—without engagement by all 10 geographic area coordination centers—the potential for this use was limited. In the absence of national consistency, application for national coordination in the 2020 fire year was ultimately limited. Additionally, concurrent transitions in dispatch reporting technology made the real-time capture of quantitative data, such as UTF (unable to fill) resource requests, reliant on manual reporting.

The tool evolved into a standard online form for data input, but data was collected through a structured conversation with one or more contacts from each geographic area coordination center. Feedback from the Northwest Area highlighted two benefits from the weekly DTAT check-ins:

1. The structured conversations were in an explicit format for revisiting each dimension to examine emergent weakness and strategize response; and
2. The data collection process was worthwhile for capturing the qualitative narrative of what became a historic fire year.

Pandemic Dimensions						
COVID-19 PPE availability	Screening	Testing	Exposure Assessment and Management	Fire to Community Transmission	Public COVID -19 Cases	
Available	Consistent & Effective	Available	Capability maintained	No known or limited transmission	Low to no increase	
Shortages, variable use	Some screening failures	Not widespread	Limited capability	Significant in local trends and context	Upward trend designation, sufficient health resources	
No availability, little use	Screening ineffective	Little to no availability	Little to no capability	Major impacts to sensitive communities	Upward trend designation, insufficient health resources	
Lag	Report based	Days	Days	Report based	Weeks	
Comments	Feedback indicates PPE not made mandatory with variable compliance	Difficulties in self-reporting and screening inconsistency in FFTs are apparent.	Confusions around testing type, responsibility.	Reports indicate local/state health unable to assist in contact tracing. Federal fire/non-fire support not in place to support tracing.	No reported instances of fire response staff transmission from to families or community.	As of 06/22/2020, 2:17 P.M. E.T., cases are on a clear increase in AZ on a 7 and 14 day average. NM now has an increasing cases of the 7 day ave. Increasing 14 day average in 3-4 W. Texas counties is substantial. Based on JHU & NYT dashboards.
Pandemic Dimensions Assessment: LEVEL 2				Trending Towards: LEVEL 3		
Comments: Initial DRAFT assessment. While data is still incoming on hospital/health system capacity in AZ, reports suggest significant strain and trend continues positive.				Comments: Initial DRAFT assessment. As hospital and facilities with critical care fill up, the pandemic environment could substantially worsen in the SWGA.		

Incident Dimensions			
ICS206 form submissions	LODD	Smoke-related COVID -19 Case Severity	COVID in Fire Camps
At or below average	At or below average	Symptoms are less than or equal to "normal" COVID symptoms	Adaptations and precautions working adequately
Above average	Above average	Outcomes are worse than "normal" COVID symptoms on a widespread scale	Minor outbreaks, handled effectively
Well above average	Well above average	Mortality-rate is significantly higher in fire/smoke related cases	Despite precautions fire camps become hotspots.
Lags	Unknown	Days	Weeks
Comments	Data Unavailable, currently assessing sources	None reported to date	No reports on topic to date, though lags will apply
Incident Dimensions Assessment: LEVEL 1		Trending Towards: LEVEL 1	
Comments: Initial DRAFT assessment. Data and reporting limitations apply, in addition to lags apparent.		Comments: Initial DRAFT assessment. No significant incidents reported, although lag times of 2 -3 weeks will likely apply to COVID in fire camp. A major outbreak in a camp could rapidly escalate this to level 2 or 3.	

Geographic Area Dimensions							
Unable to Fill	MEDL UTF	IMT UTF and IMT functions	Vendors and Contractors	IA capacity	Digital Infrastructure	Dispatch	Smoke Impacts
At or below average	At or below average	At or below average UTF, adaptation and functioning adequately	Routine availability	Routine availability in all regions	Comms and remote command functioning adequately	Adaptations and functions working adequately	At or below average
Above average	Above average	Above average UTF, IMTs unable to mobilize with full rosters	Some UTF of critical vendor (e.g. enterers) due to C19	All resource engaged, little to no IA capacity	Minor comms failures and remote command handled effectively	Localized outbreak handled effectively, contingencies work effectively	Above average
Well above average	Well above average	Struggle to meet mobilization minimums, zoning of fires	Large incidents have UTF of critical vendor.	Unable to respond to new incidents	Comms and command failures are ongoing regionally	Multiple outbreaks with failures in contingencies	Well above average
Lags	Days	Days	Days to Weeks	Weeks	Days	Days	Days
Comments	No Data	No Data	Limited data, reports suggest meeting functional standards	No Data	No Data	Based on available reporting	No known reports of outbreaks in dispatch
Geographic Area Dimensions Assessment: LEVEL 1				Trending Towards: LEVEL 2			
Comments: Initial DRAFT assessment. Data and reporting limitations apply, in addition to lags.				Comments: Initial DRAFT assessment. As data becomes available, it's possible to encounter adjustment issues and increasing smoke impacts.			

Figure 1—An early version of the analysis performed with the Degradation Trend Analysis Tool for the Southwest Area. PPE = personal protective equipment; FFTs = firefighters; NYT = New York Times; JHU = John Hopkins University, AZ = Arizona; NM = New Mexico; SWGA = Southwest Geographic Area; ICS = Incident Command System; UTF = unable to fill; MEDL = medical unit leader; IMT = incident command team; IA = Initial attack; C19 = COVID-19; Comms = communications systems.

Ultimately, hindsight provided a more quantitative opportunity to review the interactions of COVID-19 with wildland fire. Figure 2 indicates key COVID-19 metrics within the two geographic areas where the DTAT was tried out; figure 3 shows the time series for a selection of DTAT indicators.

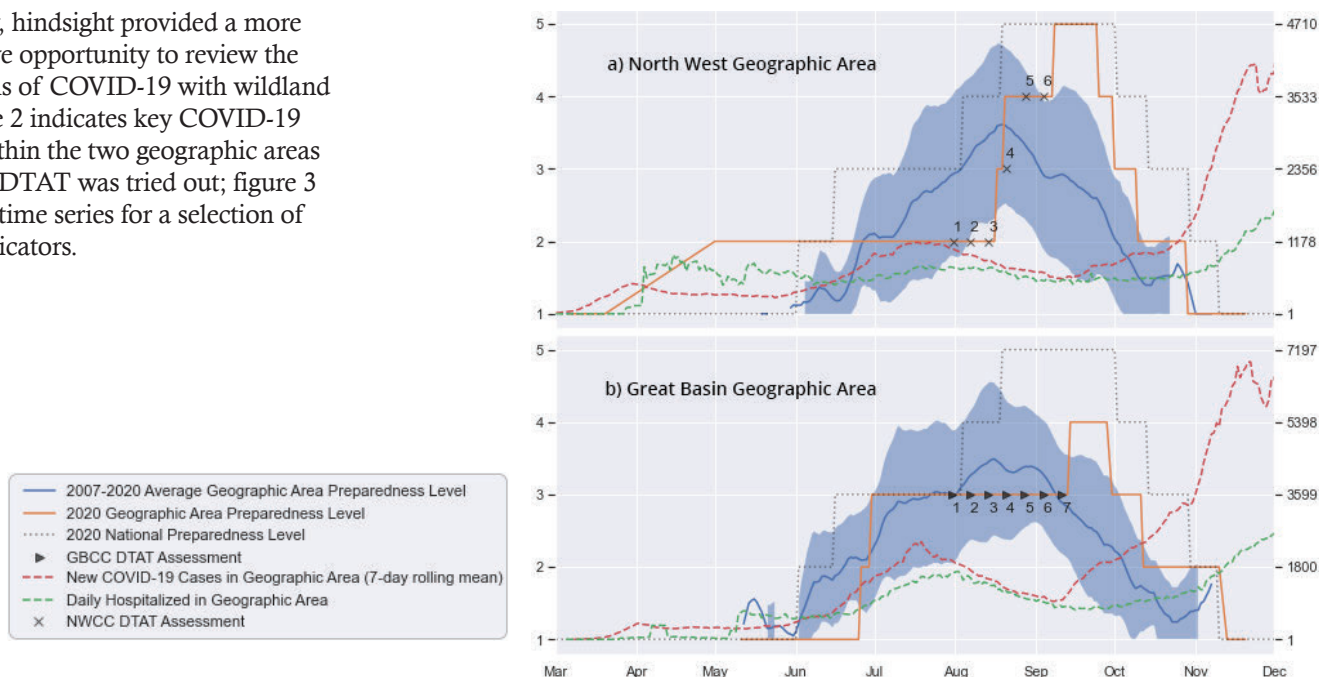


Figure 2—(ABOVE) National and geographic-area preparedness levels in 2020 compared to the 13-year mean and standard deviation (blue shading), along with the 7-day rolling mean of daily total cases hospitalized with COVID-19 and daily new (positive-increase) cases of COVID-19. Data are shown for (a) the Northwest Coordination Center (NWCC) and (b) the Great Basin Coordination Center (GBCC), with symbols to indicate the dates of DTAT assessment made by the respective coordination centers.

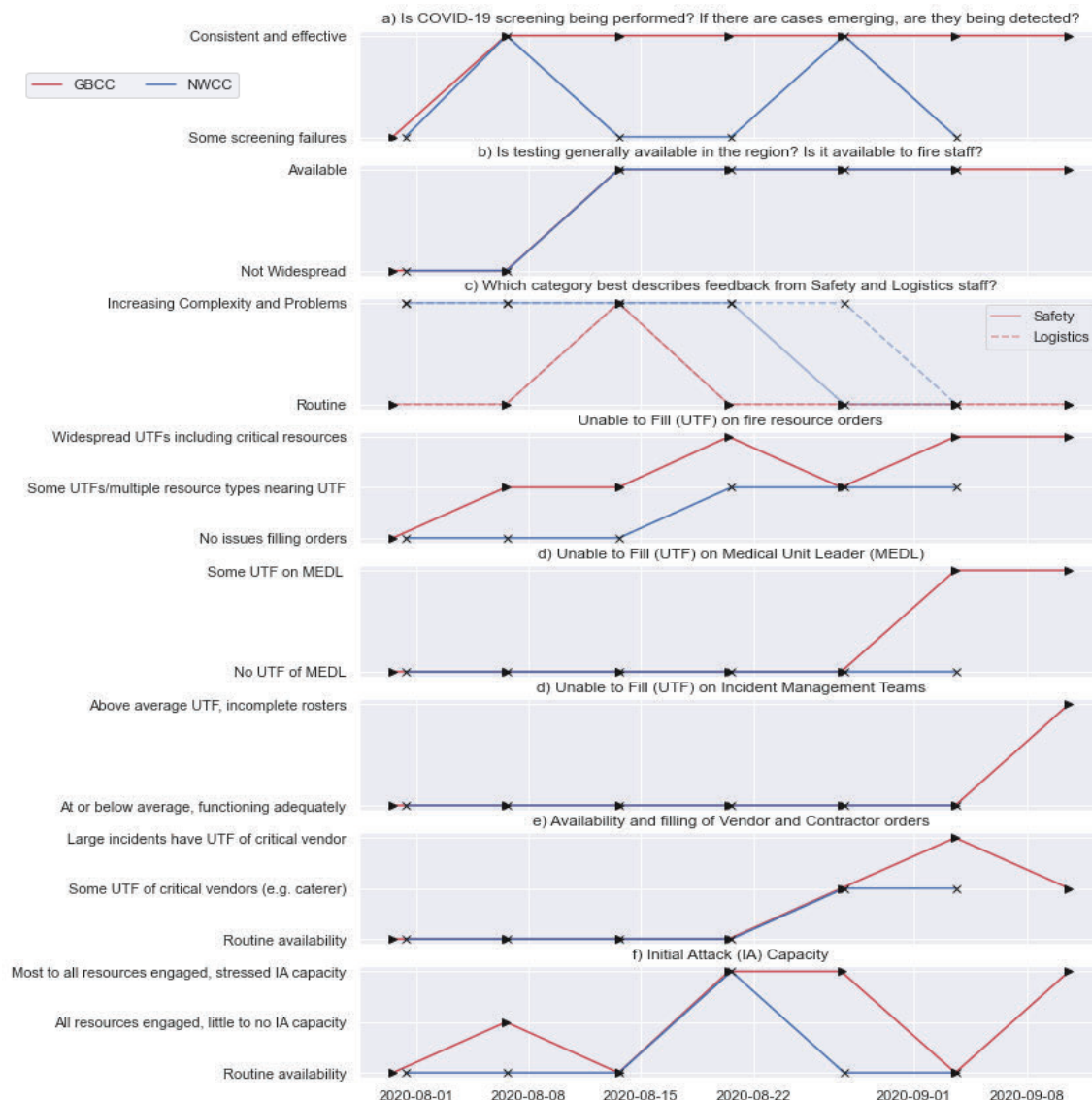


Figure 3—(LEFT) A selection of DTAT metrics (not all shown) for the study period, as assessed by the Great Basin Coordination Center (red) and Northwest Coordination Center (blue). Symbols (crosses and triangles) match the data collection dates indicated in figure 2

The preparedness levels did not reflect obvious correlations with the COVID-19 caseloads during the 7 weeks in which data for the DTAT was consistently collected. Throughout the period of data collection, the reported stresses on the logistics and safety functions of incident management were generally substantial, given the additional requirements of managing the COVID-19 risk.

Reporting stopped after the spike in fire activity in early September. Until then, COVID-19 exposures in fire camps were reported as relatively minor and managed within the capabilities of health departments. Resource orders came back as “unable to fill” for multiple weeks at a time of critical resource needs, but this was described as typical for the amount of fire activity at national preparedness level 5. The late-year spike in fire activity occurred between COVID-19 “waves” at the geographic-area scale; despite many notable challenges, health departments and fire management capabilities were not simultaneously overwhelmed.

LESSONS FROM THE DTAT

Many lessons were learned during the 2020 fire year, and a systemic failure did not occur. COVID-19 transmission occurred within a small number of fire camps but was poorly quantified, and transmission across fire camps as the year progressed was not possible to detect. Similarly, it was not possible to know whether transmission from infected responders to communities occurred at any significant scale. Diminished responder capacity over time did occur; despite DTAT data collection, however, the data was insufficient to describe the extent to which diminished capacity was directly caused by the pandemic.

Rapidly designing and implementing an analysis tool requires strong foundational datasets. With well-established functions and tools, analysts perform the tasks of analyzing domain-specific information, such as fire behavior and landscape risk. The 2020 fire year forced the requirements of analysis to be interdisciplinary to

an extent not previously encountered. In a testament to the problem-solving abilities of incident and geographic-area managers, the system did not fail. However, the limitations of data capture keep us from knowing how close the system came to failure and from documenting how the system responds to such levels of stress.

Returning to the analogy of homeostasis in the human body, the DTAT approach was an attempt to profile the system-level indicators of health in wildland fire management. As a tool for decision makers, the DTAT proved to be able to do so only qualitatively during the 2020 fire year. The year hopefully left the fire management system more resilient in the event of future shocks, stresses, and strains. However, lack of quantitative indicators, such as those collected by the DTAT, qualitatively leaves the system vulnerable in the future. Whether the next episodic stress is a new strain of the same virus or simply an unprecedented level of fire activity, the limits of a system must be understood in order to recognize when the system is approaching its limits so that an appropriate reaction can keep the system intact.

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