

JANUARY-MARCH 2020 / VOL 29.1

UNITING OUR GLOBAL WILDFIRE COMMUNITY

# WILDFIRE®

An official publication of the **International Association of Wildland Fire**



OUR FIRE GLOBE  
**AUSTRALIA**

---

CALIFORNIA UPDATE | MULTI-JURISDICTIONAL FIRES | STRATEGIC PLANNING | LIFE SUPPORT

**WHEN THE  
WORLD  
DEMANDS  
MORE,**

***AIR TRACTOR***

***DELIVERS.***



**AIR TRACTOR DELIVERS THE  
PERFORMANCE, EFFICIENCY, AND  
PRECISION THIS JOB DEMANDS.**

***IT'S TIME YOU DEMAND MORE.***

Base camp at Swan Reach in Gippsland, Victoria (AU) with the plume of the Johnsonville fire in the background, on December 31 (New Year's Eve), 2019. Photo: Wendy Leavesley, Victoria SES.



## COLUMNS & NEWS

- 4 **PRESIDENT'S DESK**  
Transitions and welcoming in a new decade
- 7 **BRIEFING**
- 8 **THOUGHTS ON LEADERSHIP**  
Don't Stop ... admiring your mentor
- 10 **IAWF NEWS**  
New connections for 2020

## THE FIRE GLOBE

- 12 **THE FIRES OF CALIFORNIA**  
Past the Tipping Point?  
*Bob Roper*
- 34 **AUSTRALIA'S FIRES: IMAGES, COMMENTARY, LINKS**  
COMMENT: More of the same won't help  
*Richard Thornton*

## FIRE MANAGEMENT

- 16 **KNOWING WHAT WE'RE UP AGAINST**  
A profile of jurisdictional complexity of wildfire.  
*Branda Nowell et al.*
- 24 **THE PATH TO STRATEGIC WILDLAND FIRE MANAGEMENT PLANNING**  
Developing a safer and more strategic response to fire-prone landscapes.  
*Richard D. Stratton*

## HEALTH AND SAFETY

- 32 **FIRELINE LIFE SUPPORT**  
We can provide a universal Basic Fireline Life Support - and we should.  
*Eli Schmed*

**COVER:** Smoke column in East Gippsland, Victoria.  
Photo: Dale Appleton, Department of Environment, Land, Water and Planning, VIC (AU).

## EDITORIAL

**Ron Steffens** - Executive Editor  
editor@wildfiremagazine.org

**Marjie Brown** - Managing Editor  
wildfirewriter@gmail.com

## BUSINESS

**Mikel Robinson** - Administration  
execdir@iaawonline.org

**Kim Skufca** - Advertising Associate  
kim@iaawonline.org

**Century Publishing**  
Post Falls, Idaho (Printing)

## WILDFIRE/COMMUNICATIONS COMMITTEE (IAWF)

**David Bruce** - Chair

**Michael Gollner**

**Richard McCrea**

**Mikel Robinson**

**Michele Steinberg**

**Johnny Stowe**

**Ron Steffens**

## ASSOCIATE EDITORS

**Zev Balsen** - Medical Editor (USA)

**G. Matt Davies** (Scotland)

**Michael Scott Hill** (USA)

**Laurie Kurth** (USA)

**Adam Leavesley** (Australia)

**Mark Masters** (USA)

**Guillermo Rein** (UK)

**Albert Simeoni** (USA)

**Johnny Stowe** (USA)

**Cathelijne Stoof** (Netherlands)

## BOARD OF DIRECTORS

**Toddi Steelman** (USA) - President

**Euan Ferguson** (AU) - Vice President

**Steve Miller** (USA) - Secretary

**Michael Gollner** (USA) - Treasurer

**Mikel Robinson** (USA) - Executive Director

**Tim Brown** (USA)

**David Bruce** (AU)

**Murray Carter** (AU)

**Tom Harbour** (USA)

**Sara McAllister** (USA)

**Kelly Martin** (USA)

**Joaquin Ramirez** (USA)

**Amber Soja** (USA)

**Michele Steinberg** (USA)

**Naomi Eva Stephens** (AU)

**Cathelijne Stoof** (Netherlands)

**Johnny Stowe** (USA)

**Gavriil Xanthopoulos** (Greece)

*WILDFIRE (ISSN: 1073-5658) is published by International Association of Wildland Fire, a 501(c)3 nonprofit organization. The magazine supports IAWF's core mission - "Uniting the global wildland fire community."*

Address:

International Association of Wildland Fire,

1418 Washburn, Missoula, MT, 59801 USA.

(406) 625-7059 | [execdir@iaawonline.org](mailto:execdir@iaawonline.org).

Editorial Email: [editor@wildfiremagazine.org](mailto:editor@wildfiremagazine.org).

WILDFIRE is a registered trademark of the International Association of Wildland Fire ©2018.

Articles appearing in WILDFIRE may not be reproduced in whole or in part without express permission of the publisher. The opinions expressed by authors and contributors to WILDFIRE are not necessarily those of the editors, publisher, or IAWF.

Postmaster: Send address change to Mikel Robinson, Executive Director, International Association of Wildland Fire, 1418 Washburn, Missoula MT, 59801 USA.

# Transitions and Welcoming in a New Decade

*“Transition times are healthy for re-asserting our mission and future goals as we look forward. We are ushering in a new decade that promises new challenges and new opportunities.”*



ALEN SLIJEPCEVIC *and* TODDI STEELMAN  
past president                      current president



IAWF's charge is to tackle the biggest contemporary issues confronting the wildland fire community as we seek a more sustainable wildland fire paradigm. Recent times have shown us just how challenging that charge is, with major destructive fires in most regions of our operations including both North and South America, Australia and Europe. As newly elected IAWF President and as recent past-president, we build on the good work of all the presidents before us. And we are proud to work alongside Euan Ferguson as our newly elected Vice President from Australia, as we continue to embrace the importance of our international mission.

We have had a very good two years – making greater inroads to become a truly international association; advancing mentoring; holding the Fire Behavior and Fuels conference on three continents simultaneously; hosting the 15<sup>th</sup> International Wildland Fire Safety Summit and 5<sup>th</sup> Human Dimensions Conference and two Annual National Cohesive Wildland Fire Management Strategy Workshops; developing issue/discussion papers; updating and improving our website, developing the Diversity and Inclusivity policy and established an active committee to advance

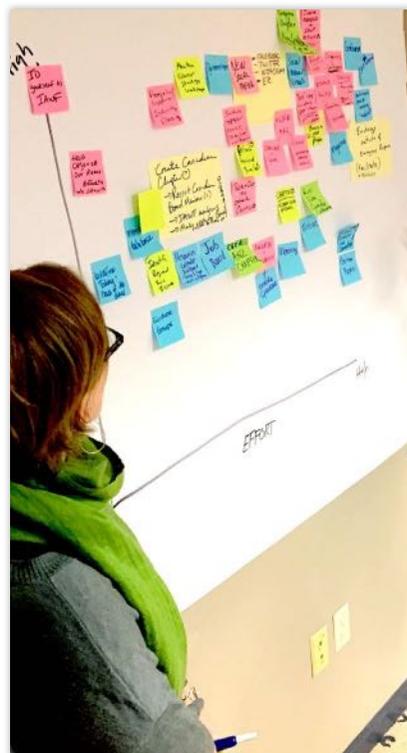
it; helping to advance the Cohesive Strategy in the US; and further strengthening our role as a non-partisan professional society. Transition times are healthy for re-asserting our mission and future goals as we look forward. We are ushering in a new decade that promises new challenges and new opportunities. At the IAWF Board meeting in October 2019, we affirmed our mission and defined key goals for our next two years.

## Networks connecting the wildland fire community

IAWF creates networks across sectors, fields and disciplines to connect the wildfire community through multiple platforms through which we communicate and convene including conferences, our website, the premier academic journal in our field (International Journal of Wildland Fire), our magazine (Wildfire) and various social media outlets (Facebook, Twitter and LinkedIn). In 2020 we will feature the 3<sup>rd</sup> International Smoke Symposium (Raleigh, NC and UC Davis, CA, April 2020) as well as the next iteration in the regional meetings for the US-based Cohesive Strategy Workshop (Asheville, NC October 2020). We aspire to hold a flagship international conference in May 2021 in California that will focus on Climate and Fire to concentrate our attention on one of the most important forces shaping wildfire and how we will respond to it in the new decade.

## Regional and International Impact

IAWF provides regional and international impact through partnerships that leverage the considerable expertise throughout our association's network. We have developed MOUs with regional and national partners such as Pau Costa Foundation (Spain) and the Wildland Fire Management Working Group (Canada) (see IAWF News for details), as well as US based partners in the US





IAWF Board planning session in Plymouth, MA., prior to the Cohesive Strategy Conference.

Forest Service, Department of Interior and Association of Fire Ecology. We are working on agreements with Australia (pending) and others. In the next two years, we aim to extend our impact through partnering with many countries much like we did through Fire Behavior and Fuels Conference in Australia, France and the United States. We will extend regional work into Canada in the near future as we anticipate taking over organizing the Canadian Wildland Fire Conference in 2021. We see greater potential to work with partners in New Zealand, across the European Union, South Africa, Indonesia, Chile, Brazil, Peru, Mexico and China—but we need to more actively recruit members in these regions who want to be part of our Association.

### A Sense of Belonging

IAWF strives to create a sense of belonging among our diverse geographically dispersed wildland fire community members by sharing knowledge, convening and developing a sense of inclusiveness. This includes a sense of shared solidarity in who we are and the values we uphold. Our ad hoc committee on Diversity and Inclusion is striving to set a standard for others in the wildland fire community to follow as we address issues related to sexual harassment and workplace misconduct. In the coming two years, our inclusivity mission will extend questions of inclusivity into workforce resilience, especially in the face of new generational demands for quality of life and the looming challenge of dealing with an extended fire season that promises to stretch into a whole calendar year. Looking within our organizations to see how we can create greater resilience and among our people will be essential to career longevity and a sustainable workforce.

We – as new president and past-president – very much look forward to the next two years and what we can accomplish together.

## TIMELINE of IAWF PRESIDENTS

2020

**TODDI STEELMAN**  
(2020-)  
NORTH CAROLINA (USA)

2019

2018

**ALEN SLIJEPCEVIC**  
(2018-2019)  
VICTORIA (AUSTRALIA)

2017

2016

2015

2014

**TOM ZIMMERMAN**  
(2014-2017)  
IDAHO (USA)

2013

2012

**DAN BAILEY**  
(2012-2013)  
MONTANA (USA)

2011

2010

2009

2008

2007

**CHUCK BUSHEY**  
(2007-2011)  
MONTANA (USA)

2006

2005

2004

**DICK MANGAN**  
(2004-2006)  
MONTANA (USA)

2003

2002

2001

2000

**BRUCE SUENRAM**  
(2000-2003)  
MONTANA (USA)

1999

1998

**MIKE DEGROSKY**  
(1998-1999)  
MONTANA (USA)



# WILDFIRE COMMUNITY PREPAREDNESS DAY. SATURDAY, MAY 2, 2020.

THERE'S SO MUCH MORE YOU CAN DO  
IN A DAY TO IMPROVE WILDFIRE SAFETY  
THAN YOU EVER IMAGINED!

Wildfires are causing more damage across the United States than ever before. But there are steps you can take to reduce your risk, protect your family, and help your neighborhood survive. The National Fire Protection Association® (NFPA®) and State Farm have teamed up to help you get ready by sponsoring Wildfire Community Preparedness Day on May 2, 2020.

Learn how easy it is for you to participate! Whether you work on projects around your home or in your neighborhood, your efforts can make a difference in the outcome of a wildfire event.

Visit the Wildfire Community Preparedness Day website today for project ideas and tips, and apply for a \$500 project award starting January 7, 2020.

LEARN MORE ABOUT GETTING YOUR COMMUNITY INVOLVED TODAY!

Learn more about  
getting involved today:  
[wildfireprepdaily.org](http://wildfireprepdaily.org)

Sponsored by





MARJIE BROWN



RON STEFFENS

# FACING THE PYROCENE

**IN THE FIRST WEEK OF 2020**, parts of Australia received a light rain. A land in a three-year drought is still in drought and the fires are returning but we could feel, half a world away, that our colleagues welcomed a short respite from their intense fire season.

A thirsty land generally only regrets a rain that turns to flood — yet these rains were too little, too late for those who've lost colleagues and family, for those breathing the smoke, for the houses and businesses burnt, for the wildlife and livestock and pets killed or injured, and for the habitat damaged and wide frand of other natural resources lost. And a fair lot of the burden of this loss is owned by our species — the patterns of drought and normal burning are far off-kilter due to human-caused climate change. This is what the International Association of Wildland Fire said in a globally focused statement issued in 2019 (<https://www.iawfonline.org/article/climate-change-week-un/>). This is what we learn from our scientist-colleagues. These are the fires and fuels our fire-manager-colleagues are tasked to control. We manage fire for good yet it is not enough to conduct prescribed burns and cultural fires; as crucial as these acts are, a fire can turn bad, quickly, in part due to a changing climate, the result of centuries of our carbon pollution. It's no longer enough to staff the firelines. It's our atmosphere, our policies, our economies and strategic leadership that now need the attention of fire professionals and community and world leaders.

**IF THESE AND OTHER FIRE PLUMES** mark the early days of the Pyrocene — the human-fire era as coined by Stephen Pyne — then it's only fitting that our coverage in the first *Wildfire* issue of 2020 circles around how we manage complexity and risk. Words and images show us the way to manage fires amid many jurisdictions and to manage landscape-scale fires using pre-planned holding lines. We look at the challenges facing us all, the Pyrocene manifested in Australia and California. And an emergency room doctor and former firefighter asks, how can we make our work safer by focusing on basic fireline life support? Yet these are not all the stories — not of this fire year, nor of managing fire amid complexity — and we believe that our shared stories are essential if we're to move safely and effectively into the Pyrocene. This year, *Wildfire* transitions to a quarterly print publication and a more frequent online publication cycle, so we can share our stories more quickly (online) and in more depth (in print and online).

We ask you to visit our Author's page at <https://www.iawfonline.org/wildfire-author-guidelines/> to share your story ideas, or send an email to [editor@wildfiremagazine.org](mailto:editor@wildfiremagazine.org). We look forward to your images, stories and ideas that will help us master these challenging days. - RS

**CLARIFICATION:** Due to editing processes, the article in Issue 28.5, "What happens when women thrive -- a life and career in fire," does not provide the exact wording of the panelists. To hear and read their exact words visit the video/transcription links online at <https://www.iawfonline.org/article/what-happens-when-women-thrive-a-life-and-a-career-in-fire/>.

# KOCHEK®

## Forestry & Wildfire Products

	
Forestry Nozzles	1" & 1.5" single jacket hose
	
Self Leveling Floating Barrel Strainers	Barrel Strainers w/Poppet
	
Lightweight - Booster Hose 600 psi service pressure	Adapters
	
26K 2-Way Ball Valve	Hose Clamps

Light weight forestry products built to last, ranging from booster hose to strainers and more.  
**Ask your dealer for genuine Kochek products by name!**

# KOCHEK®

**Building quality. Earning trust.**

Kochek.com or call us at 860 963-3377



# DON'T STOP...

*Protégés will and should outgrow their mentor -- but when you do, don't stop admiring them, respecting them, loving them.*

Mentors are people who act as our confidants, serve as a sounding board, help us sort through difficult issues, help us learn things we would not learn on our own, find ways to bring out the best in us, whose advice we seek out before making a professional or personal move, who are there at important junctures in our lives and careers.

It wasn't until recently that I realized why a good deal of the guidance on mentoring in the popular leadership press bugs me. So much of the available advice centers on relatively short-term, and somewhat transactional associations, often focused on what I would describe more as arrangements than relationships.

My mentors have been people with whom my relationships developed naturally and, often, those relationships were long-term. My associations with my mentors have been special ones – connections to people with whom I shared a bond – and I like to think that we enriched each other's lives. Consequently, that's my paradigm of mentoring; and I approach most opportunities to mentor a person as if the mentorship will become a mutually beneficial partnership and that it may eventually transition into a professional or personal friendship. Of course, it does not always work out that way, but the potential always exists.

My friends and colleagues who most cherish their mentors were mentored by people they admired and respected. I recently attended a conference in which a keynote speaker, a career fire chief, described his long-time mentor as a person he loved. I am an open-minded person, but that caused even me to sit up and take notice for a second. A middle-aged man, respected fire chief, stood there in a room full of his peers, almost exclusively middle-aged male, and used the word "love" to describe how he felt about his mentor. I found that so cool. We should all aspire to have at least one protégé who feels that way about us!

However, the Chief, despite his admiration, respect, love and gratitude for the chief who had mentored him, had eventually outgrown his mentor. And that's important to understand: our protégés should outgrow us. Doing so means that they have done their job, you have done yours, and the work is done. It is also natural that, as we progress through our lives and our careers, that our needs change and our mentoring needs change as well. So, regardless of how much a mentor has shaped us, if successful, the mentor-protégé relationship will end -- either by termination or by transitioning to another type of relationship.

One can find countless articles about ending mentoring relationships and moving-on in the popular leadership press, but I find most lacking; mostly because they often come from the narrow perspective that that the mentee's needs are no longer being met and that a breakup is needed. I really liked an article by John Greathouse that I once read in Forbes magazine. In From Mentor To Lifelong Friend – Here's How You Do It (<http://johngreathouse.com/you-are-never-too-old-or-too-successful-for-a-mentor/>), Greathouse described how, as the mentoring relationship matures and the mentee succeeds, the relationship can evolve into a sustained friendship that enriches two people's lives. The author described

**"Our protégés should outgrow us. Doing so means that they have done their job, you have done yours, and the work is done."**

that evolution as the ultimate goal of any mentoring relationship, and I agree. Evolving from a mentor to a lifelong friend; that's a worthy goal and a great outcome. Why would we not want to end up in that place with a person we respected and admired enough that we either asked them to mentor us or that we chose to mentor? However, not all mentoring relationships achieve that ultimate goal and the reality is that they end in a lot of ways for a variety of reasons; and, honestly, ending a mentoring relationship can be tough.

I am not talking about some corporate mentoring arrangement in which people are assigned to one another. I am talking about natural mentoring relationships in which two people have shared a journey involving trust; respect; admiration; reverence; closeness; and, yes, even love. Those, dear readers, are Big League emotions, often experienced over long periods of connection; and I am certain that is why so much of the leadership advice out there is couched in breakup language.

People choose to extinguish their mentoring relationships for all kinds of reasons. Either the protégé or mentor's needs are not being met. The mentee has outgrown the mentor and a further evolution of the relationship is not in the cards. It turned out to be too much work. It's not fun anymore. Someone gets let down.

So much of the advice for people whose mentoring relationship has run its course is written for mentees whose needs aren't being met and is about breakup tactics and technique. Don't end the relationship abruptly, pick a date. Plan a last meeting and your closure conversation. Tell them why you're ending the relationship.

Remember, ditching your mentor can be bad for your career. End on a high note.

However, so much of this advice minimizes an important aspect.

Mentors and their protégés are human beings and, without care, when people separate from other people with whom they've shared a bond, the awkwardness, hurt feelings, and sense of loss are very real and can be both difficult and long-lasting. So, some advice. Protégés will and should outgrow their mentor; but when we do, let's remember why they were our mentors in the first place, and not stop admiring them, respecting them, even loving them.



**Mike DeGrosky** is Chief of the Fire Protection Bureau for the Montana Department of Natural Resources and Conservation, Forestry Division. He taught for the Department of Leadership Studies at Fort Hays State University for 10 years. Follow Mike on Twitter @guidegroup or via LinkedIn.

There are so many reasons to become a member of the **International Association of Wildland Fire!**

**JOIN TODAY**

All members can improve their knowledge on emerging issues by reading our webpage and attending IAWF hosted conferences. You can also find a network of associates to share ideas and tools or work on common problems through our international membership.

[iawfonline.org/membership/](http://iawfonline.org/membership/)

## THE HOTTEST SKID UNITS IN WILDFIRE SEASON.

OVER 5000 SKID UNITS IN SERVICE WORLDWIDE!



**Produced with your safety in mind.**

Kimtek® Firelite® and Medlite® Transports effectively transform your UTVs and pickup trucks into off-road Fire and Rescue vehicles – reaching places your larger apparatus can't.

**KIMTEKRESEARCH.com**  
**BRUSHTRUCKSKIDS.com**

DESIGNED RIGHT. BUILT RIGHT. PRICED RIGHT.



326 Industrial Park Lane, Orleans, VT 05860 | 888.546.8358



## We are pleased to welcome two new Board Members in 2020.



**Joaquin Ramirez Cisneros.**  
Technosylva (San Diego, CA)  
& University of Leon (Spain).

Dr. Joaquin Ramirez is a Wildland Fire Technologist that has been working in the last 25 years on bridging the gap between scientists and end-users. From 2013 he moved from Spain to San Diego (CA),

from where he works with agencies worldwide trying to convert into actionable tools the best science. He is the creator of several of the most advanced fire behavior software model implementations and decision support systems, including the Wildfire Analyst and fiResponse software tools. From 2011, Dr. Ramirez coordinates the first European M.S. in Forest Fires ([www.masterfuegoforestal.es](http://www.masterfuegoforestal.es)) with Prof. Rodriguez y Silva (UCO) and Prof. Molina (UdL). He is also a founder and active member of the Pau Costa Foundation. Joaquin earned his Ph.D. in Remote Sensing and GIS at the University of Leon in 2003, an M.S. in Forestry from the University of Lleida, and his B.S. in Forest Engineering from the Polytechnical University of Madrid, Spain.



**Naomi Eva Stephens,**  
Acting Executive Director Park  
Operations, NSW National Parks and  
Wildlife Service (NPWS)

Naomi Stephens is the Program Director, Future NPWS at the National Parks and Wildlife Service, NSW Office of

Environment and Heritage. She is a member of the NSW Bush Fire Coordinating Committee Standing Advisory Sub-committee and represents Office of Environment and Heritage on the Australasian Fire and Emergency Service Authorities Council (AFAC), the AFAC Rural Land Management Group and the Forest Fire Management Group which reports to the Forestry and Forest Product Sub-committee of the Commonwealth Standing Council on Primary Industry (SCOPI). Prior to commencing in her current position, Naomi had 12 years of experience in bushfire management planning and suppression operations as part of her role as the NPWS Regional Operational Coordinator for the Hunter Region. Naomi is the Lead User Representative for the Prescribed Burning and Catchment Management Cluster research program under the Bushfire Natural Hazard Cooperative Research Centre. She is a member of the steering committee for the research program NPWS partners with the NSW Rural Fire Service at the Centre for Environmental Risk Management of Bushfire (CERMB) at the University of Wollongong.

## Thank you to our outgoing Board Members for their dedicated service through the years.

- **Alen Slijepcevic,** Outgoing IAWF President, Deputy Chief, Country Fire Authority, Australia (Board Member 2014-2019).
- **Albert Simeoni,** Outgoing Treasurer, Professor, Department of Fire Protection Engineering, Worcester Polytechnic Institute, Massachusetts, USA (Board Member 2014-2019).

## Wildland Fire Management Working group, Canadian Council of Forest Ministers (WFMWG)

The International Association of Wildland Fire and the Wildland Fire Management Working Group of the Canadian Council of Forest Ministers have adopted a Memorandum of Understanding to enable collaborative activities of mutual interest and benefit.

This partnership will provide collaborative opportunities to provide leadership in global wildland fire management programs and collaborative activities such as conference, workshops, etc.



*Tim Brown, Desert Research Institute/IAWF Board of Directors and Mike Norton, Director General, Northern Forestry Centre, Natural Resources Canada formalized the agreement at the Wildland Fire Canada Conference in Ottawa in November.*

Since 1990, the IAWF has represented its members around the world who are working in or have an interest in wildfire management and research. In 2007, the Canadian Council of Forest Ministers approved the formation of the Wildland Fire Management Working Group (WFMWG). WFMWG members are senior federal, provincial and territorial forestry officials. The WFMWG provides strategic advice and policy guidance on wildland fire management; promotes strategic improvement to wildland fire management in Canada; and guides the implementation of the Canadian Wildland Fire Strategy.

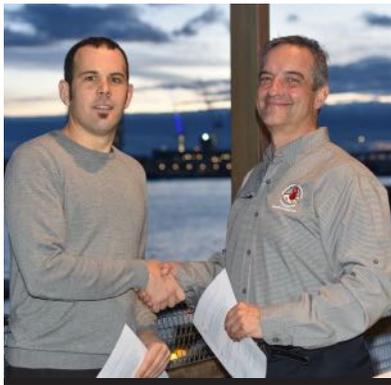
The IAWF looks forward to our partnership, which will include assisting with the organization of the Wildland Fire Canada Conference in 2021 as well as other collaborative projects.

# board members, partnerships, and mentoring

## Pau Costa Foundation

Collaboration in wildfire research, management and policy across international borders will be easier with the recent signing of an agreement between the International Association of Wildland Fire and the Pau Costa Foundation.

The agreement was signed by the President of the IAWF, Alen Slijepcevic, and the Executive Director of Pau Costa Foundation, Oriol Vilalta Caellas, at the GEO-SAFE Wildfire conference in Melbourne in November 2019.



*Oriol Vilalta Caellas, executive director of Pau Costa Foundation, and Alen Slijepcevic, IAWF president, celebrate the new cross-boundary collaborations made possible by their new agreement.*

The IAWF represents its members around the world who are working in or have an interest in wildfire management and research. The Pau Costa Foundation was established in 2011 in Barcelona, Spain but works across Europe and internationally on the conduct and promotion of wildfire research, information and training.

The agreement acknowledges the common interests of the two organizations and the mutual benefits that could arise from working together in activities such as training and professional development, research, and the exchange of students, researchers and fire management personnel.

The IAWF and PCF will work together on ways to better exchange knowledge and ideas on wildfire. This could include conferences and workshops; research exchanges and funding proposals, and; publications, media and social media, including Wildfire magazine.

## Next collaboration opens for IAWF Mentoring Program

We invite you to participate, either as a mentor or mentee, in the next collaboration of our Mentoring Program.

### What is mentoring?

The first mentioning of the word “mentor” goes back to an ancient Greek story about a young child called Telemachus who grew under the supervision of an old trusted friend of his father’s named Mentor. Since then, the name of this character started being used as a common term for “trusted tutor.”

Today, we use the word “mentor” for anyone who makes a positive, guiding influence on another person’s life. “Mentoring” is the process of direct transfer of experience and knowledge from one person to another.

### IAWF’s Approach

The IAWF will have an open period for applications two times per year. After the applications are received and reviewed, we will match the mentors and mentees based on interests and geographic location. IAWF encourages both face-to-face mentoring and online remote mentoring, depending on the location of the participants. Both parties will need to mutually commit to six months. We will provide you with resources, i.e. checklists, agreements, suggestions, etc.

### What makes a good mentor?

- Commitment to the mentee’s learning and project goals.
- Ability to provide positive feedback, encouragement, and advice when requested.
- Interest in seeing and supporting the mentee’s growth and success in their professional or personal goals.
- Ability to ask key questions to support the mentee to develop their problem-solving and creative thinking skills, and to be resilient and independent.
- Ability to establish clear expectations and commitments, to express these to the mentee, and to ask for the same.
- Generosity with tools and approaches that support others to learn
- Willingness to share key contacts and networks with the mentee, and to source other areas of expertise when required.

Please complete the online application to show your expression of interest either as a mentor or mentee.  
<https://www.iawfonline.org/mentoring-program/>

### Timeline

#### Application period open:

January 13–March 1, 2020

#### Review applications and introduce matches:

March 1-30, 2020

#### Mentoring Period:

April 1–September 30, 2020

If you have any questions, please contact Mikel Robinson at 406-625-7059 or [execdir@iawfonline.org](mailto:execdir@iawfonline.org)

# THE FIRES OF CALIFORNIA:



*Will wildfire impacts help us address the fire-preparedness backlog? A call to become “fire fit.”*

BY BOB ROPER

Looking at recent media articles about the California wildfires, I continue to see people banter about the electrical utility companies’ liability due to wildfire ignition starts and the Public Safety Power Shutoffs (PSPS). Seems that a large majority believes that if the utility companies did not contribute to the start of wildfires, our state and nation would not have the current wildfire problem.

Are they right?

Public comments express that utility companies may put shareholder interests above general public safety by deferring system maintenance for years. But just think – if we did not witness the recent influx of devastating wildfires associated with utility companies, would the politicians and others change their priorities and aggressively address/fund wildfire issues?

This thought is not unlike you and I who may know that we need to lose weight, exercise and change some lifestyle habits so we don’t suffer a heart attack, but we don’t make the hard lifestyle choices until a major traumatic event hits us. While I don’t want to thank the utility companies for their liability or the damages and tragedies that resulted, the overall wildfire situation has disclosed a range of topical issues such as infrastructure maintenance, antiquated technology, social media generational differences, insurance coverage/rate issues, population growth outpacing first-responder system growth, and the public’s role in emergency preparation.

Here in California, the issues may not be different from elsewhere, but the scale of impact is perhaps nearing a tipping point as the impacts of fire touch nearly every sector, including:

# PAST THE TIPPING POINT?



These photos from the Pelican Products “Portraits of Protection” photo competition capture the work of Los Angeles-based US Forest Service Firefighter Zachary Hanson while fighting the Saddleridge Fire, working with his crew on an engine out of Santa Clarita during a 36-hour shift in October 2019. The series was photographed by Christian Monterrosa (@chrismatography), a bilingual photojournalist born and raised in Los Angeles and selected as winner of Pelican Protects photo competition. His goal is to create pictures that serve as a window into the unseen parts of the world, amplifying the voices of people who have never been given the opportunity to speak. Currently he is focused on documenting the effects that climate change has on human life, as well as social justice issues surrounding the Latinx community. **Photographer: Christian Monterrosa, winner of the Pelican Protects “Portraits of Protection” photo competition. (<https://www.pelican.com/us/en/discover/portraits-of-protection/>).**

- **INFRASTRUCTURE DESIGN AND MAINTENANCE** has deferred the inevitable as first the occurrence of utility-line-ignited wildfires forced the issue of preventative PSPS in advance of strong winds and extreme fire conditions. Our technology infrastructure never thought that critical technology infrastructure would need backup electrical power for extended periods, nor defensible space to protect these mountaintop sites so they can provide reliable emergency alert notifications when they are needed the most. Restaurants, markets, manufacturing businesses and people dependent on medical devices found out that they too need a business/life continuity plan.
- Our **TECHNOLOGY** has not kept up with speed of fire

spread, and thus we have never overcome the “fog of war” for emergency commanders. We are just now recognizing the “digital divide” where each generation has different expectations about public notifications and how they access (and act upon) current emergency information.

- Wildfires have recently **SET RECORDS FOR STRUCTURE LOSSES** and it has pointed out several key issues and public frustrations from insurance policy non-renewals and/or escalating rate increases for premiums. Most of us do not understand how insurance policies work or how much insurance coverage we should have so life can be rebuilt. Insurance companies’ financial books have taken a hit and has raised related questions being discussed today, i.e. effects of reinsurance,



regulation by the state of rate structures, and how policy rate structures are established.

- Our **EMERGENCY RESPONSE SYSTEM** is based on established deployment systems that have not kept pace with increased population growth, especially in the wildland fire prone areas. There is a public expectation that emergency response performance metrics today should be the same or better than the levels they were 20-30 years ago.
- We are also dealing with **OLDER, PRE-EXISTING PLANNING DEVELOPMENT CONDITIONS** like narrow, dead end roads that greatly inhibit effective evacuation actions. This situation is further exacerbated by the public's expectation that if they evacuate, they can or should be able to immediately return home.
- Finally, we are witnessing a **CONFLUENCE OF EXPECTATIONS** where government response is not keeping up with the public's expectations and government is still scratching their heads on how to effectively make the public an integral part of the wildfire solution.

Whether you acknowledge climate change impacts or not, if you are not happy with PSPS actions by utility companies, just recognize that the last three years of devastating wildfires have created an opportunity to aggressively address the wildfire problem.

The National Wildland Fire Cohesive Strategy clearly identifies that as a nation we must learn to live with wildfires by restoring our landscapes, building fire adapted-communities, and having a robust

response system. We need to restore our landscapes by various means and the amount of acres burned over three years could never be accomplished by current fuel treatment practices due to bureaucratic and social-acceptance hurdles. We need to build fire-adapted communities, but this community effort has to be contiguous/continuous and not the checkerboard approach that is being done today. Our response system needs advanced technology that is available today and emergency response resources must be bolstered to meet the public's performance expectations.

As noted by a Headwaters Economics report – "Full Community Costs of Wildfire" – as a country, we need to decide if we will ever address and sizably invest in the wildfire problem before a fire, or will we simply pay for damages and subsequent post fire issues (i.e. flooding, loss of water sources, etc.) (<https://headwaterseconomics.org/wildfire/homes-risk/full-community-costs-of-wildfire/>).

In other words, when it comes to wildland fire we must go on a diet, exercise and change lifestyle habits before our heart attack – because someday we may not be there to pay for damages. The recent history of devastating wildfires should be the traumatic event that wakes us up to effectively address today's wildfire problem.

And in a strange way, we should acknowledge that those fires and subsequent PSPS issues have helped to focus political efforts. Yet political will and action relies on social will, which is ultimately an individual decision.

Have you seen the fires? Have you tried to adapt to smoke and lived without power? Are we ready, as individuals and communities, to get fire-fit?

## ABOUT THE AUTHOR

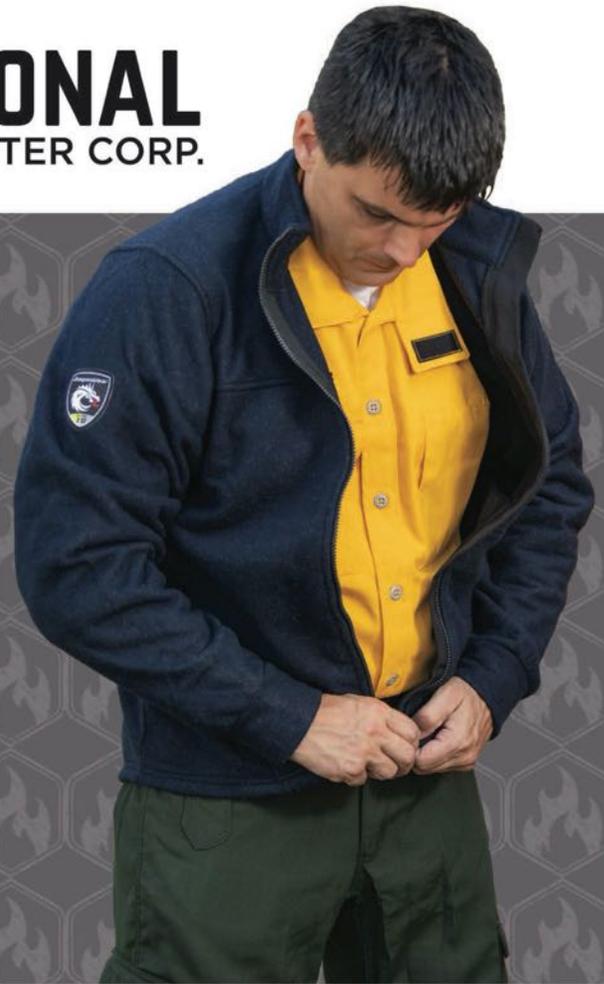
Bob Roper spent 40 years in the fire service focusing on wildland fire topics. He is the retired Fire Chief from Ventura County, CA, retired State Forester of Nevada, and currently Western Fire Chief's Association Policy Advisor. He served as the FIRESCOPE Chair and participated in the development of the National Cohesive Wildland Fire Strategy development. He was a member of Governor Schwarzenegger's Blue Ribbon Commission following the CA 2003 Firestorms. He wrote "Wildfire – The Answer," a reflection and call to action after the 2017 California fire season, in February 2018 Wildfire. <https://www.iawfonline.org/article/wildfire-the-answer/>.

# WILDLAND GEAR & PPE

FROM YOUR WILDLAND FIRE EQUIPMENT EXPERTS



**NATIONAL**  
FIRE FIGHTER CORP.



RESERVE YOUR 2020 CATALOG TODAY!



THE BRANDS YOU LOVE

**LEARN MORE AND STOCK UP**

[www.nationalfirefighter.com](http://www.nationalfirefighter.com) 800-423-8347

# Knowing What We're Up Against: A Profile of Jurisdictional Complexity of Wildfire

*Is yesterday's fire organization equipped to deal with today's complex wildfires?*

BY: BRANDA NOWELL, TODDI STEELMAN, ANNE-LISE VELEZ, KATE ALBRECHT, SARAH BAINES, SHANNON MCGOVERN, HONEY MINKOWITZ, ELLIOT NAUERT, AND RYAN SCOTT.

There is an on-going narrative in the media and among the fire community that wildfire is increasingly complex. Increasing complexity can mean a lot of different things. What we know the most about are the biophysical and economic indicators. Specifically, we know that wildfires are generally getting larger and more expensive. Larger fires may be affecting more land management jurisdictions, adding another layer of complexity. This has implications for the type of fire organizations necessary to manage this kind of increasing complexity. It also has implications for how we prepare agency administrators and incident management teams to co-manage this jurisdictionally complex environment - raising the question: Is yesterday's fire organization equipped to deal with today's complex wildfires?

It's difficult to prepare for a challenge we don't fully understand. In 2017, our team set out on a project, funded by the Joint Fire Science

Program, to learn more about how stakeholders were co-managing jurisdictionally complex wildfires. Since then, we've spoken to over a hundred agency administrators and incident commanders involved in jurisdictionally complex incidents concerning lessons they're learning about co-management.

However, while we were able to learn important lessons from this sub-set of jurisdictionally complex wildfires, a critical piece of the puzzle was missing. We didn't know how the wildfires we studied compared with Type 1 and 2 wildfires nationally. Were our fires extreme, black swan events? Or were these wildfires representative of what Type 1 and 2 fires looked like in 2018? We needed to find out.

The Fire Chasers' Jurisdictional Complexity Project aggregated data from the 2018 wildfire year to create a portrait of land management jurisdictional complexity and associated fire organizations with all National Interagency Coordination Center

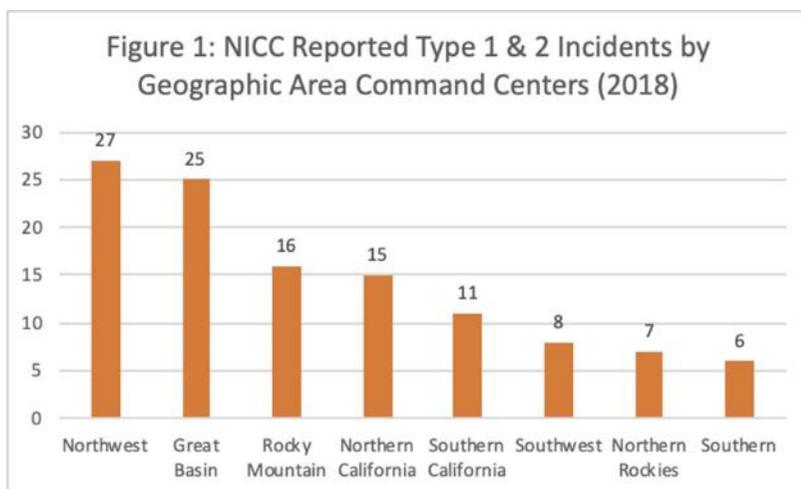
Whose land is burning? Some of our most tragic fires immediately burn across boundaries. In 2018, unified command was initiated early in the first day of the Carr Fire in northern California. At peak response some 4800 fire responders from multiple agencies responded. Eight lives were lost during and after the response, and more than 1000 homes burned (including here in Mary Lake, from drone imagery by ESRI/Hanger



(NICC) reported Type 1 and Type 2 wildfires occurring during that calendar year. The first step was to identify all wildfires that required either a Type 1 or 2 incident management team (IMT). Data was sourced from the NICC, which keeps a record of all Type 1 and 2 fires for the fire year. Once this population was identified, all Incident Command System (ICS) 209 reports were downloaded for each incident and analyzed. These data were triangulated against additional information taken from fire perimeter maps archived at the National Interagency Fire Center. The resulting data speaks to both the jurisdictional make up of NICC reported Type 1 and 2 incidents in 2018 as well as the nature of the fire organizations that were created to manage this complexity.

### TYPE 1 AND 2 WILDFIRE INCIDENTS BY GEOGRAPHIC AREA COMMAND CENTERS

A first indicator of complexity is simply the deployments of Type 1 and 2 incident management teams.



According to reporting by the NICC, in 2018 there were 116 wildfires requiring either a Type 1 or Type 2 incident management team to respond at some point during the incident. We were able to identify sufficient data for analysis from all but one of these fires, resulting in a sample of 115 fires. As shown in Figure 1, most NICC reported Type 1 and 2 wildfires in 2018 occurred in the Northwest and Great Basin Geographic Area Command Centers (GACCs), followed by the Rocky Mountain and Northern California GACCs.



A cooperators' meeting at the Goose Creek Fire (Nevada and Utah) included representatives from numerous local, state, federal, and tribal jurisdictions.

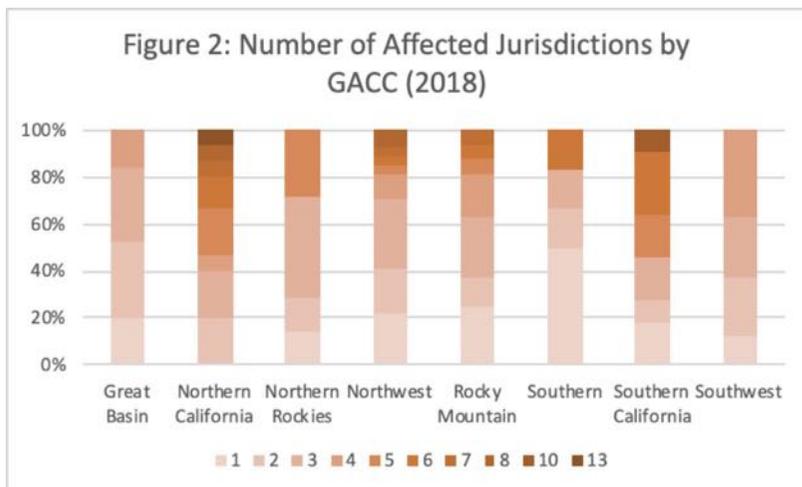
### JURISDICTIONAL COMPLEXITY OF TYPE 1 AND TYPE 2 WILDFIRES

Next, we wanted to understand the jurisdictional complexity of these 115 wildfires. Analysis, which considered international, federal, tribal, state, and local land jurisdictions, indicated that on average, a NICC reported Type 1 or 2 wildfire in 2018 impacted three different land jurisdictions. 2018 NICC reported Type 1 and 2 wildfires ranged from single jurisdiction wildfires such as the Goose Creek Fire in Nevada to fires involving numerous local, state, federal, and tribal jurisdictions. As shown in the heat map

in Figure 2, Northern and Southern California experienced the highest complexity in 2018 in terms of the total number of land management jurisdictions affected.

Next, we wanted to know the extent to which this jurisdictional complexity was distributed across levels of government. Specifically, we wanted to know how many levels of international, federal, tribal, state, and local government were involved in each of the 115 incidents. This was important because our previous research indicated that co-managing between levels of government, such as between federal and state land agencies, may have additional challenges. Results from the 2018 fire season

indicated that the majority of NICC reported Type 1 and Type 2 wildfires involved at least two jurisdictional levels of government. The most jurisdictionally complex incidents of 2018, such as the Klondike Fire in Oregon, involved co-management among federal, tribal, state, and local levels of government. **Forty-two percent of NICC reported Type 1 and 2 fires in 2018 involved at least three levels of government.** In terms of levels of government in wildfires by GACC, Figure 3 shows that California had the greatest complexity in 2018, with approximately one third of incidents in California involving four levels of government. However, high jurisdictional complexity was relatively common nationally.





INDUSTRY LEADING  INNOVATIVE SOLUTIONS

**EXXTREME™ Jacket Nomex® IIIA Fleece**



To see our complete of DragonWear visit  
**[supplycache.com](http://supplycache.com) • 800.839.0821**

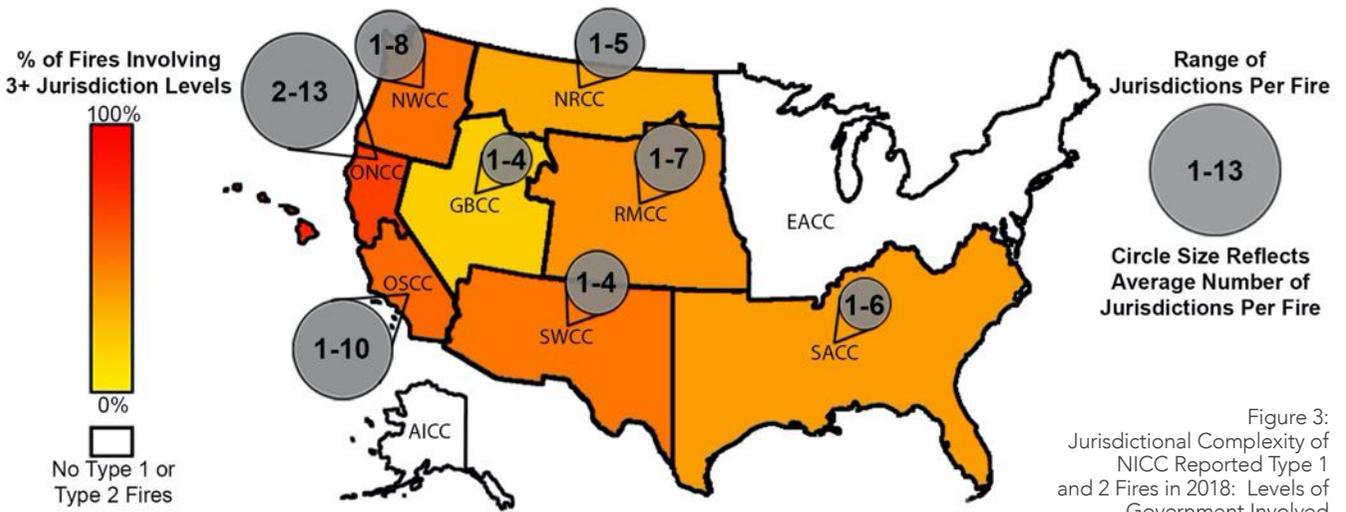


Figure 3: Jurisdictional Complexity of NICC Reported Type 1 and 2 Fires in 2018: Levels of Government Involved

**“...we saw incidents involving up to 13 different land management jurisdictions spanning four levels of government. There was clearly a lot to co-manage.”**

### FIRE ORGANIZATIONS FOR CO-MANAGING JURISDICTIONAL COMPLEXITY

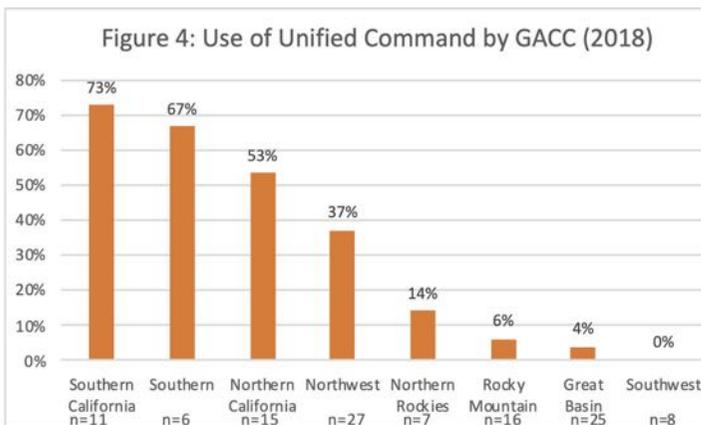
Our findings indicate NICC reported Type 1 and 2 incidents in 2018 commonly involved three or more land jurisdictions representing multiple levels of government. In terms of the most complex wildfires, we saw incidents involving up to 13 different land management jurisdictions spanning four levels of government. There was clearly a lot to co-manage.

What we know less about is how agency administrators and incident commanders are co-managing this complexity. There are multiple tools within the Incident Command System for building organizations to govern across jurisdictions during an incident. Multiple jurisdictions can issue a joint delegation of authority to the same IMT to manage an incident on their collective behalf. Jurisdictions can elect to have their own incident commander but join into unified command with other incident commanders to ensure continuity and coordination of operations.

If the topography is suitable, fires can be geographically zoned on jurisdictional boundaries and assigned to different IMTs. Zones can be coordinated through area command structures. We know that, as complexity increases, multiple tools are often used in combination. For example, the 2018 Ferguson Fire in California had a federal Type 1 IMT under a joint delegation by three federal agencies (two National Forests and one National Park) working in unified command with CAL FIRE, a state organization, and in coordination with three separate counties and numerous cooperating agencies.

We know from our field research that the decisions concerning the use of zoning, area command, joint delegations, and unified command tools are not entirely formulaic; they’re

negotiated among agency administrators and incident commanders and may evolve over the course of the incident. Currently, there is no data source that we know of that documents, nationally, the decisions that are being made in setting up fire organizations to manage these complex challenges. The ICS 209s report whether or not an IMT is in unified command but does not always indicate with whom. In 2018, we know that 33 NICC reported Type 1 and 2 incidents had some form of unified command set up at some point during the incident. Of the incidents that had unified command, 64% involved state and federal agencies. We also know that in 2018, the use of unified command varied by GACC, with incidents in the Southern and California GACCs proportionally more likely to have a unified command structure in place, as indicated in Figure 4.



\*Note: Figure 4 percentages normed by the total number of incidents within the GACC

## LESSONS LEARNED

Our 2018 jurisdictional complexity analysis offers a national picture of the landscape of jurisdictional complexity of wildfire. These data validate that co-management across jurisdictions was a common feature of incident management for NICC reported Type 1 and 2 teams in 2018. This is to be expected on some level, as jurisdictional complexity is part of the analysis used to determine the need for higher level teams. The question is whether our current tools and co-management practices are well-suited to the degree of complexity that we are seeing on wildfires today.

Governing an incident across multiple land management jurisdictions generally means:

- negotiating potentially competing priorities and objectives, often under conditions of both uncertainty and limited resources;
- communicating effectively despite different agency cultures and assumptions about “how things are done”;
- and making strategic decisions about the type of fire organization that will be best suited to handle this complexity.

This raises important questions about the type of capacity needed to manage large scale wildfires in this complex environment. Are our current tools, knowledge, and jurisdictional relationships where they need to be? These are pressing questions for the fire community to consider given the role of climate change and continued expectations of fire size increasing with the attendant consequences of affecting larger land bases and their jurisdictions.

## FURTHER READING

<https://fireadaptednetwork.org/co-managing-wildfire-conversations-you-need-to-have-right-now/>.

<https://research.cnr.ncsu.edu/blogs/firechasers/>

Comfort, L. K., Dunn, M., Johnson, D., Skertich, R., & Zagorecki, A. (2004). Coordination in complex systems: increasing efficiency in disaster mitigation and response. *International Journal of Emergency Management*, 2(1-2), 62-80.

Faas, A. J., Velez, A. L. K., FitzGerald, C., Nowell, B. L., & Steelman, T. A. (2017). Patterns of preference and practice: bridging actors in wildfire response networks in the American Northwest. *Disasters*, 41(3), 527-548.

Kapucu, N. (2009). Interorganizational coordination in complex environments of disasters: The evolution of intergovernmental disaster response systems. *Journal of Homeland Security and Emergency Management*, 6(1).

**I'M A WILDLAND FIREFIGHTER**

*My face & lungs need protection in my line of work.  
I was tired of choking on ash & smoke and getting peppered with burning embers.  
I GOT THE BEST... I GOT A HOT SHIELD!*

**HOT SHIELD USA**  
MAKERS OF THE BEST FACE MASKS & HELMET SHROUDS ON THE PLANET

5021 Verdugo Way, Ste 105-301, Camarillo, CA. 93012  
Office: (310) 710-2624 • Fax: (805) 504-9530  
info@hotshield.com • www.hotshield.com

Nowell, B. and Stutler, J (forthcoming). Public Management in the Era of the Unprecedented: Dominant Institutional Logics as Barriers to Sensemaking. Manuscript in press with Perspectives in Public Management and Governance

Nowell, B. Steelman, T., \*Velez, A, and \*Yang, Z (2018). The structure of effective governance of disaster response networks: Insights from the field. *American Review of Public Administration*, 48(7): 699-715.\

Nowell, B., & Steelman, T. (2019). Beyond ICS: how should we govern complex disasters in the United States?. *Journal of Homeland Security and Emergency Management*, 16(2).

Stelman, T., & Nowell, B. (2019). Evidence of effectiveness in the Cohesive Strategy: measuring and improving wildfire response. *International Journal of Wildland Fire*, 28(4), 267-274.

REFERENCES

Fleming, C. J., McCartha, E. B., & Steelman, T. A. (2015). Conflict and collaboration in wildfire management: The role of mission alignment. *Public Administration Review*, 75(3), 445-454. Retrieved from <https://doi.org/10.1111/puar.12353>

National Interagency Fire Center. (n.d.). Retrieved from [https://www.nifc.gov/fireInfo/fireInfo\\_statistics.html](https://www.nifc.gov/fireInfo/fireInfo_statistics.html)

ABOUT THE AUTHOR

Branda Nowell is an organizational/community psychologist and a professor in the School of Public and International Affairs at North Carolina State University. She is the director of the Firechasers Research Program which has been conducting research on the organizational and social dynamics of complex wildfire events since 2008.

Support for this research was provided by a grant from the Joint Fire Science Program. Views contained in this article are expressly those of the authors and are not endorsed by any funder or agency.



Marsha Ladner

was born in 1943 in Sacramento CA. Daughter of a WWII Vet and she now lives in Kentucky. Since retiring after 45 years in Nursing, she has worked summers on wildfires with the "WULFF" clerical support unit. Her brother and firefighters helped to inspire the painting

"Mop-Up is Done"

"MOP-UP IS DONE"

PAINTING BY MARSHA LADNER



PRINTS:

Available on E-Bay or contact Marsha at (270) 877-0258 or [ladner2@bbtel.com](mailto:ladner2@bbtel.com)  
Signed and numbered: 16x20 - \$55 | Signed only: 16x20 - \$40 | 11x14 - \$30

APRIL  
20-24  
2020

THE 3RD INTERNATIONAL

#ISS3

# smoke

## SYMPOSIUM

## RALEIGH, NORTH CAROLINA AND UNIVERSITY OF CALIFORNIA, DAVIS, USA

The 3rd International Smoke Symposium will bring together researchers from the atmospheric sciences, the ecological sciences, health sciences, mathematicians, computer sciences, climatologists, social scientists, and others to discuss the complex issues of smoke and identify knowledge gaps and opportunities for innovation and development. The Symposium will be held in Raleigh, North Carolina with a satellite location at UC Davis Convention Center. The Symposium will be a hybrid, which combines in-person and streaming presentations.

### EARLY BIRD REGISTRATION ENDS JANUARY 31, 2020.

Registration is now open. Registration includes access to all sessions and social events during the symposium. In addition, registrants will have remote access to all recorded sessions for one year after the event. Discounted rates available for IAWF Members, Students and Volunteers.

### WORKSHOPS ARE MONDAY APRIL 20 AND INCLUDE:

1. Exploring the Impacts of Wildfire Smoke on Northern California's Diverse Populations
2. Tools and Methods Used to Measure Exposure to Wild Fire Chemicals
3. Smoke and Health Research: The Years Ahead
4. How Does Community Capacity Influence Preparedness, Response, Recovery, and Resilience to Smoke?
5. Smoke Modeling from Forest to Plume: Integrated Modeling Workshop for Smoke Management
6. Incorporating Smoke Impacts into Air Quality Forecasting
7. New Generation Satellite Products for Operational Fire and Smoke Applications
8. Wildfire Detection and Dispatch – Case Studies and Enabling Technologies

### CAN'T ATTEND IN PERSON? JOIN ISS3 VIRTUALLY!

In addition to the in-person symposium, we will provide innovative training opportunities through a virtual platform. All plenary and concurrent sessions will be professionally videotaped and will be streamed live. This will allow the remote attendees to interact in real time with the presenters and other remote attendees. We will also be offering a virtual poster session, virtual trade show, and virtual networking lounge. Group rates are also available.



<https://www.iawfonline.org/event/3rd-international-smoke-symposium/>

# *The Path to* STRATEGIC WILDLAND FIRE MANAGEMENT *Planning*

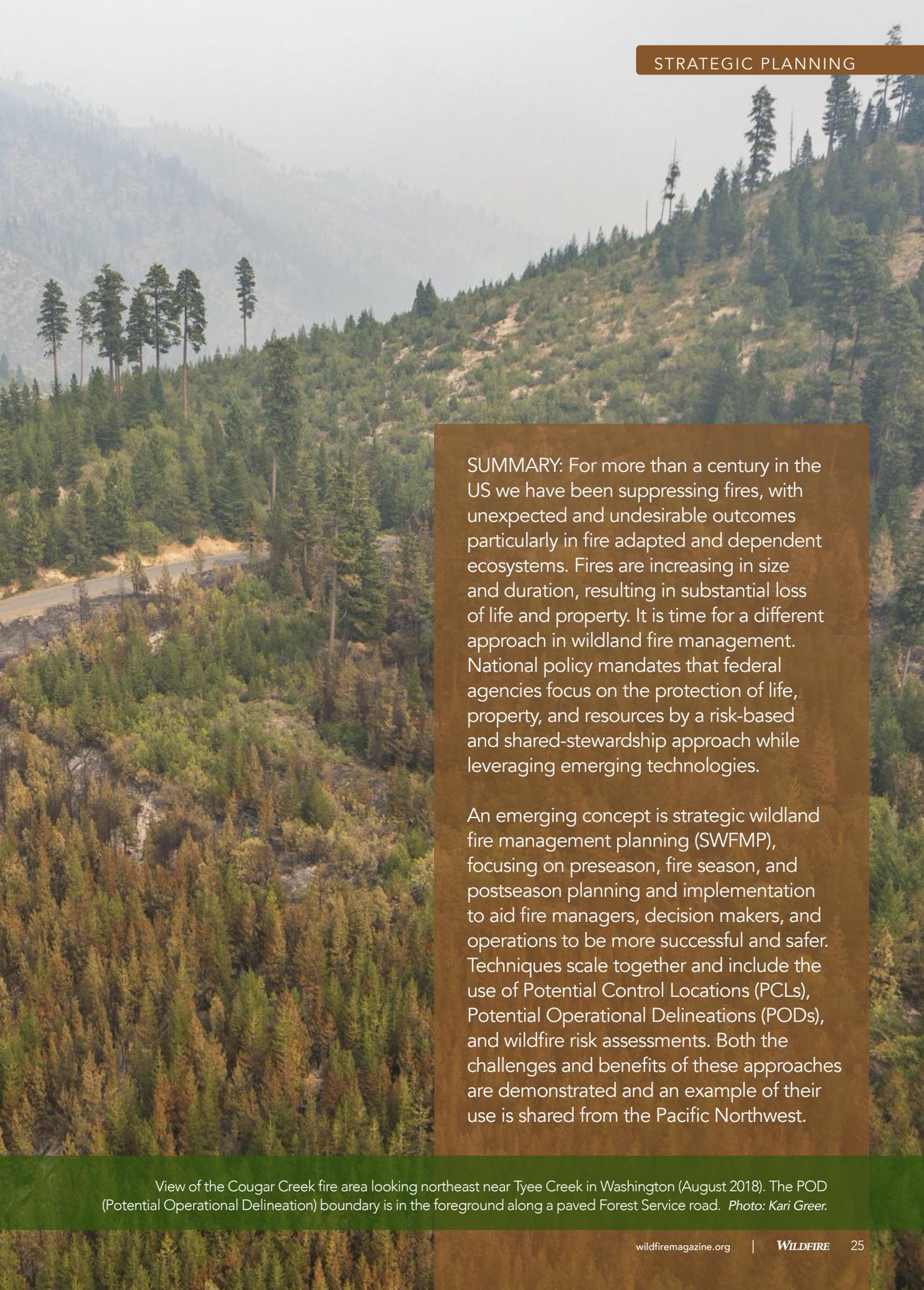
*Evolving approaches to wildland fire management – integrating pre-planned control lines and operational decisions with quantitative risk assessment – support a safer and more strategic response to fire-prone landscapes.*

BY RICHARD D. STRATTON

**What we are doing is not working.** For more than a century we have been suppressing fires in most ecosystems, particularly in the western US. We are really good at it—95+% (Booz Allen Hamilton, 2015; USDA, 2015). As a result, instead of a healthy patchwork of different aged stands of vegetation, we have large expanses of vertical and horizontal continuity of fuels conducive to large fire growth (Hessburg, 2017). Inadvertently, we have now predisposed many of our fire-prone landscapes to large destructive wildfires. This physical situation has been compounded by insect and disease, invasive species, climate change, and land management. Now factor in our love of living in the forest. It is estimated that the wildland-urban interface is the fastest growing land-use type in the conterminous United States (Radeloff et al., 2018). When this increasingly complex fire environment receives an ignition, particularly during extreme weather and fuel

conditions, the ecological, social, economic, and human impacts are often dreadful.

It is estimated that the western Regions of the US Forest Service—Regions 1 through 6—need to burn, on average, 5 to 7 times more acreage—based on Monitoring Trends in Burn Severity estimates (Finco et al., 2012) from 1984-2010 vs. LANDFIRE (Rollins and Frame, 2006) mean fire return interval (McHugh and Finney, 2014). Prescribed fire is a means for increasing area burned, but it isn't at a scale commensurate with need. In fact, if we don't do it Mother Nature will. For example, in 2018, Regions 1 - 6 of the Forest Service treated 820,000 acres with prescribed fire vs. wildfire acres of 1.8 million. If our primary goal is to mitigate large fire growth and the inevitable losses to highly valued resources and assets (HVRAs), we are not going to “treat” our way out of the problem in most fire-prone landscapes—the problem is too big, our treatments are too small, and they are taking too long to implement.

An aerial photograph of a forested hillside. In the foreground, a paved road runs horizontally across the frame, marking a boundary. The terrain is covered in dense evergreen trees, with some areas appearing slightly more brownish, possibly due to a fire or natural forest dynamics. The background shows more forested hills under a hazy sky.

SUMMARY: For more than a century in the US we have been suppressing fires, with unexpected and undesirable outcomes particularly in fire adapted and dependent ecosystems. Fires are increasing in size and duration, resulting in substantial loss of life and property. It is time for a different approach in wildland fire management. National policy mandates that federal agencies focus on the protection of life, property, and resources by a risk-based and shared-stewardship approach while leveraging emerging technologies.

An emerging concept is strategic wildland fire management planning (SWFMP), focusing on pre-season, fire season, and post-season planning and implementation to aid fire managers, decision makers, and operations to be more successful and safer. Techniques scale together and include the use of Potential Control Locations (PCLs), Potential Operational Delineations (PODs), and wildfire risk assessments. Both the challenges and benefits of these approaches are demonstrated and an example of their use is shared from the Pacific Northwest.

View of the Cougar Creek fire area looking northeast near Tye Creek in Washington (August 2018). The POD (Potential Operational Delineation) boundary is in the foreground along a paved Forest Service road. *Photo: Kari Greer.*

Figure 1 (right) displays the last 19 years of large fire history in north-central Washington as shown in the Wildland Fire Decision Support System (WFDSS) (Noonan-Wright et al., 2011). The sizes and frequencies of these fires are sobering, loss of life, injury, and property heartbreaking, and due to the uncharacteristic fuel conditions, several of the ecological outcomes were undesirable. Ironically, when we desperately need our suppression resources to be most effective—that is when they are often least effective (Finney et al., 2009). The reality is, the only way to check the spread of a large wildfire is for it to encounter another recent large fire(s), very sizable fuel treatment(s)—or a very large network of smaller treatments—or to receive a significant change in the weather (e.g., fire-stopping or season-ending event(s)) (Finney et al., 2005; Stratton, 2006). When this occurs, suppression resources can get the upper hand (Finney et al., 2009).

Table 1 (next page) looks at large fires in the Pacific Northwest and their historical ranking in the last 50+ years on federal and state lands. All but 4 of the units have experienced one of their largest fires in the past 8 years (2011–2018)—but what may be more sobering is many have experienced their top 2 or 3. The take home is obvious. Fire is inevitable in many ecosystems in the West and we have reached a tipping point where several forests and range lands are transitioning to a larger, uncharacteristic fire frequented landscape—it is time for a different approach to fire management.

### A DIFFERENT APPROACH...

Let’s face it, there are just some places we have to suppress fires no matter the ecological or financial cost due to personal property and life safety, critical infrastructure, or public, political, or cooperator pressure. There are many examples of this recently, but where we have more decision space—which is a large portion of the Western landscape—we need a different approach to managing fire.

O’Connor and Calkin (2019) outlined the use of Potential Operational Delineations (PODs) (Thompson et al., 2016) on the Pinal Fire, in a recent paper “Engaging the fire before it starts.” The authors outline how preplanning efforts on the Tonto National Forest, to develop potential control locations (PCLs) (O’Connor et al., 2017) and PODs, aided in the strategy to contain the fire near Globe, AZ.

The purpose of this paper is to (1) explain why a new approach is needed—as provided above, (2) summarize recent national fire direction and policy, (3) list the benefits and challenges of PODs on a fire-prone landscape, (4) demonstrate how this approach can integrate into a broader strategic wildland fire management planning (SWFMP) framework, (5) provide guidance to fire managers on how to apply SWFMP, and (6) provide an example of how these concepts were applied while managing a wildfire.

### SUPPORTED BY RECENT POLICY & DIRECTION

Recently the President of the United States issued an executive order (EO 13855) to the Secretaries of Agriculture and Interior.

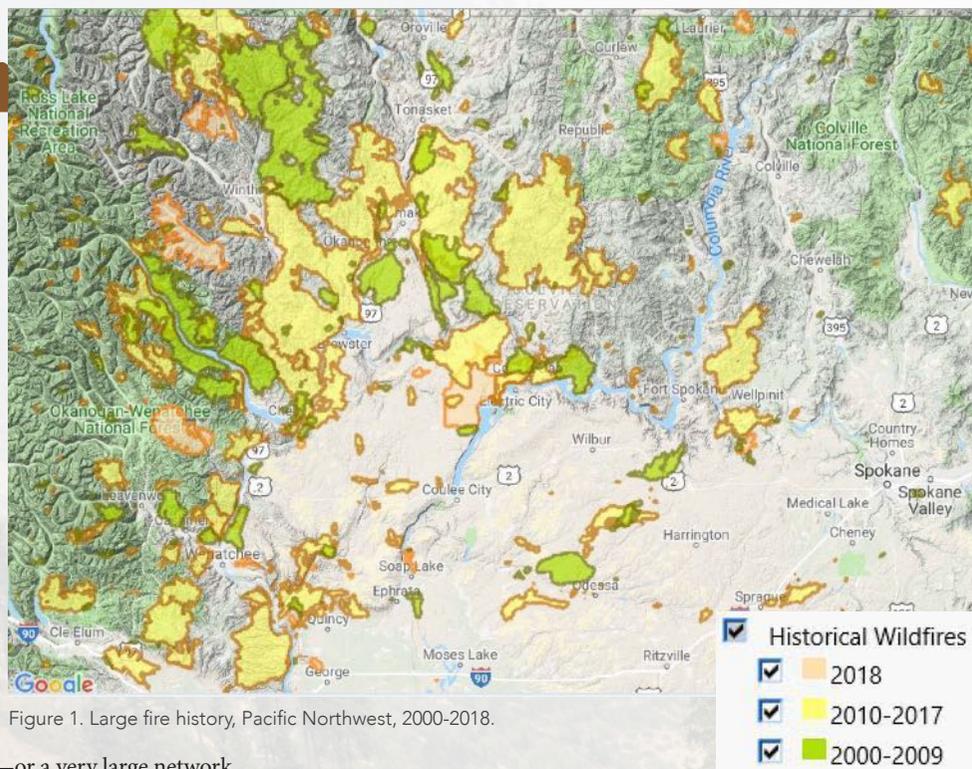


Figure 1. Large fire history, Pacific Northwest, 2000-2018.

Section 2 (Goals) stated: “To protect communities and watersheds, to better prevent catastrophic wildfires, and to improve the health of America’s forests, rangelands, and other federal lands, the Secretaries shall each develop goals and implementation plans for wildfire prevention activities and programs in their respective departments.” (Federal Register, 2019)

In response to the order, the Chief of the Forest Service stated that “We will do the right work in the right place at the right scale using advanced science and mapping tools” (USDA, 2018, p. 2). The response from the Secretary of the Interior was a 6-page order (3372) to the Bureaus, which included a directive to: “Maximize the wildfire management benefits of physical features within landscapes.” It elaborated on the use of physical features, in conjunction with vegetation management techniques, to help control catastrophic wildfires, such as rivers, streams, geological formations, roadways, etc. (USDI, 2019).

This comes on the heels of changes to Forest Service (Chapter 5140) and Department of the Interior (Manual 620, Chapter 6) direction in 2017 to utilize risk assessment information for the identification and prioritization of fuel treatments. All of this policy and direction is consistent with the National Cohesive Wildland Fire Management Strategy (USDA, 2011) and Shared Stewardship. “A steady increase in collaboration capacity and recent breakthroughs in Forest Service science, mapping, and technology are providing new tools for planning investments to reduce fire risk and improve forest conditions. We will implement these new authorities and advances in technology by: Working with States to set priorities and co-manage risk across broad landscapes. The most effective approach to wildland fire management is shared stewardship of the wildland fire environment, shared ownership of the challenges it presents, and a shared commitment to meeting those challenges....” (USDA, 2018, p. 2).

### SPATIAL PLANNING WITH PCLs AND PODs

PCLs are areas where large fires historically tend to stop or lull, due to topographic features such as lakes, ridges, and rivers; roads and trails; fuel transitions; and non-burnable vegetation. They can be solely expert-informed or a machine learning algorithm can be run on a landscape to develop a map of historical containment probability, scaled 0 to 100% (O’Connor et al., 2017). PCLs can be

Land Management Unit	Individual Fire Name	"Historical" Rank (Top 3 only)	Year	Size Estimate (Unit specific acres only)
Colville NF	Stickpin	#2	2015	48,782
Columbia River Gorge SA	Eagle Creek	#1	2017	25,583
Deschutes NF	Pole Creek	#2	2012	26,579
Fremont-Winema NF	Watson Creek	#1	2018	45,896
	Barry Point	#2	2012	43,133
Gifford Pinchot NF	Cascade Creek	#1	2012	20,296
Malheur NF	Canyon Creek	#1	2015	90,584
Mount Baker-Snoqualmie NF	Norse Peak	#1	2017	23,239
Mt. Hood NF	Eagle Creek	#1	2017	22,645
	Dollar Lake	#2	2011	6,286
	36 Pit	#3	2014	5,508
Ochoco NF	Corner Creek	#1	2015	29,660
Okanogan-Wenatchee NF	Diamond Creek	#3	2017	97,137
Olympic NF	Maple	#1	2018	3,000
	Big Hump	#2	2011	1,243
Rogue River-Siskiyou NF	Chetco Bar	#2	2017	173,225
	Klondike	#3	2018	170,426
Siuslaw NF	n/a	n/a	n/a	n/a
Umatilla NF	Butte Creek (Grizzly Complex)	#1	2015	71,285
Umpqua NF	Happy Dog	#1	2017	29,763
	Stouts Creek	#3	2015	14,824
Wilamette NF	Seperation	#2	2017	18,097
	Whitewater	#3	2017	11,501
Wallowa-Whitman NF	Cache Creek	#3	2012	56,845
Burns BLM	Miller Homestead	#1	2012	160,801
	Buzzard	#2	2014	87,141
	Holloway	#3	2012	74,912
Coos Bay BLM	Chetco Bar	#1	2017	6,743
Eugene BLM	Yellow Point	#3	2014	227
Lakeview BLM	n/a	n/a	n/a	n/a
Medford BLM	Big Windy	#1	2013	26,607
	Dads Creek (Douglas Complex)	#2	2013	12,621
	Taylor Creek	#3	2018	11,627
Prineville BLM	South Fork	#1	2014	23,826
	Boxcar 0410	#2	2018	16,091
	Razorback	#3	2011	12,887
Roseburg BLM	Horse Prarie	#1	2017	7,654
	Rabbit Mountain (Douglas Complex)	#2	2013	6,267
	Stouts Creek	#3	2015	5,477
Spokane BLM	Barker Canyon	#1	2012	17,049
	Range 12	#2	2016	12,646
	Crane Road	#3	2012	10,000
Vale BLM	Long Draw	#1	2012	548,379
	Holloway	#2	2012	164,870
	Saddle Draw (Buzzard Complex)	#3	2014	141,558
Colville Agency	North Star	#1	2015	170,561
	Tunk Block	#2	2015	81,936
Spokane Agency	Carpenter Road	#1	2015	20,583
	Cayuse Mountain	#2	2016	18,077
Warm Springs Agency	County Line	#1	2015	67,367
	Nena Springs	#2	2017	58,525
	Sunnyside Turnoff	#3	2013	51,465
Yakima Agency	Cougar Creek	#1	2015	47,892
Crater Lake NP	Spruce Lake	#1	2017	15,527
	Crescent Fire (National Complex)	#2	2015	13,022
Olympic NP	Paradise	#1	2015	2,796
Sheldon*-Hart* Mountain NWR	n/a	n/a	n/a	n/a
Malheur NWR*	n/a	n/a	n/a	n/a
Saddle Mtn NWR*	Range 12	#3	2016	30,000
State of WA (All state-owned lands)	Colocum Tarps	#1	2013	73,330
	Carlton	#2	2014	70,764
	Lime Belt	#3	2015	50,807
State of OR (All state-owned lands)	Buzzard Complex	#1	2014	78,186
	Murderer's Creek (South Fork Complex)	#2	2014	11,728

\*Includes the top 4 largest NWRs in PNW

Table 1. Large fires in the Pacific Northwest (2011-2018).

**BENEFITS**

- Use of fire in PODs are a compromise between what we know many of these fire-adapted and dependent ecosystems need, vs. agency tradition and personal preference, protection of HVRAs, and political pressure. Likewise, it is a middle-ground with other federal agencies, State, and local partners.
- In many ecosystems, we need more fire on the landscape—PODs can help us get there on a broader scale, particularly when implementing a confine, monitor, and point and/or zone protection strategy. Recently burned PODs will help us control future large fires and is an intervention to help us reach the goal of a self-regulating fire system in fire prone environments.
- PODs promote shared stewardship and can help us achieve the goals of the Cohesive Strategy (USDA, 2011). By working with partners, we can plan an expectation together before the fire occurs and partners will be more apt to support an action on the ground, if they were first involved with the strategy.
- PCLs and PODs can be identified before fire season by local expertise—when there is no “emergency”—and incorporated as part of the planning process.
- In addition to developing and implementing a strategic response for a wildfire, PODs can be utilized in the off season for prescribed fire planning and implementation.
- There are usually less constraints on personnel, funding, and smoke managing a wildfire utilizing PODs vs. the implementation and maintenance of prescribed fire or fuel treatments.
- Beneficial fire effects can often be realized while utilizing PODs, particularly in times of low, moderate, and high fire danger. Even under extreme conditions, using PODs when executing burnout operations can produce a mosaic of mixed-severity.
- Sometimes on wildfires we focus too much on trying to control a fire at a difficult location due to a jurisdictional or administrative boundary. PCLs and PODs can help us identify control opportunities at locations, regardless of ownership, where firefighters can more safely and successfully engage the fire—particularly if additional mitigation measures are taken.

linked together to form PODs—polygons that are typically thousands of acres. Think of PODs as hydrologic units codes (HUCs), but instead of the land area where water drains to a specific location (watershed), PODs are based on fire spread. Fifth or sixth level watersheds or a fireshed (Bahro et al., 2007; Scott and Thompson, 2015), usually consist of multiple PODs.

There are many benefits for developing PODs, particularly on fire-prone landscapes; there are also a few challenges and cautions.

# The Use of PCLs, PODs, and Risk Assessment in Strategic Wildland Fire Management Planning

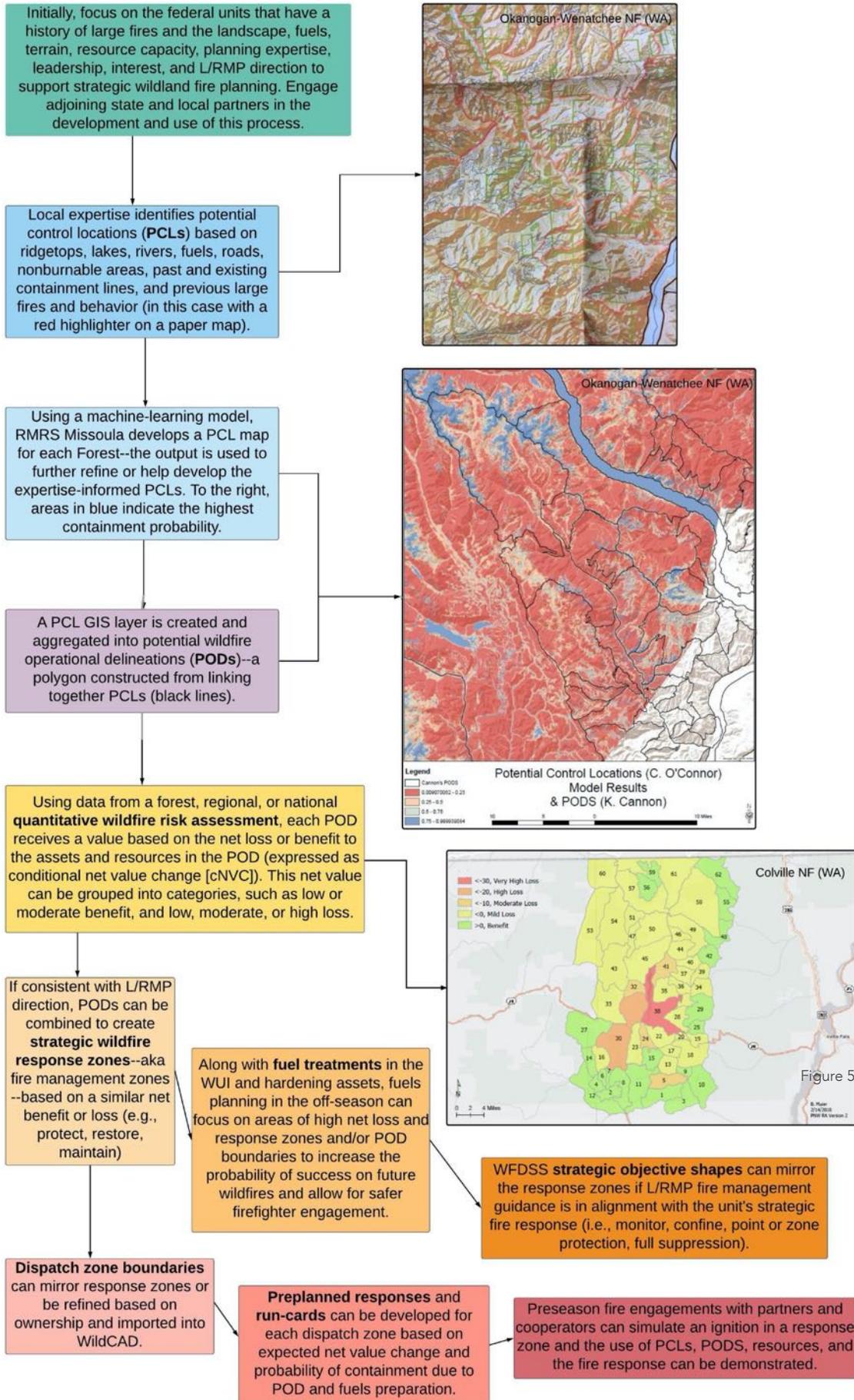


Figure 2. Flow chart of strategic wildland fire management planning.

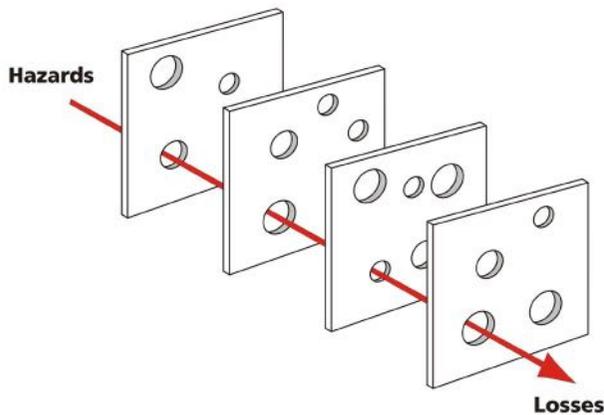
- PODs are delineated based on a known location on the ground that can be a tangible reference to an action, minimizing confusion where a specific action or strategy is to be employed.
- POD data can be quickly shared with incoming teams via Google Earth, GIS, and GPS, referenced in the leader's intent letter, and included in the WFDSS decision.

## CHALLENGES AND CAUTIONS

- Do you have the expertise to identify and delineate the PCLs and/or verify those provided by the machine learning model, and delineate the PODs?
- It is relatively easy to create PODs, but will your local unit use them? Are local fire managers, line officers, partners, and incident management teams (IMTs) informed, in agreement, have access to the data, and expectations understood?
- Landscapes with multiple ownerships can make the POD development process more challenging, but potentially very rewarding and in alignment with national direction.
- PODs need to be part of the operations and long-term planning of a wildfire. It is critical we do not lock into a specific POD, when the next ridge or POD has a higher degree of success and/or is safer to engage the fire.
- When managing a fire, the POD approach vs. direct attack may in the short run result in a higher expense, more smoke production, and increase the fire duration.
- A long-term strategy utilizing PODs may be more difficult for the public to comprehend and support, particularly those communities who have been affected by evacuation, smoke, and reduced access in the recent past.
- If PCLs and/or PODs are prepped as containment lines, local biologists and/or resource specialists may need to be consulted.

## STRATEGIC WILDLAND FIRE MANAGEMENT PLANNING

We need to do much more BEFORE the “big one” occurs—they are inevitable in many fire adapted and dependent ecosystems. We must think, talk, plan, and act more strategically on our landscapes. We have a very hard time doing this individually and as federal or state agencies. We must not wait until there is smoke in the air. This is where SWFMP plays an important role. Figure 2 is a flow chart outlining the process of using PCLs, PODs, and a quantitative wildfire risk assessment (QWRA) (Scott et al, 2013; Gilbertson-Day et al, 2018) in a SWFMP framework.



### The process consists of:

1. Use local expertise and/or machine learning to identify PCLs.
2. Develop PODs by linking together the PCLs into polygons.
3. Where available, use a local, state, or regional QWRA to assign each POD a value based on net loss or benefit to HVRAs within the POD boundary. This information is usually expressed as a conditional net value change (cNVC). This value can be grouped into categories, such as low, moderate, or high benefit or loss. For more information on the QWRA process and its application, view the following webinar: <http://www.nwfirescience.org/content/overview-applications-pnw-quantitative-wildfire-risk-assessment> (Stratton, 2019).
4. If consistent with the Land or Resource Management Plan direction (L/RMP), strategic wildfire response zones can be developed based on similar areas of net benefit or loss. A unit can assign an ecologically-based strategic response (protect, restore, maintain) or a more operational response, like that contained in the Incident Command System 209—(full suppression, confine, point or zone protection, monitor).
5. Along with fuel treatments in the WUI and hardening assets, fuels planning in the off-season can focus on areas of high net loss by POD to increase the probability of success on future wildfires and allow for safer firefighter engagement.
6. Preseason planning efforts can be incorporated into fire management planning documents, electronic systems like ArcGIS Online, and spatial fire planning in WFDSS.
7. Dispatch zones can mirror the strategic wildfire response zones and the preplanned response can be commensurate with loss or benefits to HVRAs.
8. Preseason fire engagements with partners and cooperators can simulate an ignition in a response zone and the use of PCLs, PODs, resources, and the preplanned fire response can be demonstrated.

## IMPLEMENTATION

Many are familiar with the Swiss cheese model of accident causation (Reason, 1990 and 2000)—a model used in risk analysis and management (Figure 3). The model illustrates that although there are often several layers of defense between hazards and losses, there can be inherent flaws in the defensive layers. If these flaws are aligned, a negative outcome is realized.

Using this conceptual model in the context of SWFMP, we can see how an improved outcome can be achieved. This is possible when there is an open dialogue and understanding with local fire management, line officers, and cooperators, and that their proposed actions are in alignment with the L/RMP. Furthermore,

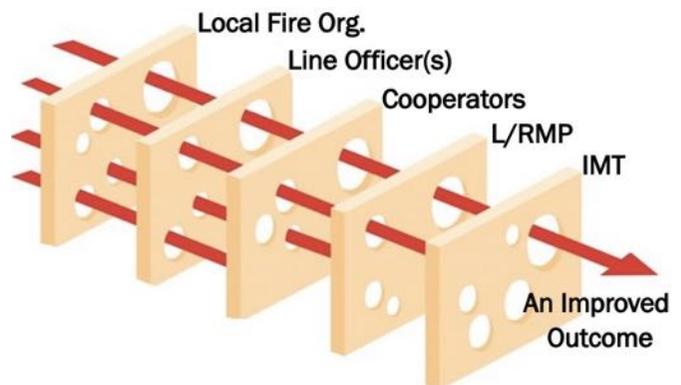


Figure 3. Swiss cheese model of accident causation (Reason, 2000); Figure 4. Swiss cheese model of wildland fire management direction alignment.

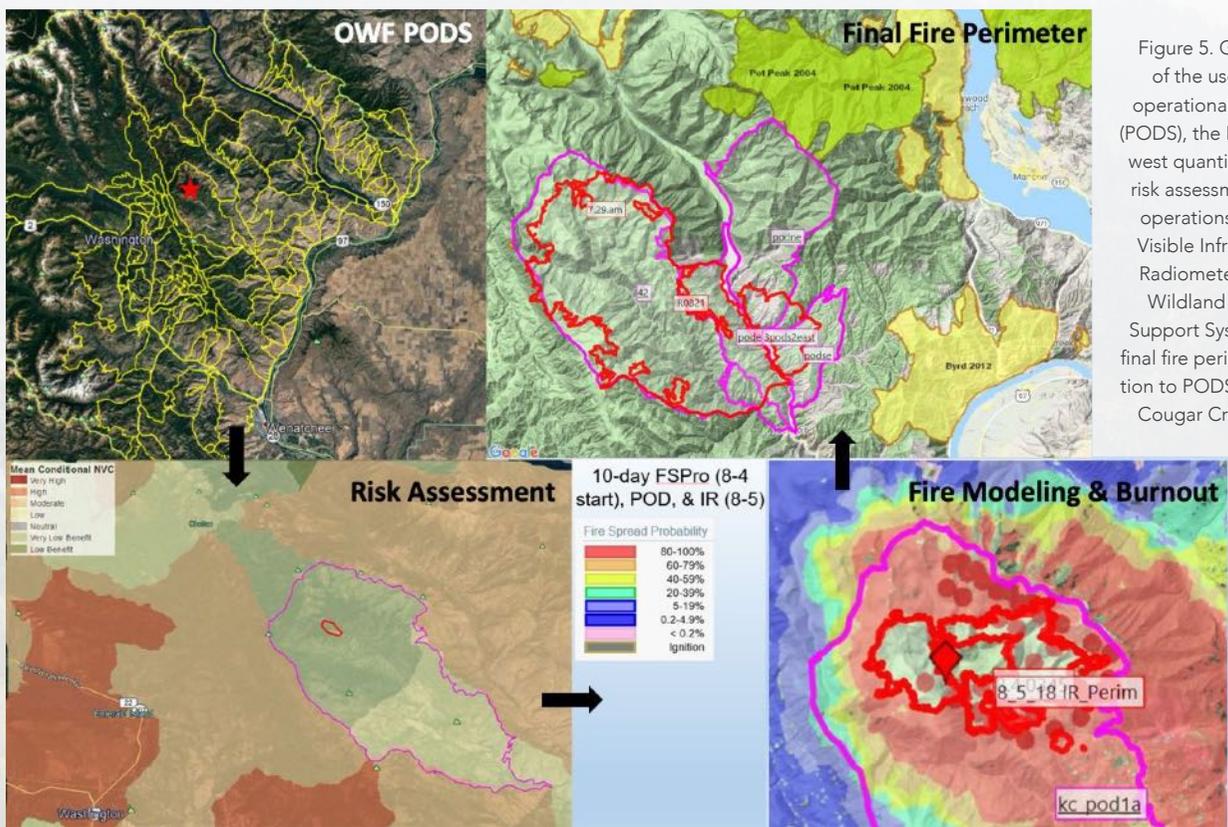


Figure 5. Graphical flow of the use of potential operational delineations (PODs), the Pacific Northwest quantitative wildfire risk assessment, burnout operations as shown by Visible Infrared Imaging Radiometer Suite in the Wildland Fire Decision Support System, and the final fire perimeter in relation to PODs for the 2018 Cougar Creek Fire, WA.

on wildfires it is essential the incident management team is aligned with this collaborate strategic vision. If even one of these entities is not in alignment, the strategy can fail or be in conflict with the L/RMP (Figure 4).

### EXAMPLE OF THE USE OF PODS (COUGAR CREEK FIRE 2018)

The Cougar Creek fire started from a lightning strike July 28 on the Entiat Ranger District, Okanogan-Wenatchee National Forest, WA. It was in an area with steep, inaccessible, and rugged terrain, heavy timber, previous large fires, and near the peak of fire season. Local managers had immediate concerns about firefighter safety and the probability of containment. Although this was a full-suppression fire, POD boundaries were utilized. PODs had been developed the year prior by a long-tenured, fire management officer using a highlighter and a paper map and digitized by a fire analyst (Figure 5). Also, the PNW QWRA was used to summarize net benefit or loss (cNVC) by sixth-level watershed. The QWRA showed a predicted net benefit of the fire in the watershed containing the ignition.

POD and risk assessment information was made available to the IMT and referenced by the line officer and local staff while communicating strategy and containment. The IMT validated the POD boundaries, prepped several of them, and began to carry fire from the north to the south on the eastern boundary. Values inside the POD were protected. A week later, when the POD boundary was breached to the SE, the next PODs were utilized to ultimately aid in the containment of the fire. Ultimately, the fire was contained at about 42,000 acres; firefighters, the public, and other assets and resources were protected, the fire-adapted ecosystem benefited with a burn severity largely low to moderate, and the future threat to HVRAs from large fires has been reduced for several years.

### HOW TO BEGIN THE SWFMP PROCESS

Meet as a unit fire organization and discuss the need (the “why”) and if the process will work given your landscape, resources,

current leadership, and partners. Identify the personnel and skills required. What partners are important to the process? Share your ideas with other fire managers. Take the proposal to your line officer who can help champion the effort and facilitate a discussion with adjoining units on contributing to and supporting the process. Receive a formal by-in—which includes if you are going to build it, line, IMTs, and your local fire organization are going to use it. Identify PCLs with maps and highlighters or turn to the Forest Service, Rocky Mountain Research Station to develop the PCLs. The more agencies and cooperators you invite to the process—in a workshop setting—the more apt they will be to support and embrace the strategy when there is a wildfire. Group the PCLs into PODs. Make these PODs available in GIS for local and IMT use on fires and in WFDSS. Monitor the product and the process and revise as conditions and personnel change. Remember to start small and keep it simple. We can’t expect to undo forest practices of a century in a year or even a decade—incremental progress is the goal, starting with areas with a higher degree of success and leveraging past fires.

If you can’t implement the entire SWFMP framework, then do what you can, even if it is just the use of PCLs.

In the off season, make the PCLs and/or PODs available in WFDSS, and in Google Earth, GIS, and map form for local use and incoming teams. Pre- and post-season fuel treatment work should utilize the PODs and be part of a landscape strategy for restoration and protection of HVRAs. Line officers should refer to the PCL, POD, and QWRA data in their leader’s intent letter/delegation of authority to local and incoming IMTs and should be echoed in the WFDSS decision (incident objectives, course of action, and rationale).

### TIME FOR A DELIBERATE CHANGE IN STRATEGY

The Cohesive Wildland Fire Management Strategy identified three primary factors as the greatest challenges and opportunities we face in wildland fire management: (1) restoring and maintaining resilient landscapes, (2) creating fire-adapted communities, and

(3) responding to wildfires. Implementing SWFMP on fire-prone landscapes will help us achieve the goals and performance measures pertinent to these three focus areas. When one considers the toll that recent wildfires have had on lives, communities, and the environment, we really have few alternatives. We can continue to battle—often unsuccessfully—where we have decision space, we can think, talk, plan (especially preplan) and act more strategically. The science has been suggesting this approach for years, and fire's response on the landscape is now forcing us to think differently about our wildland fire management practices. Isn't it about time we change?

## ACKNOWLEDGEMENTS

The author appreciates helpful reviews from Kit O'Connor, Chris Dunn, Morgan Pence, and Joe Scott, and statistical support from Teresa Alcock, Barb Haney, Brian Maier, and Sunny Ng.

## BIO

Rick Stratton (richard.stratton@usda.gov) is a fire analyst at the US Forest Service, National Office, Fire and Aviation Management. His wildland fire interests include geospatial fire modeling, long-duration fire support, fuel treatment design and effectiveness, risk assessment, and wildland-urban interface home ignitability assessments and destruction investigations.

## REFERENCES

- Bahro, Bernhard; Barber, Klaus H.; Sherlock, Joseph W.; Yasuda, Donald A. 2007. Stewardship and fireshed assessment: a process for designing a landscape fuel treatment strategy. Restoring fire-adapted ecosystems: proceedings of the 2005 national silviculture workshop, Gen. Tech. Rep PSW-GTR-203, p. 41-54.
- Booz Allen Hamilton. 2015. 2014 Quadrennial Fire Review final report. Washington, DC: USDA Forest Service, Fire and Aviation Management; USDI Office of Wildland Fire. 79 p.
- Finco, Mark; Quayle, Brad; Zhang, Yuan; Lecker, Jennifer; Megown, Kevin A.; Brewer, C. Kenneth. 2012. Monitoring Trends and Burn Severity (MTBS): Monitoring wildfire activity for the past quarter century using landsat data. In: Morin, Randall S.; Liknes, Greg C., comps. Moving from status to trends: Forest Inventory and Analysis (FIA) symposium 2012; 2012 December 4-6; Baltimore, MD. Gen. Tech. Rep. NRS-P-105. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. [CD-ROM]: 222-228.
- Finney, M., I.C. Grenfell, and C.W. McHugh. 2009. Modeling containment of large wildfires using generalized linear mixed-model analysis. *For. Sci.* 55(3):249-255.
- Finney MA, McHugh CW, Grenfell IC (2005) Stand- and landscape-level effects of prescribed burning on two Arizona wildfires. *Canadian Journal of Forest Research* 35, 1714-1722.
- Gilbertson-Day, Julie W.; Stratton, Richard D.; Scott, Joe H.; Vogler C., Kevin; Brough, April. 2018. Pacific Northwest Quantitative Wildfire Risk Assessment: Methods and Results. Final report.
- Hessburg P.F. 2017. Why wildfires have gotten worse—and what we can do about it. Tedx Bend, OR, presented May 2017. URL: [https://www.ted.com/talks/paul\\_hessburg\\_why\\_wildfires\\_have\\_gotten\\_worse\\_and\\_what\\_we\\_can\\_do\\_about\\_it](https://www.ted.com/talks/paul_hessburg_why_wildfires_have_gotten_worse_and_what_we_can_do_about_it)
- McHugh, C.W. and Finney, M.A. 2014. Estimating Historical Annual Wildland Fire Burning Rates for the Contiguous United States. Presented: The large wildland fires conference; May 19-23, 2014; Missoula, MT. Presentation was recorded and is available for viewing here: <https://mediasite.for.uidaho.edu/Mediasite/Play/a30a5e19a9ac43a1b559e9c808a125cd1d>
- Noonan-Wright, Erin; Opperman, Tonja S.; Finney, Mark A.; Zimmerman, G. Thomas; Seli, Robert C.; Elenz, Lisa M.; Calkin, David E.; Fiedler, John R. 2011. Developing the U.S. Wildland Fire Decision Support System. *Journal of Combustion*. 2011: Article ID 168473. 14 p.
- O'Connor, Christopher D.; Calkin, David E. 2019. Engaging the fire before it starts: A case study from the 2017 Pinal Fire (Arizona). *Wildfire*. 28(1): 14-18.
- O'Connor, Christopher D.; Calkin, David E.; Thompson, Matthew P. 2017. An empirical machine learning method for predicting potential fire control locations for pre-fire planning and operational fire management. *International Journal of Wildland Fire*. 26: 587-597.
- Promoting Active Management of America's Forests, Range-lands, and Other Federal Lands to Improve Conditions and Reduce Wildfire Risk. Federal Register, Vol. 84, No. 4, Monday, January 7, 2019. Presidential Documents Executive Order 13855 of December 21, 2018.
- Radeloff, V.C.; Helmers, D.P.; Kramer, H.A.; Mockrin, M.H.; Alexandre, P.M.; Bar-Massada, A.; Butsic, V.; Hawbaker, T.J.; Martinuzzi, S.; Syphard, A.D.; et al. 2018. Rapid growth of the US wildland-urban interface raises wildfire risk. *Proc. Natl. Acad. Sci. USA*.
- Reason, J. 1990. "The Contribution of Latent Human Failures to the Breakdown of Complex Systems". *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*. 327 (1241): 475-484. doi:10.1098/rstb.1990.0090.
- Reason, James (2000-03-18). "Human error: models and management", *British Medical Journal*. 320 (7237): 768-770.
- Reducing Wildfire Risks on Department of the Interior Land through Active Management. 2019. Order No. 3372. USDI, Jan. 2.
- Rollins, Matthew G.; Frame, Christine K., tech. eds. 2006. The LANDFIRE Prototype Project: nationally consistent and locally relevant geospatial data for wildland fire management. Gen. Tech. Rep. RMRS-GTR-175. Fort Collins: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 416 p.
- Scott, Joe H.; Thompson, Matthew P. 2015. Emerging concepts in wildfire risk assessment and management (Publ.). In: Keane, Robert E.; Jolly, Matt; Parsons, Russell; Riley, Karin. Proceedings of the large wildland fires conference; May 19-23, 2014; Missoula, MT. Proc. RMRS-P-73. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 196-206.
- Scott, Joe H.; Thompson, Matthew P.; Calkin, David E. 2013. A wildfire risk assessment framework for land and resource management. Gen. Tech. Rep. RMRS-GTR-315. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 83 p.
- Stratton, Richard D. 2019. Webinar Presentation: Overview and Applications of the PNW Quantitative Wildfire Risk Assessment. Northwest Fire Science Consortium. April 24.
- Stratton, Richard D. 2006. Guidance on spatial wildland fire analysis: models, tools, and techniques. Gen. Tech. Rep. RMRS-GTR-183. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 15 p.
- Thompson MP, Bowden P, Brough A, Scott JH, Gilbertson-Day J, Taylor A, Anderson J, Haas JR. 2016. Application of wildfire risk assessment results to wildfire response planning in the southern Sierra Nevada, California, USA. *Forests* 7, 64.
- Toward Shared Stewardship Across Landscapes: An Outcome-Based Investment Strategy. 2018. FS-1118. USDA FS. U.S. Department of Agriculture, Forest Service. 2018. A Statement from Forest Service Chief on executive order promoting active management. News Release. Dec. 21.
- U.S. Department of Agriculture, Forest Service; Department of the Interior, Office of Wildland Fire Coordination. 2011. A national cohesive wildland fire management strategy. Washington, DC: Wildland Fire Leadership Council. 43 p.
- U.S. Department of Agriculture, Forest Service; Pacific Northwest Regional Office. 2015. Narrative timeline of the Pacific Northwest 2015 fire season. Portland, OR. 281 p.

# We can provide a universal Basic Fireline Life Support system – and we should

*Eli Schned, an emergency room doctor and former firefighter, shares the lessons learned from a prototype course that focuses on the medical emergencies faced by firefighters on the fireline. Training and preparing for trauma, injuries and evacuations unique to the fireline should be our standard.*

BY ELI SCHNED

The National Wildfire Coordination Group (NWCG) has done a good job of prioritizing safety in wildland fire operations and promoting human life over property. For example, fireline checklists inspired by aviation safety prove their worth every day. Nevertheless, the work remains — and will always be — inherently dangerous. There are simply too many variables in nature to realistically overcome all risk. Consider a smoldering snag: Although an experienced firefighter can read a snag well, the infinite variables that keep the snag standing — soil, wind, slope, etc. — can conspire to bring the snag down suddenly and with deceptively little warning. With tens of millions of snags and tens of thousands of wildland firefighters operating about them, it is statistically certain that a snag will fatefully fall at the wrong time in the wrong direction. In an effort to improve response to the inevitable injuries, we propose a universal Basic Fireline Life Support system that addresses the medical emergencies specific to wildland fire and does not require any prior medical experience. Earlier this year we ran a pilot of this course with several crews in USFS Region 1. We propose that it can be scaled to all at-risk personnel regardless of their medical background

The fire agencies have relied on the National Registry of Emergency Medical Technicians (NREMT) to provide the foundation of their emergency medical response. The NREMT provides excellent standardized training and is integral to the national EMS response. However, the EMT curriculum reflects America's health burden — elderly with chronic medical diseases. The wilderness self-selects and it is unlikely a wildland firefighter EMT will encounter end-stage chronic obstructive lung disease, uncontrolled diabetes, or congestive heart failure on the fireline. Only a small portion (less than five to ten percent) of a standard 100-hour basic EMT class discusses traumatic injuries. Additionally, there is nothing in the curriculum on decision making for types of evacuation (e.g. ground vs. air). It is a given in the class that the EMT will be part of an ambulance team, obviating this decision point. Major trauma in the young and healthy is a major cause of morbidity in wildland fire. A wildland firefighter who encounters a major trauma in the wilderness faces the challenge of an improvised evacuation with little help from their EMT training in managing the patient.

Similarly, wilderness first responder and wilderness EMT classes provide great exposure to medicine specifically in the wilderness. It certainly helps urban based EMTs and rescuers start to think about how the practice environment often dictates patient management. However, these classes, while shorter than NREMT certifications, will often take a full week or more and are still prohibitively long from the perspective of training all wildland firefighters. And like urban EMT classes, the material is diluted by topics that are less relevant to wildland fire like toxicology (i.e. drugs and medications), pediatrics, obstetrics, geriatrics, diving injuries, and altitude illnesses.

Luckily, wildland firefighters are self-motivated, resourceful, and physically fit. These are all ideal characteristics for remote medical rescue. Virtually all wildland firefighters are facile with radio communication and many have great experience with rotor wing aircraft. With additional focused training, we can give all wildland firefighters the tools they need to successfully care for critical injuries and important wilderness medical emergencies such as anaphylaxis and heart stroke.

In May 2019, we taught a prototype course with several crews in USFS Region 1. We kept it brief, about an hour, and prioritized content that was not overly technical and could be easily taught and retained. The primary focus of the course was recognition and management of major traumatic injuries in a wildland fire specific setting. We began by teaching recognition of subtle signs of a critical injury but without traditional tools like blood pressure measurement, which requires specialized training and is onerous to use in the field and fraught with potential inaccuracies. The course borrowed from the Stop the Bleed curriculum, teaching how to manage life-threatening extremity bleeding. Although these injuries are relatively rare in wildland fire, they are the only field-treatable traumas that require no advanced training or tools to save a life. The remainder of the lecture focused on evacuation by starting a conversation about which patients need evacuation and what type of method should be used. Not all injuries require evacuation and of the ones that do, not all need rotor wing evacuation. Effective communication and coordination with rescue resources was also emphasized. The course concluded with hands-on practice with the entire crew cycling through a simulated incident that required



We train with our crews for medical emergencies, but an emergency room doctor and former firefighter suggests that we can (and should) train with a focus on the unique first-aid and emergency events we face as wildland firefighters.

rapid assessment and recognition of injury, radio dispatch, and immediate evacuation on an appropriate backcountry stretcher.

Repetition in simulation training builds muscle memory and reduces the cognitive burden when encountering an actual major trauma. Just as important is that the training is realistic and adheres to the principle of “no training scars.” Shortcuts in training are pernicious as the same shortcuts invariably rear during the real thing. For instance, it is not acceptable for the trainee to verbalize, “I would then roll the patient.” They actually have to do it or they are likely to skip the same step when they are cognitively overwhelmed in a critical event. The more stressful the training, the more inoculated to stress the rescuer will be when actually faced with a major injury. At the end of our brief course, it was rewarding to see firefighters execute critical skills including single-person rescue on an appropriate backcountry stretcher, treatment, transport, and communication with a simulated dispatcher while recognizing subtle signs of major bleeding.

Fireline medicine training needs to focus on the basics of hemorrhage control, evacuation, and fundamentals of a select group of treatable wilderness emergencies (e.g. anaphylaxis, heat stroke, heart attacks, rhabdomyolysis). The NREMT curriculum falls short of what firefighters need. But the NWCG course catalogue already provides a model for more appropriate training. Basic Fireline Life Support should be integrated into the training of all wildland firefighters. If not as part of the Basic 32 (the core introductory fire training), then as the equivalent of a 200-level S course that could be completed in a day or less. We envision the completion of such a course as a goal for all firefighters, and

especially for all interagency hotshot crews (IHCs), smokejumpers, helitack, and anyone at the Squad Boss level or above.

A higher level course (e.g. S-300, 400 level) could provide deeper knowledge for line medics, medical unit leaders, EMTs, or anyone else with an interest in additional medical training. It is time to stop trying to bring the urban ambulance to wildland fire and time to start prioritizing rapid evacuation and lifesaving interventions.

**Eli Schned, MD, FAWM, DiMM, EMT-I**, is a former US Forest Service hotshot firefighter and smokejumper. He practices Emergency Medicine and currently lives in New Haven, Connecticut. He recently completed a fellowship in Wilderness Medicine at Yale University.



#### FURTHER READING

Alex Viktora. “Medevac: How We Got Here.” Wildland Fire Lessons Learned Center June 13, 2019.

<https://wildfirelessons.wordpress.com/2019/06/13/medevac-how-we-got-here/>.

**BIA Wildland Fire First Aid Program.** <https://www.bia.gov/bia/ots/dfwfm/bwfm/safety/first-aid-project>. An example of a fireline focused medical program, launched by the Bureau of Indian Affairs in 2018, that is “... specially designed for wildland firefighters who are non-medical professionals.”



# AUSTRALIA'S

IMAGES, COMMENTARY, LINKS

*It's just past mid-fire-season in parts of Australia and this fire continent has already burned beyond what's been experienced in our lifetimes.*

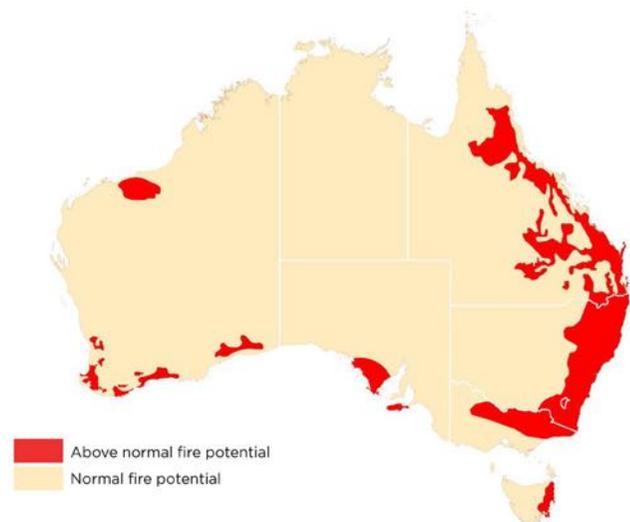
*Our coverage will continue in future issues of Wildfire. For now, we share these updates — as told in images, commentary, and links.*

# FIRES

**As the mid-December “Hazard Note” predicted for Australia, drought and heat waves are extensive, record-setting, and likely to continue into March. With 2019 the hottest and driest on record for Australia, what began as a challenging fire season has burnt 10.7 million hectares (26 million acres) as of January 8, 2020, with 29 fatalities reported and an estimated 2200+ structures burnt. And this long season is likely to burn longer than normal.**

## FROM HAZARD NOTE 68...

With the combined hot and dry conditions in place it is not surprising that the southern fire season started early and has been severe to date. Large areas have seen record fire danger overall, as well as a very early start to the high fire danger period. In area average terms, the fire weather as measured by the Forest Fire Danger Index (FFDI) for spring was record high for Australia, as well as all states



**FIGURE 1:** AUSTRALIAN SEASONAL BUSHFIRE OUTLOOK DECEMBER 2019. AREAS ARE BASED ON THE INTERIM BIOGEOGRAPHIC REGIONALISATION FOR AUSTRALIA AND OTHER GEOGRAPHICAL FEATURES.

RFS Captain at Kangawalla Fire near Glen Innes NSW. Photo: Katerina Morjanoff.

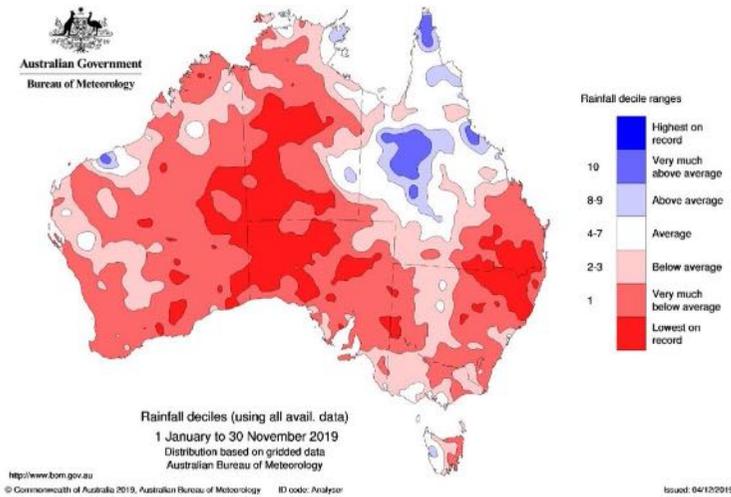


FIGURE 2: RAINFALL DECILES FOR JANUARY TO NOVEMBER 2019 SHOWING DRY CONDITIONS OVER MUCH OF AUSTRALIA.

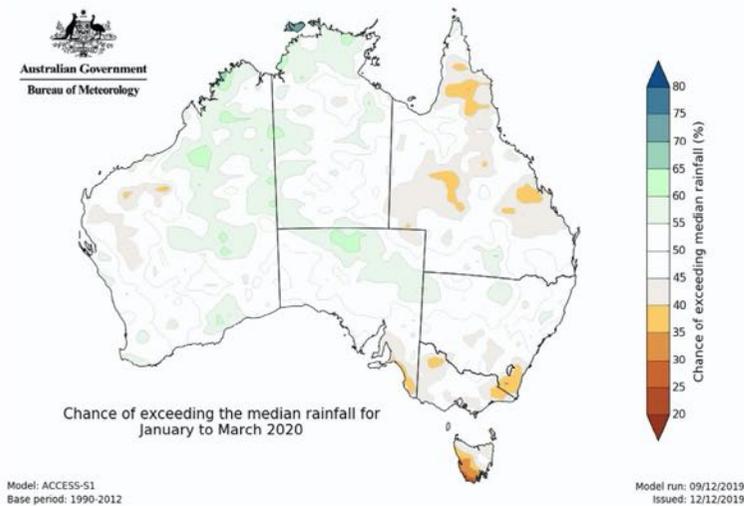


FIGURE 4: CHANCE OF EXCEEDING THE MEDIAN RAINFALL FOR JANUARY TO MARCH 2020.

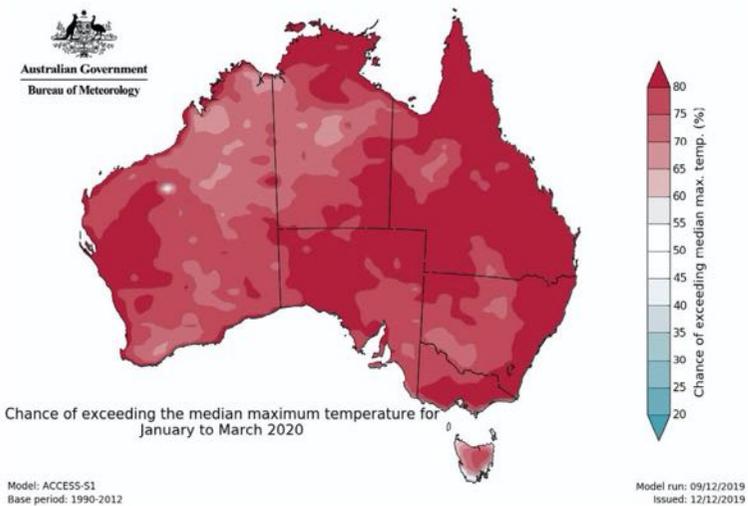


FIGURE 5: CHANCE OF EXCEEDING THE MEDIAN MAXIMUM TEMPERATURE FOR JANUARY TO MARCH 2020.

and territories apart from South Australia (second) and Victoria.

The tendency for fire seasons to become more intense and fire danger to occur earlier in the season is a clear trend in Australia’s climate, reflecting reduced and/or less reliable cool season rainfall and rising temperatures (see State of the Climate 2018). Fire season severity is increasing across much of Australia as measured by annual (July to June) indices of the FFDI, with the increases tending to be greatest in inland eastern Australia and coastal Western Australia.

While both climate drivers [the positive Indian Ocean Dipole pattern and negative Southern Annular Mode] are likely to decay by mid-summer, their legacy will take some time to fade. The positive Indian Ocean Dipole and the dry conditions experienced in winter and spring are known to be associated with a more severe fire season for south east Australia in the subsequent summer.

The rainfall outlook for January to March (Figure 4) suggests that rainfall is likely to be above average in western areas, while eastern Australia generally sees odds which are close to 50:50. The decay of the Indian Ocean Dipole means that probability swings are less strong than earlier in the season for eastern areas, suggesting that some relief in dry conditions is possible in the coming months.

## TRACKING FIRE & WEATHER (selected links)

### FIRE ACTIVITY & RISK

- Digital Earth Australia Hotspots: <https://hotspots.dea.ga.gov.au>
- MyFireWatch (satellite mapping): <https://my-firewatch.landgate.wa.gov.au/map.html>
- New South Wales (NSW) Rural Fire Service, Fire Information. <http://www.rfs.nsw.gov.au/fire-information> and <https://www.rfs.nsw.gov.au/fire-information/fires-near-me>.
- Victoria Country Fire Authority . <https://www.cfa.vic.gov.au/warnings-restrictions-total-fire-bans-and-ratings>.

### WEATHER

- Australia Government. Bureau of Meteorology. <http://www.bom.gov.au/climate/outlooks/#/overview/summary>.
- SPEI Global Drought Monitor. <https://spei.csic.es/map/maps.html#months=1#month=11#year=2019>.

Text and images from “Australian Seasonal Bushfire Outlook: December 2019.” <https://www.bnhcrc.com.au/hazardnotes/68>.



Aerial image of Tutti Fruitti farm, destroyed. Near Bilpin, in the Blue Mountains of New South Wales. <https://tuttifruitti.com.au/>. Photo: Sean Cox.

# More of the same won't help

This commentary by Richard Thornton – CEO of the Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC) and former IAWF Board Member – was published in *The Weekend Australian* on Saturday, January 4, 2020. <https://www.theaustralian.com.au/inquirer/doing-more-of-the-same-on-fires-will-not-mitigate-disaster-impact/news-story/e2d831e3383b9d07d1fe36a4124ae9c0> (Paywall required).

by Richard Thornton

Watching this fire season unfold, I am, like I hope every Australian, shocked and horrified by the extent of the destruction. The tragedy, despair and loss across our nation is deeply saddening.

Back in late August, the Bushfire and Natural Hazards Cooperative Research Centre released our bushfire outlook for the coming season showing large areas of eastern Australia facing above-normal potential. Never did we believe that the season would systematically change those red areas on the map to black. I, and on behalf of all those I represent in the research community, extend our condolences to all the communities affected and our heartfelt thanks to all those who have battled the fires so valiantly, and will continue to do so in the months ahead.

To paraphrase American scholar Henry Mencken, there is always a simple solution to every complex problem that is neat, plausible and wrong. That is the position we are in with much of the recent commentary on the causes, impacts and solutions to the bushfires we've faced this season across Australia.

There are many views on how the fires could have been prevented. More hazard reduction burning or prescribed burning. Lock up those who deliberately start fires. Turn off electricity supplies. Build fire-resistant houses. Get communities better prepared. Don't live in the bush. Buy more aircraft. Bring in the army. Grow green fire breaks. Stop greenies. Stop climate change. The list gets longer every day.

However, what we are dealing with is a wicked problem and

there is a very real risk in attempting to solve this complex issue with simple approaches. This simply makes the problem change but does not get us any closer to solving the problem. Indeed, it can create new problems, sometimes worse than before.

We demand simple answers and yet we know only too well that this is not a simple problem to solve.

Australia has had almost 100 inquiries into fires and fire management between 1983 and 2017, generating many hundreds of recommendations.

These have included royal commissions, parliamentary inquiries and special inquiries with the powers of a royal commission. Many of these recommendations have been implemented with far-reaching changes seen in firefighting operations, landscape management, community safety and urban planning.

Of course, things have improved — a quick glance back at the way the 1983 Ash Wednesday fires or 2009 Black Saturday fires were handled shows much has changed. But maybe even that's not enough.

It's not just Australia asking these questions. In the US fires have ripped through communities and displaced thousands in recent years.

The US fire suppression budget is huge and increasing, and it has at its disposal the largest aerial firefighting force in the world.

But it seems that's not enough, either.

I am going to make a prediction. Once this fire season ends, we will have many inquiries that will come up with a new raft of recommendations. History tells us that these recommendations will not be a lot different to those already found. The cycle continues.

What is needed is a quantum shift in our thinking. Just doing the same thing or planning to do the same thing, but just more of it, is a simple solution that is neat and plausible. And wrong.

To pursue the same path is tacitly to say that there is an acceptable number of deaths, injuries and property losses from bushfires in Australia each year. To do more is to lower that number of acceptable impacts. That's not good enough.

We can learn a lot from the approach we have taken to other complex, wicked problems such as the Towards Zero road safety campaign and the Quit Smoking campaign. The only acceptable targets are absolute — no road deaths, no smoking deaths. But the genius of these campaigns is that they understand the fundamental drivers of human behaviour and the capacity for humans often to make choices that put themselves in danger.

In bushfire, as with most natural hazards, we need to have a better grasp of this complexity to achieve real change. We need solutions that take into account all human, environmental, cultural and economic considerations. And, most importantly, we

## "Cut Line in Less Time!"



Super P Pro 40



Hoe 40



Chingadara 40



Bigfoot 40



Designed by Professional Wildland Fire Captain.

Proprietary Steel Formation Holds Sharpened Edge Longer and Resists Chipping.  
Universal Neck Allows for all Parts of Tool to be Fully Replaceable and Interchangeable.

MORE PRODUCTS AVAILABLE AT:

**JRFIRETOOLS.COM**

P.O. Box 1617 • Cedar Ridge, CA. 95924 • (530) 272-1444



Pounder II 40



Scalper 48



McLeod 48



Wire Fire Broom 52



need to all agree that despite all the good ideas, all the good research, all the goodwill, perhaps we don't have a complete set of answers yet.

Here is a suggestion for "a national conversation" that could lead into the proposed Council of Australian Governments meeting in March.

To move forward, and to depart from the endless cycle of bushfire crises, we must build upon what we have already done.

**Past inquiries:** We need to better analyse what we have already found from past fires and other natural hazards. What changes worked, what evidence was critical, what recommendations need to be completed. And which recommendations remain to be implemented because they were "too hard".

**Science and technology:** What is our state of knowledge and what more do we need to know about climate and severe weather, fire modelling and suppression, landscape fuels and mitigation, health impacts, land-use planning and building codes, future workforce and community recovery. The National Research Priorities for Natural Hazards Emergency Management, compiled in recent years by the Bushfire and Natural Hazards CRC with experts across Australia, are a good place to start to tell us what more research is needed.

**Understanding risk:** We have already done the hard work; let's now concentrate on making it work. Profiling Australia's vulnerability: The interconnected causes and cascading effects of systemic disaster risk and the National Disaster Risk Reduction Framework both respond to Australia's adoption of the Sendai Framework for Disaster Risk Reduction 2015-2030.

The **Sendai Framework** recognises the importance of not only managing disasters but managing disaster risk across all aspects of our society.

This also highlights a focus on understanding the essence of human society's vulnerability to natural hazard impacts.

When the smoke drifts away and we start the very long road to recovery in the communities devastated by these fires, let us not walk away from them and hide behind simple solutions and inquiries.

This is the time to consider seriously the hard questions and not continue with business as usual. This will require new thinking, new research, new investment and, importantly, new commitment.



## EXPLORING THE SCIENCE

As we seek to understand and support the efforts in Australia, we find that a search of "Australia" in the International Journal of Wildland Fire (<https://www.publish.csiro.au/WF/search?q=australia&sjournal=on>) pulls up 209 articles. A sampling of topics (by no means complete) may help answer questions about this fire season and help prepare for future seasons.

For instance, we can ask what combination of extreme fire and weather may lead to a fire season this intense, and find that Harris et al discovered that "Most of the life and property losses due to bushfires in south-eastern Australia occur under extreme fire weather conditions – strong winds, high temperatures, low relative humidity (RH) and extended drought." And they go on to observe that "what constitutes extreme, and the values of the weather ingredients and their variability, differs regionally."

"Variability and drivers of extreme fire weather in fire-prone areas of south-eastern Australia." Sarah Harris, Graham Mills and Timothy Brown. 13 February 2017. 26(3) 177-190 <https://doi.org/10.1071/WF16118>

And how do this season's conditions help us understand how to interpret and act on global climate models? Clarke et al concluded that by 2100, "Based on these changes in fire weather, the fire season is projected to start earlier in the uniform and winter rainfall regions, potentially leading to a longer overall fire season." Their research explains how and why this may become a more common pattern, all of which seems to match the 2019-2020 fire season.

"Regional signatures of future fire weather over eastern Australia from global climate models." Hamish G. Clarke, Peter L. Smith and Andrew J. Pitman. 20(4) 550-562 <https://doi.org/10.1071/WF10070>

And what conditions are more likely to lead to house loss? Blanchi et al analyzed 54 bushfires between 1957-2009 that resulted in nearly 8300 houses burned. The key observation: losses occur when the McArthur Forest Fire Danger Index (FFDI) is over 100. Observe that "Virtually all of the house loss has occurred above the 99.5th percentile level in the distribution of daily FFDI for each of the regions considered."

"Meteorological conditions and wildfire-related house loss in Australia." Raphaelae Blanchi et al. 05/11/2010. 19 (7). <https://doi.org/10.1071/WF08175>.

To explore and understand the "why" of extreme fire behavior in Australia, this BNHCRC Core Project page for Threshold conditions for extreme fire behaviour, which features a research team, including fire-manager end-users ... that is "investigating the conditions and processes under which bushfire behaviour undergoes major transitions, including fire convection and plume dynamics, evaluating the consequences of eruptive fire behaviour (spotting, convection driven wind damage, rapid fire spread) and determining the combination of conditions for such behaviours to occur (unstable atmosphere, fuel properties and weather conditions)." <https://www.bnhcrc.com.au/research/understanding-mitigating-hazards/1300>.

# ...and the firefighters face the challenge



Water bomber returning to Casino Air Base. Photos these pages: Katerina Morjanoff.

These photos, here and on prior pages, are shared by members of the Gospers Mountain Fire team, New South Wales (with members from Canada and the US), and reflect the range and scale of their work as they manage amid an unprecedented scale of fire.



Smoke plume from Pinkett Fire, Backwater NSW.



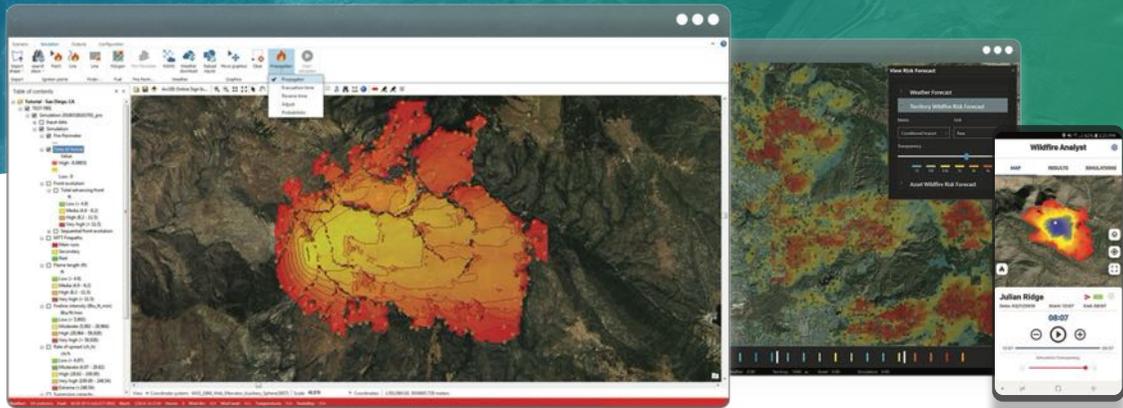
South Australian Crew at Glen Innes Base Camp..



# Real-Time Wildfire Modeling

Solutions for Fire Behavior Simulation Analysis & Wildfire Risk Forecasting

[www.wildfireanalyst.com](http://www.wildfireanalyst.com) • [www.technosylva.com](http://www.technosylva.com)



Wildfire Analyst is software that provides real-time analysis of wildfire behavior and simulates the spread of wildfires. Wildfire Analyst is available as a standalone Desktop software program and an Enterprise wide subscription service. Both offerings utilize the same Wildfire Analyst modeling engine that provides **advanced fire behavior analysis in seconds**. Enhanced modeling capabilities support deterministic, probabilistic, real-time adjustments based on field observations, and values-at-risk exposure analysis.

## Wildfire Analyst Desktop for Analysts & Planners

The Desktop version is designed to meet the needs of fire planners and operational fire behavior analysts, FBANs and LTANs. Time is of the essence, and Wildfire Analyst was specifically architected to support initial attack situations, giving the Fire Chief and Incident Commander the critical intelligence needed to support suppression and resource allocation decisions.

## Wildfire Risk Forecasting Subscription Service – FireCast

The Enterprise version is available as a cloud-based subscription service. Millions of simulations are undertaken daily through integration with advanced weather forecasting models to derive a wildfire risk forecast for a 72-hour horizon. The hourly risk forecast is accessible from desktop, web and mobile applications for subscribers.

Contact us for a demo!

[contact@technosylva.com](mailto:contact@technosylva.com)





# MARK-3<sup>®</sup>

When you need to  
move water, ask for  
the MARK-3<sup>®</sup> pump.

When you're in the field, you know there's no room for compromise. The iconic **MARK-3<sup>®</sup>** portable fire pump has been trusted by generations of wildland firefighters since the 1960s.



"These pumps are tougher than nails and have my 100% trust when working a fireline!"

- Jared Coombs, Wildland Firefighter, Canada

[WATERAX.COM](http://WATERAX.COM)

**WATERAX**   
WE MOVE WATER



# THE EVOLUTION OF THE ICONIC MARK-3<sup>®</sup>

**30%**  
LIGHTER

**20%**  
SMALLER

**100%**  
MARK-3<sup>®</sup>

You asked. We listened. Maintaining the tradition while taking it forward. The **MARK-3<sup>®</sup> Watson Edition** is designed to meet the needs of wildland firefighters of today and tomorrow.

Get all the details and add your name to the **MARK-3<sup>®</sup> Watson Edition** pre-order list. As we launch, quantities are limited.

[WATSON.WATERAX.COM](http://WATSON.WATERAX.COM)

**WATERAX**   
WE MOVE WATER