

No.	TOPICS (click on page numbers right column to go there)	PAGE & LINKS
USES OF FIRE WEATHER INDICES		
1	Indices for thresholds & methods relating to public burn permitting	6, 6
2	Indices for fire program staffing levels	5, 4
3	Indices and FBP tools for burn plan prescriptions	9
WEATHER TOOLS AND PROCEDURES		
4	ak mesowest web tools	7, 10
5	7-day product improvement	7
6	red flag criteria and calls	8, 10
7	lightning analysis and decision criteria	7
8	RAWS locations and manual stn upgrades.	10
LINKING WEATHER AND INDICES TO FIRE BEHAVIOR		
9	documenting observed fire behavior (case studies?)	5
10	smoke tools and assessment process	
11	RED App in Canada (and Alaska?)	9
12	Mesowest FBP web app	8
13	advanced CFFDRS tools. Prometheus, pfas, burn-p3	7
FUELS AND FUEL MOISTURE		
14	Grass fuel moisture estimation in AK and Canada	9
15	LANDFIRE fuels guide	10
16	Duff fuel moisture sampling and its relation to DC/DMC	4
17	Overwintering issues for the DC code	6
OTHER SCIENTIFIC AND MANAGEMENT TOPICS		
18	decision transparency and documentation	7, 8, 9
19	AWFCG request for CFFDRS tools in WFDSS	5
20	Need for operations production rates related to AK methods	5
21	permafrost & hydrology	14
22	remote sensing	16
23	Training on CFFDRS use for AK and L48 resources	4
24	Upgrades to CFFDRS	6, 7

**Look for Action
Items!**

2014 10/28-30 Canadian Forest Fire Danger Rating Summit, Fairbanks, AK

Notes for Morning Session, 10/28/2014 – Sue Rodman

Summit Expectations – Tom St. Clair

- Does an index in Southcentral have the same meaning / value between 2007 and 2014, and does that meaning or value correlate to Interior danger ratings?
- Find / identify / use terms that are common between CFFDRS and NFFDRS for teams and firefighters coming to AK from the Lower 48.

Increase understanding and communication of CFFDRS

CFFDRS Refresher – Robert Ziel

- Review of Fire Weather Indices and Fire Behavior Prediction system
- All of us should help share this system with others to expand its understanding
- References (insert links from FRAMES): Weather Guide for CFFDRS, AK/MN FBP & FWI Field Guide
- Weather Guide helps user apply changes in weather after the daily observations are posted so that these influences of afternoon conditions can be applied to fire behavior predictions
- FWI inputs capture “solar noon” dependent on latitude. Consider the breadth of Alaska in longitude and that solar noon varies across the state beyond the 1400 FWI measurement (Alaska has one time zone, used to have four)
 - FFMC, ISI and FWI can be adjusted throughout the day based on current conditions
 - DMC, DC and ISI calculated only one time per day need to correct, not sure when ISI is calculated
- FWI Primer and indicators for fire fighting
 - FFMC as indicator of fine fuels’ (grass) ability to carry fire (highest recorded 96)
 - DMC is a proxy for stress to live fuel moisture in loosely compacted organic material
 - DC reflects moisture content of deeper compacted layers; serves as an indicator of ground fire problem and mop-up difficulty
 - Using FWI, can you describe the weather later on in the season?
 - ISI is best indicator of daily fire potential in spring; it changes throughout the day per wind speed and FFMC; input to FBP system
 - BUI is a combination of DMC & DC but is influenced most by DMC; indicates depth of burn, fuel consumption and mop-up problems; used in Alaska to gauge significance of summer dry periods
 - FWI is a combination of ISI & BUI, equals consumption + spread; varies throughout the day as ISI does
 - Thresholds
 - FFMC – ignition
 - DMC – lightning ignition, fuel available in duff layer
 - DC – reflects potential for hold-over fires and mop-up difficulty
 - ISI – spread potential

- BUI – fuel consumption
- FWI – fire intensity and control difficulty
- Adjectives used should be common to reflect danger levels
- Define the relationship of DC relative to fine fuels and overall fire danger for the day. **Important to recognize that no one code can adequately describe the conditions!!**
- Zeke suggests that we could use the Fire Behavior Prediction system more and apply it to help make tactical decisions on the ground.
- Fire line calculations don't require a computer! Behave (Remsoft) made this easy, as did other software, but it's not necessary.
- AK daily preparedness levels are largely determined by fuel type and spread rate. Connect this component of operations to how we can effectively integrate FBP more.
- Comparison of National FBP system to Canadian FBP (Zeke's slide) reflects the simple, objective inputs and outputs to the Canadian system.

Timeline / History of CFFDRS

Kato Howard

- 1985 Larry VanderLinden, Red Shelton, John See, Dan Burroughs, Rod Norum collectively saw the application of CFFDRS in Alaska
- 1988 Waring Mountain Fire burned over camps and instigated the conversion from NFDRS to CFFDRS
- 1989 AWFCG adopted FBP system (check this date, ??1992)
- 1992 C2 Fuel Model poster by Marty Alexander and Frank Cole
- 1994 Alaska personnel attended the Canadian FBP class
- 1995 Paint ball maps
- 1996 Taught Advanced FBP class in AK
- 2002 Roger Ottmar measured field conditions in advance of forest fire and led AK Photo Series development which helped AK get recognized to use the Canadian System (Randi: actually Roger's work with duff moisture sampling and measurements of consumption was to develop the equations for emission model CONSUME in Alaska boreal forest)
- Overwintering of DC may be variable between northern and southern parts of Alaska. Field testing by Eric Miller to help make these determinations and for use in spring and fall prescribed fires.
- Skip Theisen and Kato Howard's chart of FWI using 10 years of data

For history of CFFDRS implementation in Alaska and issues summary, see Jane Wolken's white paper written for AWFCG on AFSC Website (ADD LINK HERE).

Tim Lynham

- 1928 fire research effectively began in Canada.
- By 1957, there were 4 major danger rating systems and many regional modifications

- This all lead to the basis of FWI in which the danger index was based solely on weather to give uniform results throughout Canada (how fire behavior varies with fuel types was a different analysis)
- DC cannot fully resolve overwintering issue. Alaska is a challenge because of permafrost.
 - Fuel moisture codes (FFMC, DMC and DC) reflect wind and drying
 - Moisture + Wind >> ISI (not FFMC)
 - BUI = 80% DMC + 20% DC

Overseas use of CFFDRS – Marty Alexander

- Reference Marty's article with Stephen Taylor (frames.gov/cffdrs) reflects scientific, technological and human factors in developing a fire danger rating system.
- Key Elements
 - #1 Sustained program of scientific research
 - #2 Reliable technical infrastructure
 - #3 Guidelines, decision aids and training for fire managers
 - #4 Cooperation
- Training courses at www.cifc.ca
- DVD trainings have been converted to web based programs (FWI, FBP, CFFDRS, Safety on the Fire Line)
- Using historical data to plot the weather / FWI trends over time **Marty recommends a published climatology where long term data is available
- FBP fuel types only developed for Canada
- FWI adopted in many countries, ie. Argentina, Australia, Chile, New Zealand, Fiji, Samoa, Spain, South Africa, etc.
- References: Global Early Warning System, Global Observation of Forest & Land Cover Dynamics
- Marty worked with Grant Pearce of SCION in New Zealand (www.scionresearch.com) to develop FWI application there
- Caution: The Fire Danger Rating Paradox (Rothermel 1987): systems aren't accurate enough; systems are too complicated. Presumably, crude but reliable decision aids are needed at the field level.

PANEL Part 1. How is CFFDRS being used in Alaska now? Kato Howard, Larry Weddle, Sharon Alden, Mark Hale, Robert Schmoll

- K Howard. Use on military zone lands by AFS to decide whether to use pyrotechnics and explosives by military for training. Determine the threshold FWI and rate of spread.
- R Schmoll. Staffing levels and hours determined in early spring by FFMC, DMC. Use O1b in early season for grass model. In late May and June, focus on surface spread in C2 model. Staffing levels are determined by trend of indices, extent of high pressure system (likely more ignitions).

- Larry Weddle. Fire Family Plus uses fire start date and indices. NPS managers monitor high fire potential with tools such as the Lake Minchumina RAWs to assess climate change and fire season length. See Denali State of the Park Report.

Summary of comments from this discussion

- Do a crosswalk between ERC on the landscape and BUI; put CFFDRS into WFDSS. Caution because ERC has a “short memory.” FFMC correlates better to ERC than does BUI.
- Make tools available for dispatchers.
- Suggest to add quantifiers to the Adjective ratings to include the FWI or BUI and the influences
- Need production rate for each resource, ie. helicopter with bucket to catch 10 acre fire... LINK fire danger rating and fire behavior to production rates.
- FBP can be used for tactical operations but need production rates to control escapes on prescribed fire
- Making decisions on resources should include FBP along with the FWI values. Consider FMO’s level of understanding of FBP and how to allocate resources based on it.
- FBP fuel type map of Alaska needs to be updated as some communities have. IFTDSS coming online soon – can evaluate fuel treatments.
- CFFDRS use in Wisconsin for fire staffing, fire danger and fire behavior. It has break points for seasonal changes during fire season.
- Upper Peninsula of Michigan produces staffing from the GLFF site using FFMC in spring and BUI in summer. Prescribed burn guidelines based on CFFDRS. Burn permit site based on Adjective rating; options are no burn, burn after 1800, burn all day.

Develop a crosswalk between ERC and BUI

Provide easier tools to link fire behavior to weather indices

Draft 11/20/2014

Tuesday, October 28

NOTES

Afternoon:

Organizer: Tom St Clair	Facilitator: Lisa Saperstein	Notes: Randi Jandt
-------------------------	------------------------------	--------------------

1330 Management case studies: Tom St. Clair plus panels of Alaska, Canadian and Great Lakes managers. Panel: How CFFDRS is used in Canada and Great Lakes

- Tim Lynham, Ontario: Fire under provincial control b/c federal govt not a land owner
 - Jim Barnier, WI DNR: WI launched CFFDRS side-by-side with FWI/NFDRS page first couple years until 2010 went solely to FWI. WIMS was locked behind passwords, and wanted more general access to weather data, so created the Great Lakes weather page.
 - Keith Murphy, Michigan: CFFDRS used in MI since 1990's. Use for staffing decisions, public burn thresholds; teaching most of S-290 as "pre-work" to add CFFDRS to class instruction this spring. Public burn permissions triggered automatically by web-based system, so no more permits. This has saved \$\$ and also cut down on illegal burning due to ease of access. Enforcement officers can only write tickets for escapes or burning unallowed materials.
1. Scott Linn, USFS, WI. CFFDRS on the Chequamegon-Nicolet National Forest: Used for setting "breakpoints" i.e. thresholds for levels of fire risk which trigger different actions and staffing levels. Used 20+ years weather data and WI's scanty database on fire occurrence to set up these breakpoints. Have set up simplistic Excel automated data harvest of actual wx and forecasts from Great Lakes weather webpage for monitoring and later analysis as well as e-mail notification system. Breakpoints use combinations of ISI, FPMC, and BUI.
 2. JB- Districts all have their own breakpoints, regional differences, but try to coordinate along public travel corridors to avoid confusion. Some are statewide, some season-dependent.
 3. SL- staffing levels on Hiawatha NF lower than DNR b/c fewer human ignition sources.
 4. Robert Schmoll, Fairbanks DOF: Larger areas of FAI, Matsu & KKS tend to have different staffing levels than smaller areas.
 5. TL-An escaped burn in 2007 in a remote area caused embarrassment for the research Rx burn program b/c burned (with provincial permission) during public "restricted fire zone" time. This is like a US "red flag warning".
 6. **Action items:** Tom Kurth interested in web-based approach to burn permitting and public notifications for AK. Automated harvest of predictions and weather (available via Mesowest contract?) may be useful for monitoring quality of f/c regionally.

Canadian plans for CFFDRS update: Chelene Krezek-Hanes

- August 2014 webinar by Mike Wotton on changes to CFFDRS is available at akfireconsortium.alaska.edu.
- Changes are to improve known issues and integrate new technology but will not change the "face" of the tool to most end users. More tools will be available for more advanced users including new fuel types (shrub, for example) and ways to enter quantitative inputs like CBH to modify predictions.
- Dan Thompson & others working on adjustments to the DC overwintering algorithm
- There may be adjustments to drying algorithms and codes in specific regions and fuel types: for example, in Ontario concerned about the lack of consideration for plant

evapotranspiration effect on subsurface moisture. Mike Wotton's grass moisture model (dynamic) and dual equilibrium spread models to be incorporated in FBP.

- Other new fire management tools include RedAPP—a universal fire behavior calculator that uses web map and weather streams. Marty Alexander notes the spotting module in this app is from US (Albini) algorithm.
- Prometheus is a fire growth model similar to FARSITE, projects real-time fire growth over days. Supported by Alberta ESRD.
- PFAS is a long-range model for fire growth over weeks, came online in 2011, somewhat like FsPRO but uses different modeling approach. Also projects probability of natural extinction. Supported by Kerry Anderson, CFS Edmonton.
- Burn P3: Long-term planning tool using Monte-Carlo simulations to look at burn probabilities across a landscape. Supported by CFS Edmonton, Marc Parisien. Zeke notes Flammap has a capability like this.
- Links to handy smoke management tools (Canada using BlueSky and other tools shared with US) can be found on The Lung Assn webpage, under “smokenews”
- There is a peat fire working group: Merritt Turetsky is on this group—may have most relevance to Kato's question about carryover fires.

Panel Discussion: How managers would like to use CFFDRS in future:

- Kent Slaughter: AFS has only 1 real staffing level but uses info from FWI in deciding to boost forces. General feeling among FMO's that CFFDRS reflects AK fire regime well. Would like to see more personnel learning & using the system and doing more documentation of how fire behavior/occurrence/effects match forecasts.
- Mike Wotton (via phone), research scientist with CFS, involved in “new gen” CFFDRS development. Also will have a new national fire occurrence model (prediction) which incorporates lightning and will live on CFS website. He did a fire occurrence study in prep for his AK visit and webinar this year and found results in AK very similar to Saskatchewan and Alberta. FFMC is main driver for human & grass fires.
- John Saltenberger, (via phone) USFWS, Portland at NWCC. Goal to develop tools for managers including anticipating outbreaks of large, costly fires. There are 12 predictive service areas in NW: looked at top 5% of large fire activity days and found instability and winds not as important as they thought. Major variables to predict these days were human ignitions (holiday weekends) and lightning. So working on Lightning occurrence prediction: 70% of large costly fires start from lightning.
- Heidi Strader : on ‘production’ side of CFFDRS in Alaska. New Mesowest contract for Fire Weather Index forecasting and 7-day display product outlook for large fire potential. Gridded weather data for AK now available in addition to the “paintball map” of FWI codes we are accustomed to. Question about whether drying trends factored in 7 day product: yes—the BUI and FFMC have a “memory” of recent precipitation so that is how drought gets incorporated into the FWI. Also they are studying appropriateness of red flag warnings in AK as has been some feedback from user community that there may be too many. Issue may be user understanding of RFW or overemphasis. Would like to have better way to predict coverage of lightning for T-storm RFW, also maybe should consider FWI indices in addition to wind when issuing a wind RFW?
- Peter Butteri: has used 7-day product to get ERC codes needed to run WFDSS. Heidi doesn't recommend that source: lack of trust in how they're calculated.

- Heidi reviewed 4 types of Red Flag Warnings/Watches in AK: **1) >25% coverage of large t-storm and precip <0.1" (precip hard to predict!) 2) wind >25mph with RH <30% 3) low RH (<15%) 4) Wind AND low RH**
- Tom Kurth. Face problems with increased fire due to climate warming and no allied increase in staffing, therefore must prioritize resources. Use FWI for daily decision making: prepositioning, staffing, statewide drawdown levels, action fire decisions, conversion date, RX prescriptions. State has faced 3 important legal challenges recently—Miller’s Reach fire in Matsu in 1996, 2004 “smoke out” with inquiries from FNSB, Railbelt fire on defense of structures. All challenges wanted to know **how decisions were made**. State has a decentralized fire protection model (opposite of AFS) with many parts to move around to optimize protection for regions most at risk. Also often need to decide when risk is lowest to give necessary time off to resources. Almost 50% of resources used on fire in AK now come from L48.
- Robert Ziel: the AK dilemma is CFFDRS seems very useful but WFDSS (using NFDRS) is statutory requirement. He also notes the 7-day outlook for large fire potential product (using NFDRS) is going to be used nationally for resource allocation whether AK uses it or not. Our challenge (and Great Lakes challenge) is to use a blended system. Ongoing action is Mesowest contract (funded by BLM Alaska Fire Service): we’ll now have graphical map display replacing the tabular info on fuel moisture codes and FWI. Transition in 2 years to the map. Hourly codes/indices (another upgrade) will help determine the length of burn period. FWI fuel moisture codes can be leveraged to provide local knowledge to WFDSS analysis inputs: example—use FFMC/GFMC values to set dead fuel moisture inputs to short term fire behavior module in WFDSS. And FFMC/BUI forecasts can help evaluate forecast ERC. There is an app **like RedAPP** included in Mesowest contracted products for predicted FBP fire behavior (numbers not a perimeter map) based on FWI’s.
- Marty Alexander thinks we may be “calling wolf” with too many Red Flag Warnings.
- Al Edgren thinks giving dispatchers easier access to tools to predict general fire behavior would be useful.

Discussion & calls for action:

- Tom Kurth would like to see better documentation of decision rationale and better science relating fuel moisture indices to actual fire occurrence/behavior.
- Kent Slaughter notes National fire suppression production rates have been published but not matched with AK methods. Need to document AK production rates.
- Zeke: Need to finish an Alaska “adjectives” table i.e. what codes will be used for thresholds of “high” “low” etc. and which complement of wx stations should be used for those calculations.

Document rationale for daily decisions & document AK suppression “production rates”

Identify Alaska fire danger code breakpoints for basing decisions and actions

Wednesday, October 29

Morning:

Organizer: Sharon Alden	Facilitator: Jen Northway	Notes: Randi Jandt
-------------------------	---------------------------	---------------------------

0800 Key points from day 1: Jen Northway

0810 Break out groups for discussion on specific applications:

- 1. Universal fire behavior calculator RedApp:** Sponsored by CIFC, community webpage by Franco Nogarín, IT lead for NWT fire applications, with provincial support: Came online in 2012, weather and mapping tied to internet but application is downloaded (free, with invitation) onto desktop. Provides a graphical interface: can choose province, city, etc., enter lat/long, or current location. Features include social connectivity feature allowing users to see activity by other users and connect/collaborate. Links to historical and forecast weather streams (Canada—need to figure out how to connect to ROMAN or other US weather). Also possible to enter weather inputs manually or edit inputs, such as loading weather from a portable RAWS. Weather inputs can be daily or hourly. Then the app calculates FWI codes hourly or daily: these can be fed into FBP, which requires the user to choose one of the 16 Canadian fuel types (C-2, G-1, etc.) A photoseries pop-up appears to help validate the user’s choice. The FBP module then calculates ROS, HFI, CFB, Fire type, AND (*this is different than Mesowest fire behavior calculator*) a rough perimeter based on the wind direction and spread rate. This quick & dirty calculation is rapid and very easy to use, but does not have all the functionality in WFDSS to choose different crownfire initiation models, multiple fuel types, add barriers, etc. Spotting utility is same formula as BEHAVE + according to Marty A. Also unlike WFDSS, you do not have to be agency-sponsored to get a userid and password: users can invite other users to RedAPP. Action items: Request REDApp developers to give a webinar, including AK example. If this looks like a valuable tool for AK, could work thru the AK NW compact (Kurth) and maybe with GtLakes compact (Jim Barnier) to add functionality such as weather stream choice for USA.
- 2. Military zone fires:** Action items: add Miller grass fire behavior model—specific improved product for the type of grass on the ranges (different than G-1/G-2 which model matted grass). This will hopefully be published soon. Also, have a workshop jointly with the Army.
- 3. Burn plans:** Should be able to use CFFDRS in burn plans (use FWI codes for thresholds, etc. since AWFCG “adopted” it in 1992. Still would like to see FBP capability in WFDSS but this is very unlikely because of the limited user group nationally. How to grow the RxFire program and get experience when not much burning is done in AK? Kato would like to see better interagency \$ support for fire science research—beyond JFSP, and better documentation of Rx burn results.
- 4. AFS/FMO Staffing Plan:** Current process lacks transparency for cooperators and needs better comms, maybe better documentation. Preseason decisions are one problem area: when to be fire ready? More scientific data and better seasonal forecasts are desired for this decision. Action items: Committee (M. Butteri) to study setting guidelines/thresholds for various actions like air tanker alerts, lunch staffing, weather/tactical schedules, support staffing (transpo, warehouse, etc.), and IA forces

Provide training session on Canadian tool RED App

besides just tankers and jumpers. Noted that written “guidelines” can be used against agencies in legal actions, so need to be cautious.

5. **LANDFIRE**: USGS Charlie Martin ran the Stuart Ck fire in FARSITE using Scott’s dynamic fuel models (US) compared to Canadian fuel types as a case study. One problem with FBP is it does not have any pure deciduous models which was an important fuelbed for that fire. In FARSITE can choose Scott/Reinhardt crown fire model which works better-not available in FLAMMAP (Note: can that be an action item to request choice of CF model in FLAMMAP?) Bottom line result is that FARSITE using TU4 worked well to predict observed fire behavior. Write up available from Lisa Saperstein.
6. **Mesowest**- Has 5-yr contract (2 yrs development/3 yrs maintenance). Changes include will be able to look at all historical weather data, not just last 2 years like now. Rainfall continues to be weak link in predictions—not much radar in AK. There is an interagency group to oversee the contract, which is with Alaska Fire Service.
7. **Public Burn Permits**: principal wildfire cause for DOF=debris burning. Examples of processes used in MI, WI an MN very helpful for AK DOF.
8. **Red Flag warnings**: Action item—AICC may survey users understanding of watches/warnings and will look at past large fire growth days to see if red flag days are a good predictor. (Sharon Alden)

Modify Red Flag Warning criteria
or improve user understanding?

1030 Review interagency management of RAWs, WIMS, WFDSS:

Bev Fronterhouse: An Interagency Telecommunications Coordinating Group (ITCG) was establish in 1990 to manage RAWs, Radios, disaster plans and interagency coordination. Under a 1995 ITCG-Agreement for maintenance, NPS/FWS do seasonal maintenance on equipment south of the AK Range while BLM does north of the Range. About 45% of all of the RAWs/Radios are managed under this agreement which was estimated to have saved about \$63,000 in the first year-1995, perhaps as much as \$250,000 annually today. The ITCG-A also has specifications for equipment types and replacement schedule for components. There are 146 RAWs in total (BLM 22, DOD 10, FWS 27, NPS 17, FAA 16, S&PF 46, USFS 8). Fuel moisture is calculated from solar radiation and precip. BLM maintains SOA RAWs under a reimbursable agreement. Emergency maintenance costs are not covered: if a RAW is not working contact your agency contact, i.e. Kent Gale at AFS for BLM/SOA. Also should let AICC Predictive Svcs know data is off.

Heidi Strader: WFMI is automated system which downloads data from the RAWs and from there it is picked up by AICC, WIMS, ROMAN and WRCC independently. If corrections are made ‘downstream’ at AICC, for example, they would not be carried into the other systems without communication between the offices. WIMS calculates the NFDRS values. Humans have to determine and enter the snow-free and start of Green-up dates for FWI indices to be calculated. Also freeze-up dates. Calculation of fuel moisture is done automatically.

Under the new MesoWest contract, Heidi & Sharon will be able to edit/correct the data there just like at AICC. Marty notes we should call this data the *Daily FW Index System*, not CFFDRS (like we tend to do) because it has no link to fuels or FBP.

AWFCG forward request for desired FWI's (like BUI) in WFDSS

Mark Hale: WFDSS may soon be able to access gridded weather (instead of having to pick a representative station) and topography. If AWFCG want to see specific data like FWI, BUI in WFDSS outputs, they need to put in a formal request. At least for BUI, Mark thinks this could happen—he can take the request forward for us.

1100 Overwintering and past experiences: Sharon Alden:

- Not all springs are created equal it seems with regard to DC and overwintering
- It may not matter much in most areas (S. of Alaska range, for example) because winter precipitation is usually over the threshold for using the default code in spring. In dry areas like Delta, Upper Yukon valley, Healy where little snow or snow is lost to wind and sublimation would be where it mattered the most.
- Sharon did a case study in Delta 1998-1999 and Chalkitzyk 2004-5 (big fire years) to see what difference overwintering the DC or not would have made.
- There are a couple options if you decide to overwinter the code, like what fraction to carry over (%), the effectiveness of the precipitation (50-90%), in addition to the winter precip and fall drought code. These options are somewhat subjective.
- Snow level can be estimated from closest year-round weather station or estimated from snowpack reports.
- DC is not used directly in fire behavior calculations. It does factor into the BUI which is used in ROS calculations, in BUI ranges of 20 (so not super-sensitive). Sharon compared theoretical fire behavior using overwintered vs not in the 100-mile fire area as a sensitivity analysis: May 1st theoretical ROS was 21 ch/hr using default DC or 25 ch/hr with overwintered. June 1st was 23 vs. 25 ch/hr. How significant is this?
- She noted that overwintering DC's can carry some drought thru an entire summer in years with very low rainfall, long-term drought.
- COMMENTS:
Tim Lynham has been studying overwintering in Alberta with Brian Stocks and they are coming to the conclusion that it may be best to use default code. Many hydrological mechanisms are not reflected by model including sublimation, run-off etc. and these factors may have different effects on soil moisture depending on ground temperature in spring. Some of their research has indicated the moisture deficit indicated by the “overwintered” code were not validated by their field samples. In the DMC layer they have seen fall value=spring value in 3 instances. Marty Alexander notes there is a guide to verification of overwintering codes by Lawson & Darlymple: why not do field sampling to validate start-up value? Also in Canada they allow local areas to be site-specific with regard to overwintering calculation. Jen Northway: if validating duff consumption levels and fire behavior are desired, why not use FEMO's more on wildfires? They are available but almost never ordered.

1300 **The NWT experience with Fire Weather Indices in the extreme fire season of 2014: showed video of lead NWT meteorologist Beverly ___? discussing how weather and FWI set up for the record NWT fire season of 2014.** Provided by Kris Johnson, NWT Fire Science Lead. Video available for viewing on www.akfireconsortium.uaf.edu

CFFDRS Summit in Alaska

Day 2 Afternoon Session Notes – taken by GaBriella Branson

Duff Fuel Moisture and FWI Codes

1. Eric's presentation from Interagency Fall Fire Review– he didn't have the PPT, but he went quickly over his process...
 - a. He has been working on modeling standing dead grass
 - b. The Alaska Fire Service Military Zone performs a lot of prescribed burning on training ranges in order to burn off grass to prevent tracer fires etc
 - c. Eric participates in the burns as Fire Effects Monitor and each time out the past 6 years took weather measurements and brought back bottles of grasses
 - i. Has 74 site days and about 285 days of weather to match with moisture content
 - d. He utilized the Bookkeeping method for his analysis– took data and fit into the equation (is it the Anderson equation??)
 - e. Can convert to code similar to Wotton in 2009 for Ontario, but in his equation solar radiation is an important factor
 - f. Eric's is for standing dead grass and solar radiation not an important factor to Eric's
 - g. On a final note – the work has been done and Eric is working on getting it published – believes it will be in use before it gets published
 - i. Will be featured in the next generation of Zeke's book

2. Sampling...See presentation
 - a. In the past folks from Canada have asked why Alaskan researchers don't use 2-cm layers for fuel moisture sampling vs. material type (live moss, dead moss, upper duff) as done in Canada (Randi's note: Brenda Wilmore's thesis work compared both methods for best match with FWI codes and recommended material type method for Alaska)
 - b. There is variability in Alaska duff types by region – and the layers vary in depth
 - i. The upper duff layer is thicker in the Fairbanks and Anchorage has a thicker live moss layer
 - c. Wanted to compare Alaska data to other published equations – took equations, reversed them and compared to DC
 - d. Do the published equations work?
 - i. They have a lot of points and a lot of scatter - why so much scatter?
 - ii. Peter B - Because trying to estimate based on different layer depths and not going by 2cm
 - iii. Marty A – could precipitation duration be a factor? And there are a lot of different sites...
 - iv. Randi – feels it is microsite variability – disagrees with Peter
 - v. Jen – some places were very eager to sample; Copper River was very interested and they felt they would find things to be really wet, and in fact they did find that it was wet
 - vi. Jen - regional differences, different moss types are all variables

Continue to use
AK FETG duff
moisture
sampling protocol
or modify?

- vii. Eric – agree with Randi – duff plugs vary even within the same area
 - viii. Marty – rule of thumb – if kneeling down for 10 minutes and my knees are wet – it won't burn that day
 - ix. Zeke – did you notice a difference between 4 sites versus 10 sites?
 - x. Eric – could be some sample error – did three major trainings...trying to get everyone to do the same things
 - xi. Marty – fortunate to get range in DMC, have you thought about tarping to get higher DMC's?
 - xii. Eric – had the idea, but went into fire season
 - xiii. Marty – done, and highly effective and allows you to get data after multiple wet seasons
- e. DC and Upper Duff Moisture
- i. Marty – precipitation duration has never been considered in the DMC and DC, and could be a factor. But how would we get precipitation duration at a manual weather station...unless we kept someone on the ground constantly. Really thinks there is value in looking at how long the rain was happening and feels there would be less variability.
 - ii. Peter – deepest layer that we have; feels there is a vast difference between “upper” upper duff and “lower” upper duff – it is not uniformly wet
- f. Eric – in spring he can find pockets of drying
- g. Tom – when out sampling – ...and I missed the rest of his comment
- i. Eric – generally think of moisture going up and down, but it sometimes goes side to side
- h. Marty – can always sample by 2cm-increments and add them together to consider whole layer (like dead moss for DMC)
3. Dataloggers (also from Interagency Fall Fire Review...I think)
- a. There are Lowland and Upland differences
 - b. CFFDRS is a weather model NOT a hydrologic model and does not account for moisture moving up and down
 - c. The datalogger has weather on one side, and moisture sensors on the other side
 - d. Two have been in the field for one year (a third is in the lab)
 - e. Some things going on in data at this point that cannot be explained
 - i. Ice crystals in dead moss layer but not in lower layers
 - ii. Ice crystals and then ponding below
 - iii. Maybe snowmelt is coming down and freezing at a certain point
 - f. Hydrologic model – would like to plug data into the model by Keith in Canada
 - i. But should we go in a new direction or fix what we are already using?
 - g. Where is the water going and where is it coming from?
 - h. Tim – are you concerned about how to get 2 cm layers or the number of samples you would have – bread knife to saw it and then guillotine to make separation

- i. Jen – our organic layers are very loosely – data not working very well in Anchorage so they started using measurements – see Lisa’s comment
- ii. Lisa – top 2 cm for live, skipped a couple and then 5-10 and then more – did work different, and was not sure if it was a better fit
- iii. Jen - Brenda’s work was done by 2 cm increments (as well as by material type—did it both ways); Sampling group have not put all the statewide data together yet...may have 400-600 duff data samples to put together

Ecohydrology of the Alaskan Boreal Forest (Bob Bolton, UAF)

1. Data from PHD work and some recent work
2. Looking at how permafrost affects freshwater flow
3. Climate, ecology, permafrost, hydrology – all interrelated
4. Permafrost makes our environment unique – we have discontinuous permafrost – some here and not there
5. Drive a lot of what is going on, particularly in this region
6. Two different types of ecosystems
 - a. Deciduous – south facing slopes
 - i. Permafrost free
 - ii. Transpiration dominated
 - iii. Vertical water fluxes
 - b. Coniferous – north facing slopes
 - i. Permafrost dominated
 - ii. Evaporation dominated
 - iii. Horizontal water fluxes
 - c. Very dramatic and different systems
 - d. Most of research in Chatanika – Caribou-Poker Creeks research watershed
 - e. Snow melt
 - i. South facing slopes melt out before north facing slopes
 - ii. End up with different pulses of water entering the system
 - f. Snow melt water uptake
 - i. Deciduous vegetation takes up a lot of the water
 - ii. Birch trees were expanding a lot and measurements were being taken daily
 - g. Ecosystem water use
 - i. EvapoTranspiration
 - ii. Remember transpiration is a biological process – physiologically controlled
 - h. Jen – not a difference between white spruce and black spruce? No – black is in the coniferous and white spruce is not a large transpirator or user of water. (I think-this I missed)
 - i. Jeremy – during growing season, is there cold air pooling?
 - j. Bob - No...not during summer...
 - k. Boreal Forest Soil Moisture
 - i. Permafrost free area – surface and subsurface soil moisture are disconnected

- ii. Areas with permafrost – permafrost free soils display a lower soil moisture content than those that are permafrost free
 - iii. Peter – definition of organic soil from Bob’s perspective?
 - 1. It is 5 cm...from the surface of the soil down
 - iv. Soil moisture versus fuel moisture codes
 - 1. Seems to have the same slope until late summertime
 - 2. 1-2km distance of rain gauge from site
 - 3. Randi - 25cm depth – what we would consider lower duff – a layer we don’t often compare to drought code
 - v. Strong temperature gradient between soil (warm) and atmosphere (cold)
 - vi. Study by Kane and Stein in 1983 out in Goldstream Valley
 - vii. Study by Woo, 1986
 - l. Permafrost distribution and stream flow
 - i. High permafrost areas – higher discharge during precipitation, lower regular flow, longer recessions compared to lower permafrost areas
 - m. Climate, ecology, permafrost and water are connected
7. Questions
- a. Judy Reese – wondering about white spruce in Southeast? Would they be engaging in this same taking up of water?
 - i. Bob - Do not seem to respond the same way as the deciduous. Do not take up as much water and do not transpire as much
 - b. Judy -If no recharge from snow in Mat-su...
 - i. Bob - Would still flux a lot of water out in winter and soils would be drier after snow melt
 - c. Tim – FWI developed, one code is DMC based on temp, rh, and precipitation...if trees are pumping water out of the ground, how important is that? What if by ignoring that we are missing a crucial point, is it more important?
 - i. Bob - Depends on vegetation type. In deciduous type, feels it is critical...but not in coniferous.
 - d. Bob - Not sure that permafrost dictates the amount of water...
 - e. Tim – it could be really big (if permafrost dictates water quantities)
 - f. Jennifer – what about shrubs? If spruce are not contributing to the water, it would be great to find out about shrubs
 - i. Bob – study specifically excluded shrubs, but Jessie just received funding to pursue that
 - g. Heidi – have you been able to consider sublimation and its impact?
 - i. Bob - Have not gotten to sublimation
 - h. Kent – do you still have snow pillows?
 - i. Bob - Yes
 - i. Randi – what would it take to get some specific looks at the moisture fluctuation in specific layers? Some collaboration?
 - i. Bob - Sure it could happen if there was a need and funding
 - j. Chelene – work in Souz St. Marie (sp) – looking at moisture when cut roots off – the temp of soil has been affecting transpiration, and seems start to be limited by the biotic (I got a little lost here)
 - i. Bob - Jessie done a lot of work and modeling

The High Latitude Satellite Proving Ground and Wildfires in Alaska

1. No single image tells the whole story
2. Day night band is not as good for fires during the daytime
3. The Fire Temperature composite
 - a. Peter – how does cloud cover affect this imagery?
 - b. Eric - Badly – clouds will get in the way
4. Understand that research is different than operations
5. Heidi – getting a version of AWIPS for coming season and they could export and put into briefing slide
6. Sharon – what would be the delay? From time image is taken to when it might be available?
 - a. Eric - Best case scenario – ½ hour from time satellite goes over...GINA is working on speeding up the processing
7. Sharon – using MODIS on ArcIMS site...
8. Get more passes from these polar orbiters
9. Just a thought – NWS has found funding for Arctic Test Bed – will include (Karvin Scott ?) maybe more work could be done on arctic fire images?? Just brainstorming...
10. Peter – what is the image resolution?
 - a. Eric - Depends on specific instrument. As fine as a few hundred meters.
 - b. Modis is 1km and compared to MODIS - has better resolution on the edges
11. Judy Reese – if images were shared, are they georeferenced?
 - a. Eric – we could build on something that is already done, when GINA cranks out products they send things to NWS and place online as GIFs and place in GIS environment. Imagery is also archived (at GINA), whereas the NWS is all about the now
12. Tom – CFFDRS – FBP system – try to calibrate fire predictions, and based off rough modis dots or a flight – would be really cool to use these time stamped images
13. Peter – how many passes?
 - a. Eric - The further north you go the more passes one gets – Fairbanks about 6 passes. A new satellite will be launched in 2 years. About 90 minutes per lap around the planet.
14. Randi – do you think a project like an application development could a grant proposal?
 - a. Eric – not involved in grant writing...Tom Hendricks, director at GINA, and passionate about science in the real-world would be the one to discuss this with.
15. Tim – just a note, from what they are hearing in Canada, MODIS is not operational satellite system and the new operational system is VIRS; when they die they are gone..

Improving the Canadian Forest Fire Danger Rating System fuel moisture codes using SAR data

No further discussion or questions

Pursue a research project to use satellite data or ground moisture probes to ground-truth the CFFDRS fuel moisture indices

CFFDRS Summit - Notes for Thursday, Oct. 30, 2014 (morning)

Notes by Jen Northway

Get opening notes from KT.

Tom St. Clair (comments from opening discussion)

- What is the product from this meeting? We want to try to get future direction on where AK wants to go with the FWI, FBP and Accessory Fuel Moisture components.
- Need to have a plan for when Robert Ziel leaves DOF
- Plan to get notes together from this meeting and collect Action Items. We can work through these action items with FRDAC and FMAC committees.
- Need to keep the momentum moving forward, continue having meetings, and communicate with others in Canada and Great Lakes, perhaps meeting there next time.
- On the short term, can work on burning projects over a range of ISI's and develop a good FBP fuel type map.

Robert Ziel – Seasonality and CFFDRS

- Seasonality plays a big role. It's built in the DMC and DC (day length factors, etc.). Also if FWI outputs and FBP fuel types (mixed wood, Deciduous and grass types). But is it strong enough?
- What's not incorporated in FWI or FBP
 - Snow cover factors → When to start the codes?
 - Ignition potential between green-up and curing
 - Seasonal changes in permafrost → How it effect fire behavior and fire danger
 - Day length/plant physiology/flammability
 - Regional differences in vegetation and fuels conditions and how they relate to seasonal changes
- There are some resources that might be able to help us answer these questions
 - Snow Cover/Snow Free Dates:
 - Can we leverage info from remote sensing applications in the time framed need?
 - Permafrost:
 - Need to recognize how relates to onset of fire activity and how to relate that to our business.
 - Is the ground still frozen? How does that influence early season or mid-season conditions?
 - Green-up and Growing Season:
 - The transition from human ignited grass fires to crown fires burning in Black Spruce. Is this transition period different than spring and summer conditions?
 - Alaska seems to green-up from the top down.

- What do we need to be paying attention to?
 - Is there also a similar transition in fall when return to that dead fuel type?
 - Have some greenness information available nationally but cloud cover impacts imagery
 - Brad Reed was looking at vapor pressure deficit. Peaks seem to be related to fire activity on the Kenai
 - Tim Lynham comments: New veers satellite may work well for snow cover. European satellite has 350 m resolution but difficult to acquire.
 - There are also published papers on Daily Severity Ratings, a mathematical translation of the FWI that can be averaged and used for daily, weekly, or seasonal ratings
 - Concerned about effect transpiration on DMC. May have huge impact but just don't know how big a factor.
- Need keep eye on future. Does FWI tell us what we want to know? Are the tools still working in the face of climate change?
- Marty Alexander comments:
 - Can check coniferous seasonality. Compare Canadian foliar moisture with AK data.
 - Hardwood can carry fire well certain times of the year. Can we see it? Can we forecast it?

Jeremy Littell – Detection, Attribution & Prediction: Fire Climatology Forecasts in Alaska

- New research on PDO says may not be as useful predictive tool as previous thought
 - Persistence is key but now correlations are not as strong. Is it still equally predictive?
- Other tools out there:
 - ENSO: Not that much skill in predicting temperature & precipitation. Sometimes successful in predicting fire behavior but might be useful in combination with other tools
 - Pacific North American (PNA) Pattern: Could be useful seasonally or weekly to monthly scale
 - East Pacific Pattern: Single best predictor for fire season (other than June Temperature), Duffy paper).
 - Regionalization of Climate in AK → in progress. Peter Bienek working on it.
- What is the predictive capacity of these tools? How do they fit together? What do we really want to know?
- Current forecasts are in experimental phase.
- Are past fire events correlated in climate? This is less developed in AK. Mike Flannigan, etc have worked on these questions.

Marty Alexander – Synthesis on Crown Fire Behavior in Conifer Forests

- Chapter 8 in “Synthesis of Knowledge of Extreme Fire Behavior: Volume I for Fire Managers”
- Volume II coming soon
- Fire Management Today – Volume 73, No.4, 2014. “Synthesis on Crown Fire Behavior in Conifer Forests”. Readers Digest Version.
http://www.fs.fed.us/fire/fmt/fmt_pdfs/FMT73-4.pdf
- Three type of Crown Fires – degree of dependence on surface fuels.
 - Passive
 - Active
 - Independent
- Torching does NOT equal Passive Crowning
- First Crown Fire Initiation Model (Charlie Van Wagner – 1977) was very basic.
 - Crown base height & foliar moisture
 - Incorporated into FBP system and others
- Cruz et al (2004) couldn’t find effect of foliar moisture on crown fire
 - Found canopy bulk density threshold in which crown fires would transition from passive to active and threshold that would no longer sustain passive
- Rothermel developed crown fire rate of spread model in 1991. Cruz et al (2005) differentiated between passive and active crown fire rates of spread.
 - Cruz et al found Rothermel under predicted rates of spread in conifer fuel type
- Flame length for Crown Fires:
 - No models are consistent.
 - Best Rule of Thumb: 2-3 times the stand height = Flame length. As good as going to get for now.
- Have some Alaska Case Studies
 - Rosie Creek – Rod Norum (3 publications)
 - Behave vs FBP results were very different.
 - FCCS was under predicting
 - Donnelly Dome Fire 1999
 - FWI indices matched Intensity Class (5 with an attitude)
- Fire Behavior Monitoring and documented Case Studies are very important!!
 - Fire from 1962 was the last peer reviewed published Case Study from AK.
 - We need more!!

Tami Parkinson, Robert Ziel, Amy Skraba, Matt Lammers, Mark Hale - Training Recommendations for the future

- Add more Fire Danger course work to NWCG classes
- High interest from Lake States, Alaska, and research groups for CFFDRS
 - Currently not consistently delivered in training nor are training materials consistent

- Working together with Fire Behavior Subcommittee to develop consistent materials to be incorporated into S-290/390/490 series as optional modules
- Getting \$10,000 from NWCG to be used in 2015 for material development, digital supplements, etc. Still working on plan for funding use.
- Got good feedback on Fire Behavior Field Reference Guide (1992)
 - Updates will include CFFDRS info
 - YouTube Channel being set up to support FBFRG
 - Will be linked on Alaska Fire Science Consortium website soon (Fire Modeling Page)
- Goal dovetail into existing series. Add enough CFFDRS but still maintain NWCG criteria
- AK Team assisting with development: Sharon Alden, Heidi Strader, Robert Ziel, Tom St. Clair, Eric Miller
- AFS and DOF also plan to include in S-290 and above
- Discussion starting with UAF program to include as well (John Jorgenson & Tyland Martin)
- Meso West contract:
 - Final software release April 2016
 - BETA April 2015. Looking for evaluation to make revisions
 - Plan include FBP calculator
 - Got visual display (web mapping) fixed (needed use Alaska Albers Projection)
 - Tested indices calculation code against historical calculations and were identical.
- WFDSS Training Materials:
 - Website
 - Working on YouTube videos
 - RD&A Group putting on training. Also Rick Stratton.
 - Alaska Interagency Fall Fire Review:
 - Need to identify and utilize WFDSS Facilitators
 - Put on training for Facilitators, FMO's and jurisdictional
 - Fire Modeling Analysis Committee (FMAC) working to put on webinars this winter/spring
 - RD&A Group looking to do Line Office Training and Training for Incident Management Teams
 - May also be incorporated in S-581/AK IMT meeting in April 2015. DOF Spring Ops meeting also on option

Jennifer McMillan, KT Pyne and Sarah Trainor – Engaging Researchers and Supporting Managers

- Top Two Research Priorities:
 1. Fire Behavior Models: Validation and Application
 2. CFFDRS Fire Weather Indices: Evaluation and Calibration

- CFFRS topic has been very high since the list was created
- What AWFCG Research Committee does to promote the list:
 - Presentations in AK and L-48
 - Website www.frames.gov/afsc/frdac
 - Pamphlets/Handouts
- Research Committee can provide letters of support for proposals that meet the criteria
- Suggestion: Ask “what are the management needs?” instead of “what are the research questions?” as different way to frame the question. (Peter Butteri/Kato Howard)
 - How to reach out to fire fighters for tactical/operational research needs.
- Sarah Trainor: Has access to Grad & undergrad level students @ UAF who might be interested in fire science projects.
 - If have visions on how the Alaska Fire Science Consortium can contribute, please let them know.
 - Work closely with several AWFCG committees

Dan Warthin - Meeting Wrap Up and Action Items Discussion

AWFCG has some immediate actions that can be taken

- Collect notes and action items for discussion in Dec meeting and January face to face

To the Audience – What kind of other help do you want from AWFCG?

- Need to endorse FBP maps for Alaska? AWFCG can follow up and support Interagency collaboration to get it done.
- Still the question of “How do we hold ourselves accountable to keep progressing?”
- Tom Kurth: Fire fighter – Manager Gap:
 - Where do we put information (CFFDRS related)?
 - Some reactions from fire fighters: “Don’t care what the indices mean, just show me the fire so I can put it out.”
 - At what level do we start to reinforce what we know? Where do Type 2 Crews fall in the mix?
- Kent Slaughter: There’s been a cultural shift. Why are we doing what we are doing (referring to fire fighting)? How do we do it well? Why do/should we care?
 - We’ve allowed that culture to develop.
 - Haven’t had emphasis in education/training CFFDRS since last class in 1996 and have let it percolate through the years.
 - Has some ideas on how to approach this for the AFS management team.
- Some informal Case studies have been completed by DOF
 - Turquoise Lake Fire
 - Dune Lake Fire
- Need to collect/gather existing case studies
- Need to collect more fire behavior/fire weather information from IA Resources

- Teams are doing better with documentation but need to be clearer on what info need from FBANs.
- Tom St. Clair: Should think about how to support a full time person to devote time and energy. FBAN's and others have day jobs. Go out for 2 week assignment and 2 weeks behind in day job. No mechanism to spend the time to publish peer reviewed case studies.
- Jennifer Barnes: The Fire Behavior Knowledge Base still exists. Are we using it? Would it be beneficial?
 - Mike Wotton started but the system is no longer being used. Status Unknown.
 - NPS has good fire behavior observations from 2007 but the data still sits unused.
- Tim Lynham: Agrees need devoted people to put together team. If not, it will not succeed.
- Kato: We have transitioned from case studies to lessons learned to AARs (after action reviews). We have a start but need to finish.
- Marty Alexander: Last issue of 2003 Fire Management Today has an easy template for a putting together a Case Study. It has chronology, environment, observations, modeling and conclusion sections.
- Zieke: Should build in prompts for feedback in existing mechanisms (similar to what Scott Linn did with his excel program and automated emails). We should send notes to people to ask "How well did etc, etc, work today?" By building feedback mechanism into existing processes we can turn them into pieces we can glean data from.
- Judy Reese: If we want fire fighters to collect fire behavior data, need to get them interested and have some ownership.
- Tie the science in with the IRPG or the L series NWCG courses.

AWFCG would like a rough prioritized of action items for the Dec 5th meeting

Action Items From Thursday AM Session:

- 1)** Think about the questions that were addressed in the presentations on Seasonality and Using Climatology for Fire Season Forecasting. In some cases additional research is needed to learn how to use the existing tools/technology to answer our questions. In other cases, we need to further develop the questions we are asking. What do we really want to know? How can we use that information? How can we use the existing technology to answer those questions?
- 2)** More case studies and fire behavior monitoring. Use the simple case study template in Fire Management Today (last issue in 2003).
- 3)** Do our own experimental burning in the fuel types (shrub and birch) we need data for over a range of ISI's.
- 4)** Develop a research dedicated team or find a way to devote time in our current work force through interagency priorities.
- 5)** Work to engage our current firefighting workforce to understand the importance and significance of the Canadian systems and how that directly applies not only to their profession but their safety.
- 6)** Work with the AK Training team to develop NWCG sanctioned CFFDRS modules for the 290/390/490 series course. Build and utilize existing materials to incorporate into your training schedules at the local level.
- 7)** Using CFFDRS in WFDSS: Many training options available. KT working to put together trainings catered to 3 different users: facilitators, suppression FMO's and jurisdictional personnel. AWFCG FMAC group working to put on webinar through the late winter/spring. This could also be incorporated into the Spring S-581 class and the DOF Spring Ops Meeting.
- 8)** Identifying Research Priorities in AK (AWFCG – FRDAC): Consider framing questions differently to target managers/firefighters. Connect with Kato, Peter Buttteri and others on how reach that group for tactical/operational science related needs.
- 9)** Identify and consolidate the existing informal fire case studies and fire behavior information that has been collected over the years in Alaska.
- 10)** Target IA resources to collect & report initial fire behavior.
- 11)** Set specific standards for teams on what information want FBANS to collect.
- 12)** Utilize FBANs, FEMOs, FOBS, etc. on incidents, regardless of size, to collect needed data.