CANADIAN WILDLAND FIRE & SMOKE

NEWSLETTER

FALL2019

VERDANT FIRE CASE STUDY
by Kiera Macauley

PYROLIFE PROJECT KICKS OFF
by Celia Conde & Dr. Cathelijne Stoof

STRATEGIC PLANNING AT CIFFC
by Maria Sharpe

FROM BOOKS TO BLAZE AND BACK AGAIN
by Kate Bezooyen

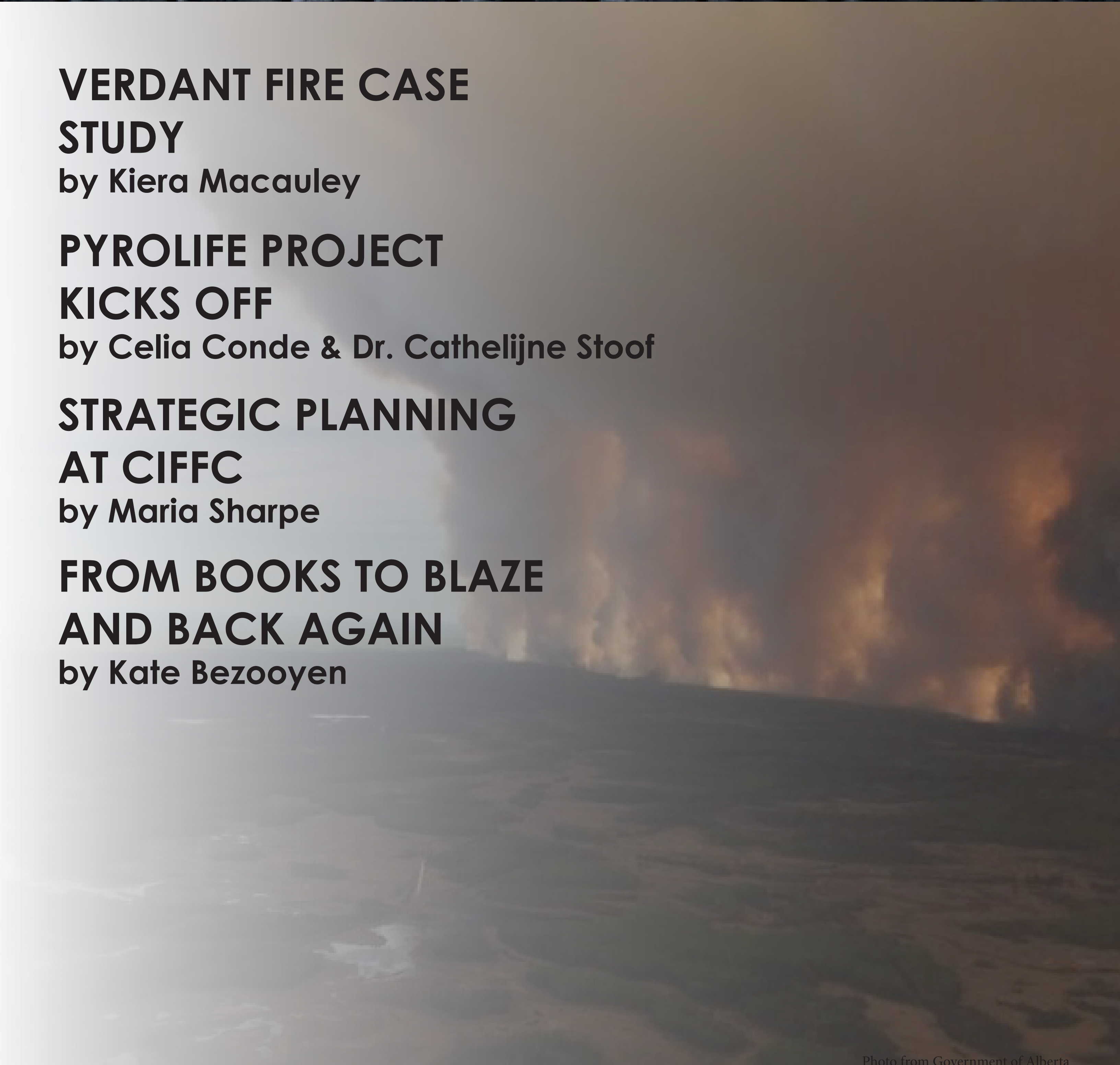

Photo from Government of Alberta

Verdant Fire Case Study

By Kiera Macauley
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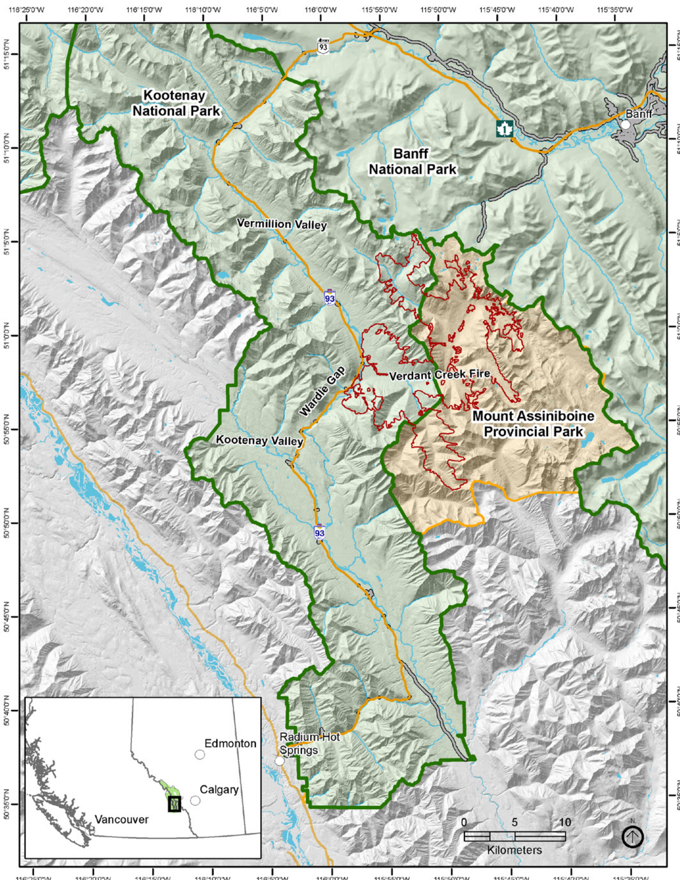

Figure 1: Location of the Verdant Creek Fire and Wardle Gap

One-day of fire growth: August 4th towards Wardle gap

A lightning strike in Kootenay National Park on July 10th, 2017, ignited the Verdant Creek Fire. On August 4th, the fire burned 11,000 ha in Kootenay National Park (KNP) and Mount Assiniboine Provincial Park (MAPP), predominantly in the Vermillion Valley. The Vermillion Valley lies to the east to the Kootenay Valley, with the two valleys connected by Wardle Gap.

Fires in Wardle Gap and within the Kootenay Valley represent a hazard to values at risk, including Highway 93S, Kootenay Crossing, and logging leases located outside of the National Park boundary. On many occasions during the Verdant Fire, managers expected the fire to move from the Vermillion Valley towards Wardle Gap; however, on August 4th, 2017, the fire made an unexpected advance towards Wardle Gap. This report begins by summarizing the fire environment of the Verdant Creek Wildfire, focusing on Wardle Gap (Figure 1). A description of the observed fire weather and behaviour of the run follows, and analysis of WindNinjas (Forthhofer et al., 2018) ability to model complex local topographic winds. The report concludes with considerations for future applications of WindNinja.

Description of the Fire Environment

Topography

KNP and MAPP are situated in the north to south trending Main Ranges of the western Canadian Rocky Mountains (Figure 1) (Environment Canada, 1984). The Continental Divide (2900 masl) separates British Columbia from Alberta and KNP and MAPP from Banff National Park (BNP). In KNP, north-south trending valleys are narrow and steep. Wardle Gap (Figure 2) in KNP extends between the Vermillion Range to the north, and Mitchel Ridge to the south, and links the Vermillion Valley to the east and Kootenay Valley to the west. Vermillion Valley is 8 km across with a minimum elevation of 1300 masl, and Kootenay Valley is wider at 14 km across, with a lower minimum elevation of 1170 masl.

Fuels

The forest cover in the valley can be described by the Biogeoclimatic Ecosystem Classification system (Figure 2). The bottom of Wardle Gap consists of the Montane Spruce Eco zone, composed of subalpine fir and Engelmann spruce trees, which transition upwards with elevation into the Engelmann Spruce Subalpine Fir zone to include lodge pole pine. Above this, the forest cover thins to include whitebark pine trees, before transitioning to alpine tundra characterized by alpine heather and other vascular plants near the summit of Spar Mountain. Dense stands are typical on the north-facing slopes of Wardle Gap, transitioning to open stands near mountain summits (Figure 2).

The fuel types developed in the FBP system do not precisely align with Rocky Mountain fuel types, as fuel types were developed using experimental and prescribed fires outside of the Rocky Mountains. As a result, FBP fuel types are assigned using the best fit for the fire environment (Figure 2). Parks Canada fuel typing identifies the Vermillion Valley bottom as a C-2 Boreal Spruce. In Wardle Gap, fuel typing identifies the valley bottom as C-3 Mature Lodgepole pine, transitioning to C-4 Immature Lodgepole Pine near in the alpine and in avalanche paths.

Weather

Topography influences the climate of the Canadian Rocky Mountain Parks (Environment Canada 1984). On a synoptic scale, the climate of the Canadian Rocky Mountains is continental, with long cold winters and brief cool summers. This climate is further modified by the mountainous topography and north-south orientation, which alter temperature and precipitation patterns to produce regional variations. On the BC side of the Continental Divide, the climate is more maritime, as upslope air mass lift results in more significant precipitation. On a local climatic scale, Kootenay Crossing near the Verdant Fire is "inexplicably and unusually cool" (Environment Canada 1984, pg.7) in comparison to Vermillion Crossing.

On August 1st, a surface high-pressure system developed over the Alberta plains contributing to hot and dry conditions that had characterized the previous few days. An upper-level high developed concurrently over Montana, persisting until August 5th. Interaction between these two high-pressure systems accentuated the drought-like state of the region. Conditions west of the Continental Divide were warm, dry, and sunny, in contrast to conditions east of the divide where a cold front generated slightly cooler conditions. Fire weather indices in the Kootenay and Vermillion Valleys differed with ratings in the "extreme" and "high" range, respectively(Table 1).

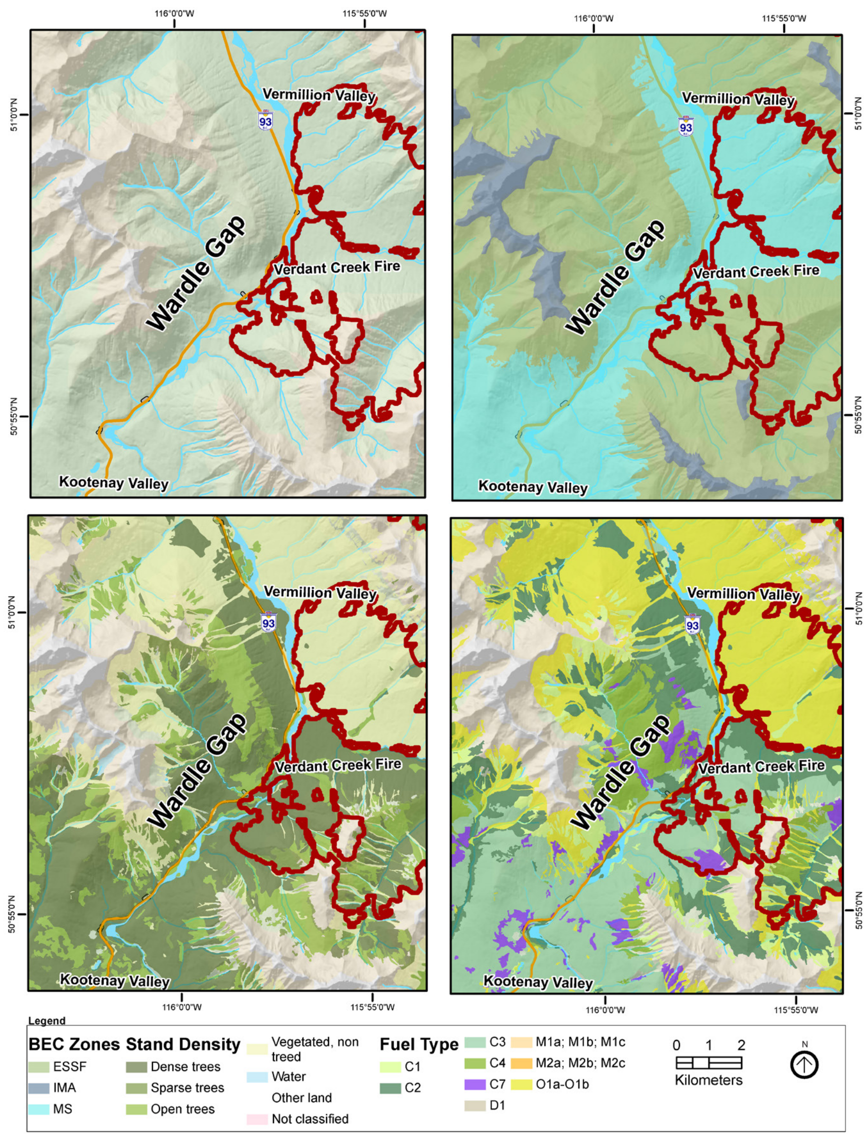

Figure 2: Wardle Gap topography (top left), BEC zones (top right), stand density (bottom left), and fuel types (bottom right).

Table 1: FWI values for August 4th

Indices at 1300h	Temp	RH	Dir	Wspd	Rain	FFMC	DMC	DC	ISI	BUI	FWI
Kootenay Crossing											
August 4th	26.2	25	327	3.9	0	93.1	103.6	416.4	8.1	127.7	30.3
Vermillion Crossing											
August 4th	26	29	308	2.6	0	92.3	99.2	413.5	6.8	124	26.6

On the morning of August 4th, forecasted winds were northwest with speeds of up to 30 km/h, gusting to 50 km/h in the Vermillion Valley. Forecasts indicated strong upper-level easterlies in the afternoon near the Continental Divide and did not predict mixing between upper level and local winds.

Observed wind patterns at local weather stations (Table 2) differed with respect to speed and direction in comparison with forecasted winds. Before 1200 hrs, surface winds between the Kootenay and Vermillion valleys were east-southeast. By 1300 hrs, wind direction shifted to the north-west, and by 1400 hrs Kootenay Valley experienced southeast winds while Vermillion Crossing experienced northeast winds. The wind direction in the two valleys differed by only 19° at 1300 hrs. After 1400 hrs, variations in wind direction between the valleys ranged from 55-167°. In the Vermillion and Kootenay Valleys winds reached a maximum of 6 km/h and 5km/h, respectively, at 1300 hrs, and remained below 5 km/h for the rest of the afternoon. At Simpson Upper Avalanche Station, winds were consistently northerly, reaching a maximum wind speed of 17 km/h at 1400 hrs, then dropped below 10 km/h until 1900 hrs when wind speeds gradually increased to 15 km/h at 2100 hrs.

Weather observers reported the presence of easterly upper-level winds. Surface winds flowed south-eastward into the Vermillion Valley, westward through Wardle Gap, and then northward through the Kootenay Valley. The complex topography of the Rocky Mountains likely influenced the discrepancies between forecasted and observed winds at the surface.

Fire Behaviour

On the morning of August 4th, the fire burned in C-2 fuels in the Vermillion Valley south of the Simpson River, and on the most easterly ridge of Spar Mountain just outside Wardle Gap (Figure 3; Figure 4). After inversion breakup, a large convective column developed. By 1400 hrs, the convective column bent to the west. In the afternoon, the fire transitioned into C-3 fuels as it entered Wardle Gap, and burned in an unnamed valley between the two ridges of Spar Mountain in Wardle Gap (Figure 5; Figure 6). The convective column continued to bend west until 2030 hrs (Figure 7), after which no observations are available.

VIIRS satellite imagery did not capture active growth on August 4th. VIIRS imagery from 0500 hrs on August 5th indicated the fire had progressed along the Simpson River into Wardle Gap and spreading 2 km west and 2.44 km south up the face of Spar Mountain. The fire added 1,500 ha in area burned for a total burned area of 12,500 ha.

Fire Analysis

REDapp (2018) uses observed physical conditions in combination with the FBP system to estimate fire

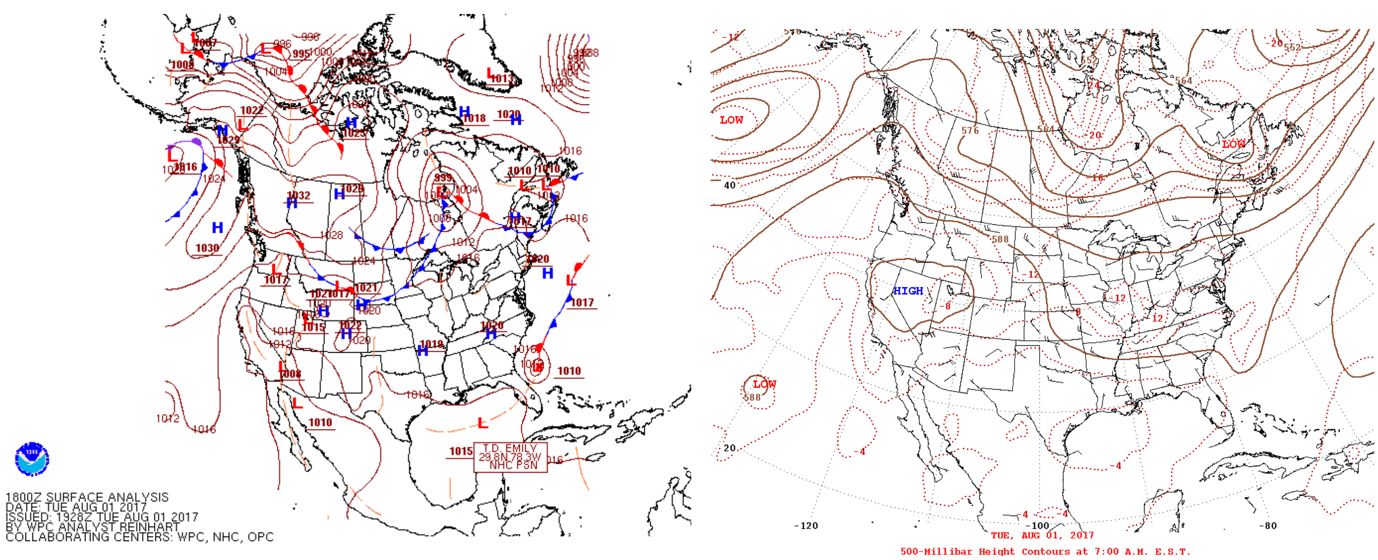

Figure 3: On August 1st, a surface high-pressure system builds over the Alberta plains, continuing the hot and dry conditions from the days previous (left). The surface high remains stationary over the prairies until August 6th -7th when a cold front gradually begins to push the high southward. An upper level high begins develops on August 1st and persists through August 5th, intensifying hot and dry conditions(right). Images retrieved from NOAA (2018).

Left top: Figure 4. At 1231 hrs on August 4th, the fire burned on the eastern slope of Spar Mountain just outside of Wardle Gap. The fire is burning through C2 fuels, no column development is observed. (Parks Canada. **Left middle:** Figure 5. At 1434 hrs on August 4th, the first burns in the Verdant Valley at the base of Spar Mountain in C2 fuels. It is difficult to observe, but it appears the fire has developed a column. (Parks Canada). **Left Bottom:** Figure 6. At 1820 hrs on August 4th, the first burns in the Verdant Valley at the base of Spar Mountain. The fire appears to have moved into the unnamed valleys between two of Spar Mountain ridges. A column appears to have developed. (Parks Canada). **Above:** Figure 7. At 2015 hrs on August 4th, the fire has developed a large column with copper and white coloured smoke. Further images indicate this column has built between the ridges of Spar Mountain in Wardle Gap. (Parks Canada) characteristics (Taylor and Alexander, 2016). Predictions of anticipated fire spread were conducted using model inputs representative of conditions at the Wardle Gap location during the period the fire burned. These conditions included topography characterized by a 40% slope and 30-degree aspect at 1500 masl, and forest types' best represented by the C-2 and C-3 fuel types. Observed winds were used in predictions instead of forecast winds, which were not consistent with observations

REDapp projections indicated C-2 fuels would sustain continuous crown fires at IC6 with maximum head fire intensities at 27,600 kW/m at Kootenay Crossing, and 31,000 kW/m at Vermillion Crossing. The estimated maximum rate of spread was 19.4 m/min at Kootenay Crossing and 23.2 m/min at Vermillion Crossing.

The FBP system estimated that C-3 fuels might experience intermittent crowning, but would mainly sustain surface fires at IC4 with maximum head fire intensities of 4300 kW/m and 5000 kW/m at Kootenay Crossing and Vermillion Crossing, respectively. The estimated maximum rates of spread were 3.1 m/min and 4.5 m/min at Kootenay Crossing and Vermillion Crossing, respectively.

Fire behaviour and rates of spread could not be verified due to a lack of documentation. However, an estimated rate of spread can be determined from an observed 7-hour convective burning period and observed spread distances. Estimated rates of spread are 4.8 m/min west and 5.8 m/min south. The estimated rates of growth are larger than those expected in C-3 fuels, but are significantly less than those anticipated in C-2 fuels.

Light surface winds likely influenced initial fire growth towards Wardle Gap. Winds drawn from the Vermillion Valley into the Kootenay Valley likely influenced the direction of fire spread towards Wardle Gap. By 1400 hrs, photographs indicated a high-intensity crown fire

Figure 8: At 2024 hrs on August 4th, the fire has developed a large column with copper and white coloured smoke. Observed flames indicate a continuous crown fire. (Parks Canada)

in C-2 fuels and development of a convective column (Figure 3; Figure 4). As the fire moved into C-3 fuels in Wardle Gap, it continued to sustain a large column and active crowning until at least 2030 hrs (Figure 5-7).

When the dispersed smoke plume transitioned into a convective column at 1400 hrs, observed fire behaviour changed. The momentum created by the fire burning convectively before peak burning likely contributed to fire intensities and rates of spread in the C-3 fuel type that exceeded those predicted from weather conditions at the time. The FBP system assumes local winds and topography are driving fire behaviour and spread, and not convective activity. Fires release significant amounts of heat and moisture into the overhead air mass. If atmospheric conditions are supportive, surface winds of less than 35 km/h and an unstable atmosphere can allow the overhead parcel to continue to rise (Charney and Potter, 2017). If these factors occur, a convective column develops and causes high-velocity inflow, increasing heat transfer, fire intensity, and fire spread (Finney and McAllister, 2011). At this stage, the smoke plume directs fire growth and spread, rather than local winds and topography (Rothermel, 1991).

WindNinja Analysis

WindNinja (2018) is a computer program that calculates site-specific wind speeds and directions based on local topographic conditions. The result is a spatial map of adjusted wind parameters called a wind field. Fire managers apply WindNinja to understand how local topography may influence winds and fire growth. This analysis employs WindNinja in an attempt to understand the pattern of wind flow on August 4th.

Wind flow parameters recorded at each station were first examined independently and then combined within a wind flow model (Figure 8). Wind data from the Vermillion Crossing and Simpson Upper weather stations accurately model wind flow through Wardle Gap. Wind flow models from Kootenay Crossing Station report winds flowing eastward instead of westward through the gap. The best model results occurred when all four stations were used in conjunction to model wind flow.

Forecasted northwest winds were modelled to understand if the forecast translated to observed winds when WindNinja was used to account for local topography (Figure 9). Using the northwest winds, WindNinja successfully represented the observed wind speed and direction in the Vermillion Valley and Wardle Gap. There were discrepancies between the winds forecasted and observed in the Kootenay Valley. A broader topographic analysis would assist in understanding local wind patterns in the Kootenay Valley. Nonetheless, the forecasted northwest winds were overall modelled correctly by WindNinja and showed winds conducive to fire spread through Wardle Gap.

In summary, while the forecasted northwest winds were not expected to move the fire towards Wardle Gap, the WindNinja models indicate that northwest winds were conducive to directing wind and fire behaviour through Wardle Gap. In the future, it may be beneficial to assess when local winds are directed towards a value at risk and relate these conditions to level winds that occur during this time.

Table 2: Summary of weather conditions observed at Kootenay Crossing, Simpson Upper Station, and Vermillion Crossing for August 4th, 2017.

Date and time	Quick Deploy 3 Kootenay Crossing				Avi - BYK Simpson Upper				Vermillion Crossing			
	Temp	Rh	Dir	Wspd	Temp	Rh	Dir	Wspd	Temp	Rh	Dir	Wspd
04/08/2017 10:00	22.3	39	153	4.1	11	63	6	16.4	22.2	39	82	1.3
04/08/2017 11:00	23.4	35	122	5.1	12.6	54	2	9.6	23.3	34	152	3.3
04/08/2017 12:00	26.2	25	327	3.9	14.5	43	355	8.5	26	29	308	2.6
04/08/2017 13:00	26.5	19	167	6	15.6	34	4	7.6	26.3	20	81	5
04/08/2017 14:00	25.2	24	194	5.1	14.4	35	4	17.3	25.1	24	27	2.6
04/08/2017 15:00	24.5	27	105	4	14.5	37	357	10.2	24.5	28	50	2.1
04/08/2017 16:00	24.6	27	159	5	16.9	34	356	9.5	24.5	29	66	3.5
04/08/2017 17:00	23.4	28	197	2.6	13.6	42	341	6.9	23.1	28	55	1.1
04/08/2017 18:00	22.8	30	278	3.2	13.5	43	339	8.2	23.2	30	36	1.4
04/08/2017 19:00	20.6	36	150	3.6	11.9	47	4	11.7	20.6	36	97	1.5
04/08/2017 20:00	19.2	37	157	5.7	10.2	53	2	11.1	19.3	37	113	4.2
04/08/2017 21:00	17.9	43	125	5.3	8.9	61	348	15.7	18	43	80	3.8
04/08/2017 22:00	17.7	43	272	5.2	8.2	65	2	19.4	17.7	43	329	4.4
04/08/2017 23:00	16.1	46	213	3.8	7.9	65	0	20.8	16.3	45	231	2.7

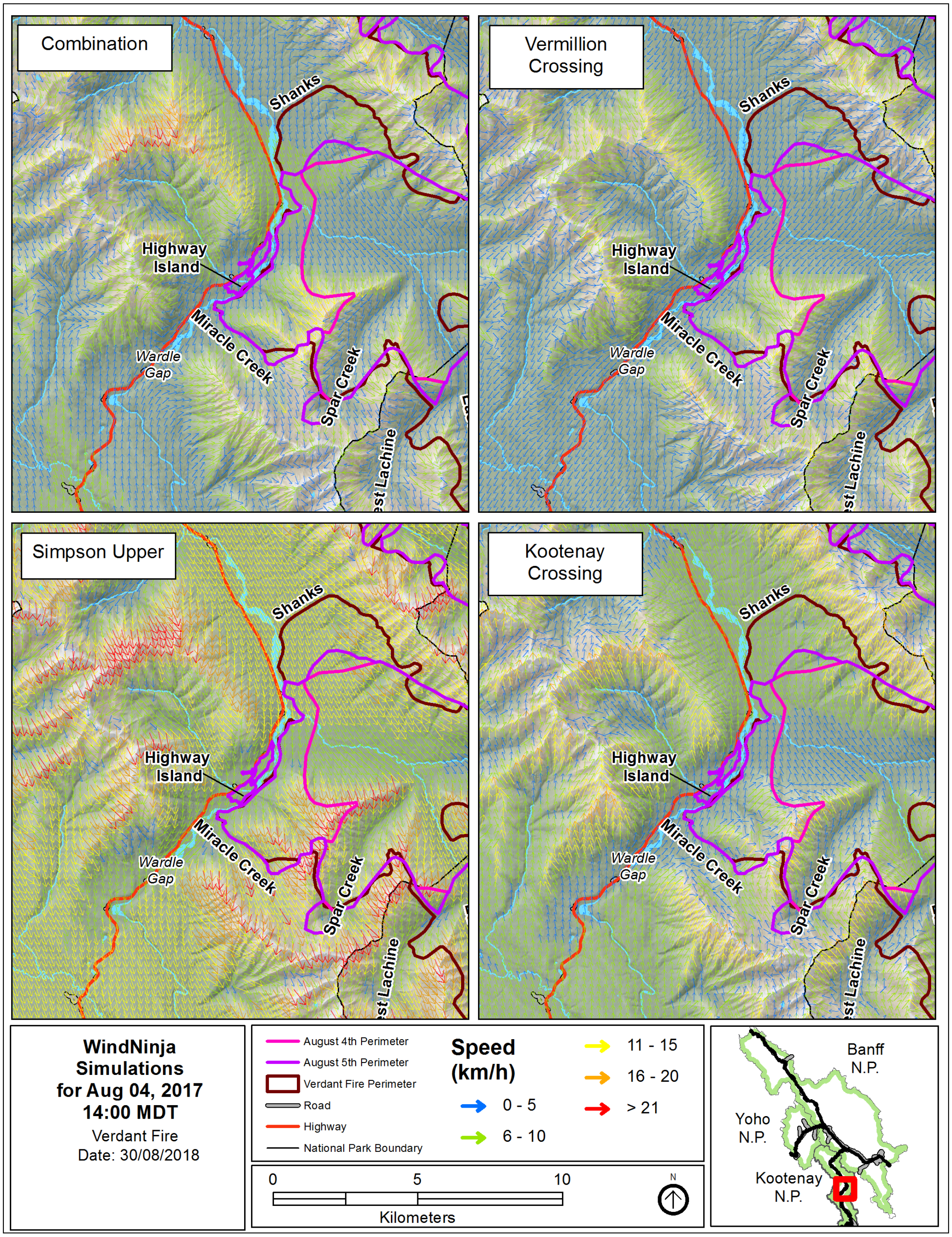

Figure 9: Fire growth between August 4th-5th 2017 and WindNinja output of wind speeds and direction for each station and combined on August 4th.

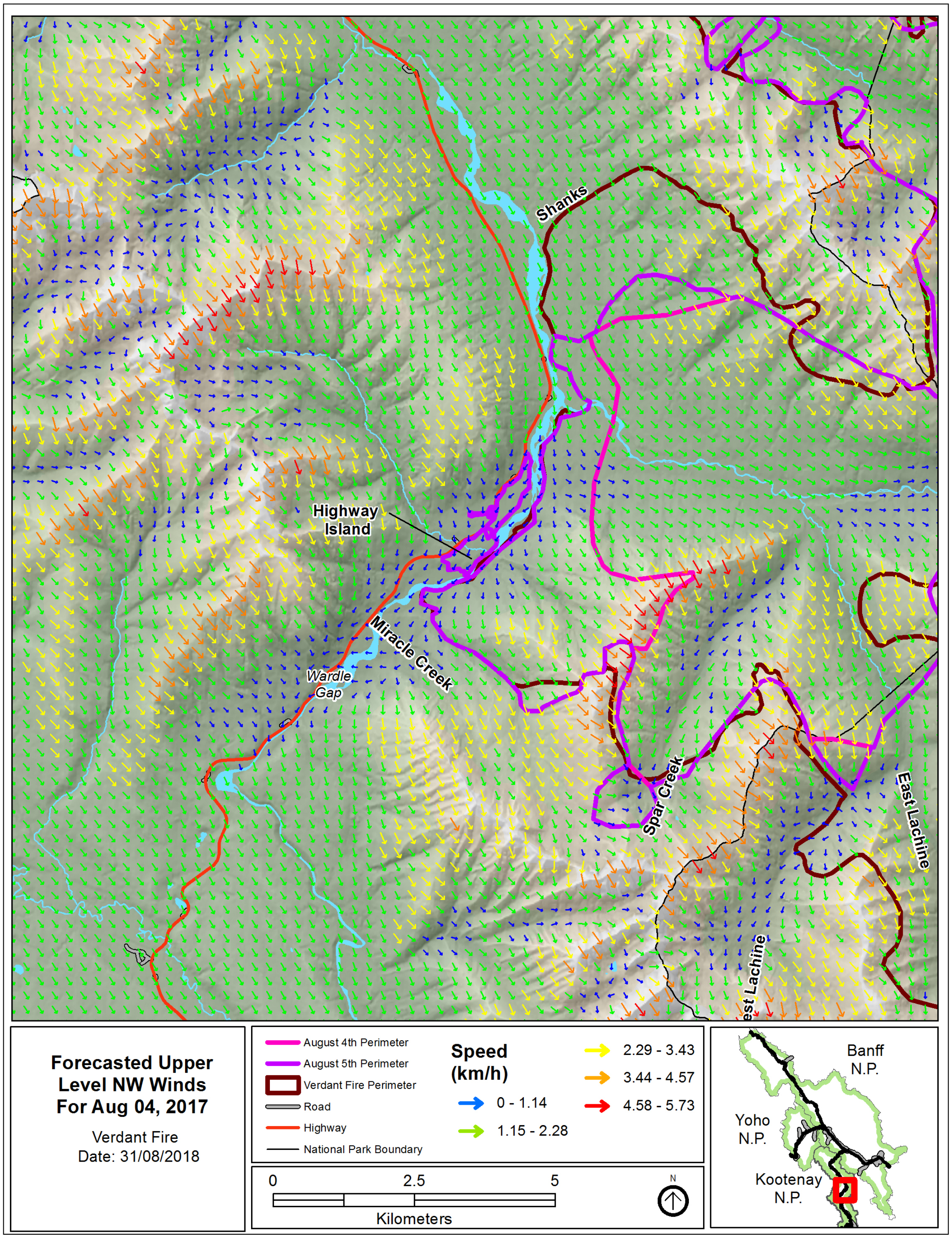

Figure 10: WindNinja model of 500mb NW winds. Correctly modelled winds in Vermillion Valley and Wardle Gap but does not match winds observed in the Kotoenay Valley.

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PyroLife project kicks off:

an ambitious Innovation Training Network on wildfires

By Celia Conde & Dr. Cathelijne Stoof
Project Coordinator, PyroLife, contact PyroLife here

PyroLife, a Marie-Curie Action, has started recruiting 15 PhD candidates across the globe to pursue cross-disciplinary wildfire-focused research

In early October, all beneficiaries from PyroLife gathered at Wageningen University & Research (WUR), PyroLife's coordinating institution, to establish and design the first strategy for the programme.

The PhD positions have been announced and the recruitment process has begun to meet the start date of the PhD projects on the 1st of April 2020. Please visit https://pyrolife.lessonsonfire.eu/recruitment for all PhD positions. PyroLife is an Innovative Training Network that will train our new generation of integrated fire management experts, by providing a structured doctoral training program based on research, network-wide training activities, workshops, online courses and outreach.

Kick Off meeting at Wageningen University (The Netherlands)

PyroLife's new website is available here and all the updates will come into the Project's Social Media (Twitter @PyroLife_ITN, LinkedIn coming soon)

PyroLife Project (Marie-Curie Action, Horizon 2020)

The aim for the projects is to aid in facilitating the advancement of holistic, integrated wildfire management. For its participants, PyroLife focuses on incorporating diverse backgrounds that may promote creativity for innovative

15 PhD Students

10 leading European Universities

11 International partners

wildfire strategies. A key goal of the initiative is to instill intersectional, transferable knowledge and maximize employability for its graduates. PyroLife is a novel facet in the global wildfire network and may bring innovative ideas from a wide range of fields during a critical time in wildland fire research.

The past two years were characterized by deadly wildfires in Southern Europe and an increasing number of wildfires in northern regions. This is a glimpse of what is expected in the future. The European Union assigns a 4 million euro grant to PyroLife, a project in which a new generation of experts will be trained in integrated wildfire management. Wageningen University & Research (WUR) will coordinate the project.

Climate change will increase the risk on wildfires. Not only in Southern Europe, but also in countries where wildfires were traditionally sparse, such as the Netherlands. Attention shifts from fighting and preventing fire to 'living with fire', in which resilient landscapes are designed and communities are better prepared for wildfires. The EU-project PyroLife will train a new generation of experts in integral fire management

Using water management techniques for wildfires

The PyroLife project brings together knowledge from different countries, scientific disciplines and practices. Southern European leadership in fire expertise will be used to understand and predict wildfires in Northern Europe, whilst Northern European lessons learned in the prevention of floods will be applied in Southern Europe. Dr. Cathelijne Stoof is PyroLife coordinator and will lead the project. "The Dutch are world famous for the way in which they manage and live with water," she says. "By working with experts on water management and landscape architects, we will use their knowledge to design resilient landscapes and prepare communities to live with fire."

Training programme

PyroLife provides 15 PhD candidates. The project is the first large and integrated doctoral training programme on wildfires globally. WUR will offer four PhD positions on the effects of wildfires and ashes on soil and water quality, designing landscapes adapted to the increasing risk on wildfires, and applying Dutch knowledge in water management (prevention and the widely-known 'poldermodel') to 'living with fire'.

Large European consortium

PyroLife is funded by the prestigious Marie-Curie Action within the European Horizon 2020 programme. WUR will lead a consortium of 10 leading European universities and institutes. All PhD candidates will receive training from 21 international partners, including governments, fire services, business and non-profit agencies. An overview of partners and beneficiaries is given below:

Eleven International Partners

- Hellenic Agricultural Organization (Demeter) - Greece
- Fredriksborg Fire and Rescue Service (FBBR) - Denmark
- Arup - United Kingdom/ USA
- Instytut Techniki Budowlanej (Building Research Institute) (ITB) - Poland
- Food and Agriculture Organization of the United Nation (FAO) - International
- Forestry Commission England (FCE) - United Kingdom
- University of Alberta (UAlberta) - Canada
- New Zealand Forest Research Institute (Scion) - New Zealand
- National Fire Protection Association (NFPA) - USA
- Águas de Portugal (AdP) - Portugal
- WildfireTacAd (WTA) - United Kingdom

Ten leading institutions from seven countries

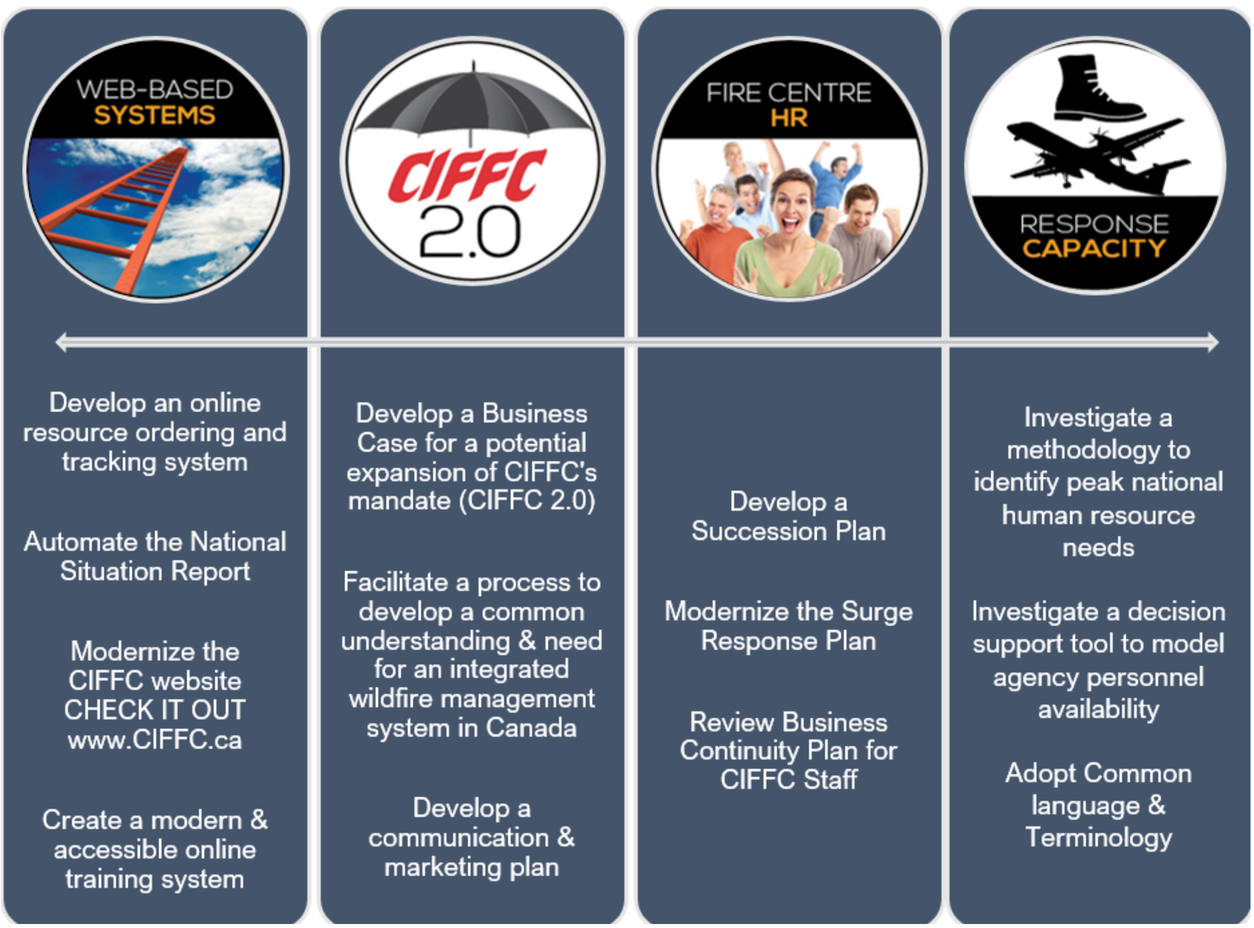
- Wageningen University - The Netherlands
- Universitat Oberta de Catalunya (UOC) - Spain
- Imperial College London (ICL) - United Kingdom
- Universidade de Trás-osMontes e Alto Douro (UTAD) - Portugal
- Pau Costa Foundation (PCF) - Spain
- University of Birmingham (UoB) - United Kingdom
- European Forest Institute (EFI) - Germany
- European University Cyprus (EUC) - Cyprus
- Institut National de Recherche en Sciences et Technologies pour l'Environnement et l'Agriculture - France
- Tecnosylva (TSL) - Spain

STRATEGIC PLANNING AT CIFFC:

The next three years

By Maria Sharpe, MSc RPF
Fire Science and Information Manager, The Canadian Interagency Forest Fire Centre

It has been a busy year in Canada for strategic planning in the field of wildland fire. At the beginning of 2019, Natural Resources Canada released the Blueprint for Wildland Fire Science in Canada (2019 – 2022) and this summer Canada Wildfire began exploring, in partnership with NSERC, the possibility of a broadened research network spanning from coast to coast. At the Canadian Interagency Forest Fire Centre (CIFFC), we too have seen changes. Our new CIFFC Strategic Plan (2019-2022) has been the driving force for CIFFC staff this year and will continue to be until 2022 with a focus on modernizing the work we do to better serve the Canadian Wildland Fire community. Here are the priorities and action items for the next three years:



Be sure to check out the next Canada Wildland Fire and Smoke Newsletter for a window into the CIFFC Fire Science Committee where we will provide a summary of the CIFFC Fire Science Rebranding Workshop scheduled in conjunction with Wildland Fire Canada 2019 this fall. For further details about CIFFC, check out our new website.

From books to blaze, and back again:

Gaining a well-rounded education in fire management

By Kate Bezooyen
Master of Science Student, Wildland Fire, University of Alberta, kbezooye@ualberta.ca

During the fall and winter, I am working towards an MSc degree in Wildfire science at the University of Alberta. I began the program in September of 2017 and decided it would be incredibly beneficial to supplement the knowledge I'm gaining through research with real wildfire experience.

I started working as a Helitack Firefighter in the summer of 2018. Considering I've always enjoyed positions with an active outdoor component and my fascination with wildfire, it was no surprise that I was hooked on the job before even completing the training course. I'll never forget my first day, fresh out of training and sent out for man-up on a day with high fire hazard; I thought for sure I would be working on a fire that day. Of course, what I neglected to realize in my excitement for the position was that even when the hazard is high, you need a source of ignition for there to be any fires.

There have been many lessons like this I have learned during my time working as a helitack member. Things that may seem obvious, but when you work in the position, concepts that you learn in a classroom become solidified with real-world experience.

In my first year, I was lucky to be able to work on a big fire incident in British Columbia. I was incredibly happy to gain experience in sustained action after a busy spring and early summer full of exciting, but small, initial attack fires. It was a whole new world being a part of a response plan with hundreds of personnel. All kinds of positions I had never heard of were being filled and our morning briefings were far more complex. I tried my best to soak it all in and make sense of it all — while also asking my crew leader about 100 questions a day to try and gain an understanding of the big picture and everything going on in the meetings that we crew members weren't a part of.

This season, I was pleased to have another export opportunity to work on the Chuckegg Creek wildfire in High Level. Our four-person helitack crew was combined with two 8-person crews to form a "unit crew" for export. When we arrived, my leader was assigned to the position of "Strike-team leader" and once again we entered the complex world of big incident management. I thoroughly enjoyed my time assisting with controlling the Chuckegg Creek Wildfire. I even gained experience managing a few pieces of equipment and other personnel at my section of the fire line.

Once we returned from export, the fire hazard dropped significantly from steady precipitation across most of the province. When fire hazard is low it gives the fire crews a chance to conduct further training. I had the opportunity to participate in the ICS-200 course, the second level of the Incident Command System. Finally! Everything I had experienced working on the large fire incidents suddenly made so much more sense! Having experienced the structure of the ICS on the incidents and reading daily Incident Action Plans for the fires I worked on made the course the perfect explanation for all the questions I had previously.

My experience in the summer doesn't just make me an effective firefighter; every fire I work on provides insight into the strategies and tactics that work under different scenarios and the structure necessary to achieve complex objectives, as well as challenges to achieving those objectives.

Gaining operational experience has been a valuable asset to my education and understanding of wildfire management. And the best part about getting to take a break from a master's degree to be a firefighter ... it's fun! I'm excited to be pursuing a career in a field that I love. I consider myself very lucky to be able to work amongst so many great individuals who can come together and work as a team to accomplish important work!

Upcoming conferences, symposiums, and workshops

Actionable Best Practices For Communities And Agencies Impacted By Wildfire
Engage with the recovery community surrounded by the beautiful High Sierra.
April 6-8, 2020 Granlibakken Tahoe, CA

Featuring two tracks:
- Practical Tools & Techniques for property owners, community leaders, agencies responding to fire.
- Technical information for scientists, engineers, trainers, and consultants

AMS100
ADVANCING SCIENCE, SERVING SOCIETY SINCE 1919

13th Fire and Forest Meteorology Symposium

12-14 May 2020, Palm Springs, CA

Click here for more info

International Conference on Fire Behaviour and Risk (ICFBR2021)

The Conference aims to involve scientists, researchers and policy makers whose activities are focused on different aspects of fires and their impacts. Held in Alghero (Sardinia,Italy) from May 18th to 21th, 2021. The conference will also include a Special Session on Remote Sensing and Fires, under the patronage of EARSEL's Special Interest Group on Forest Fires.

Visit www.icfbr2021.it for more information