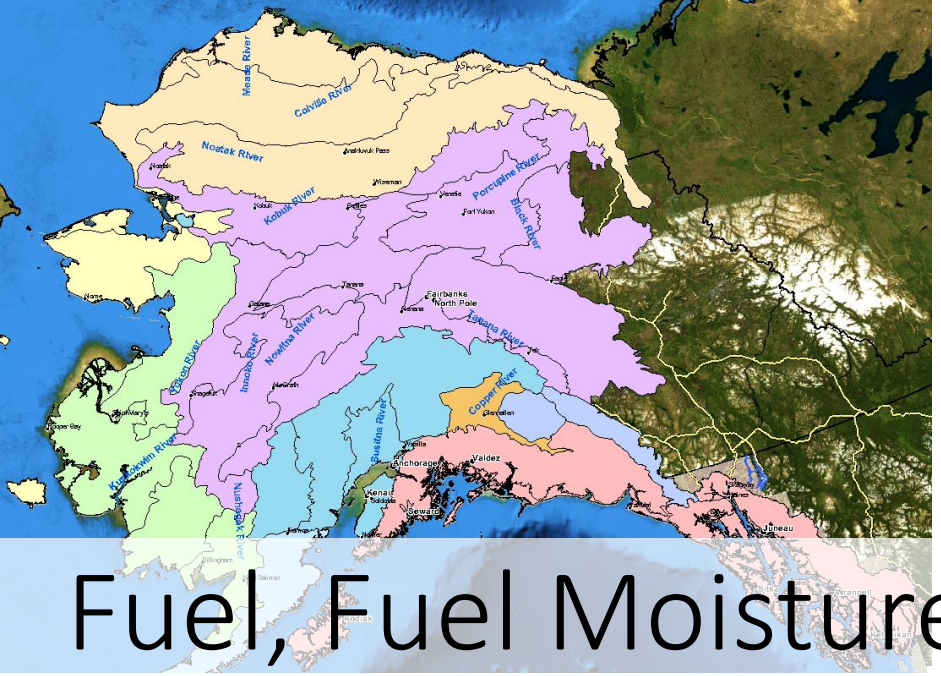
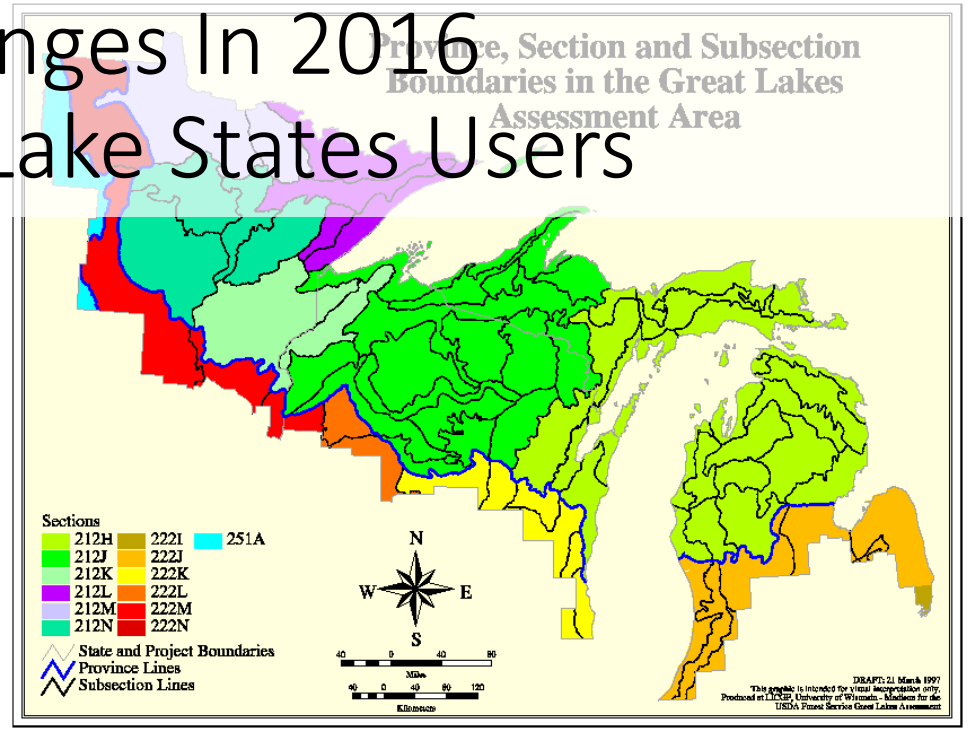
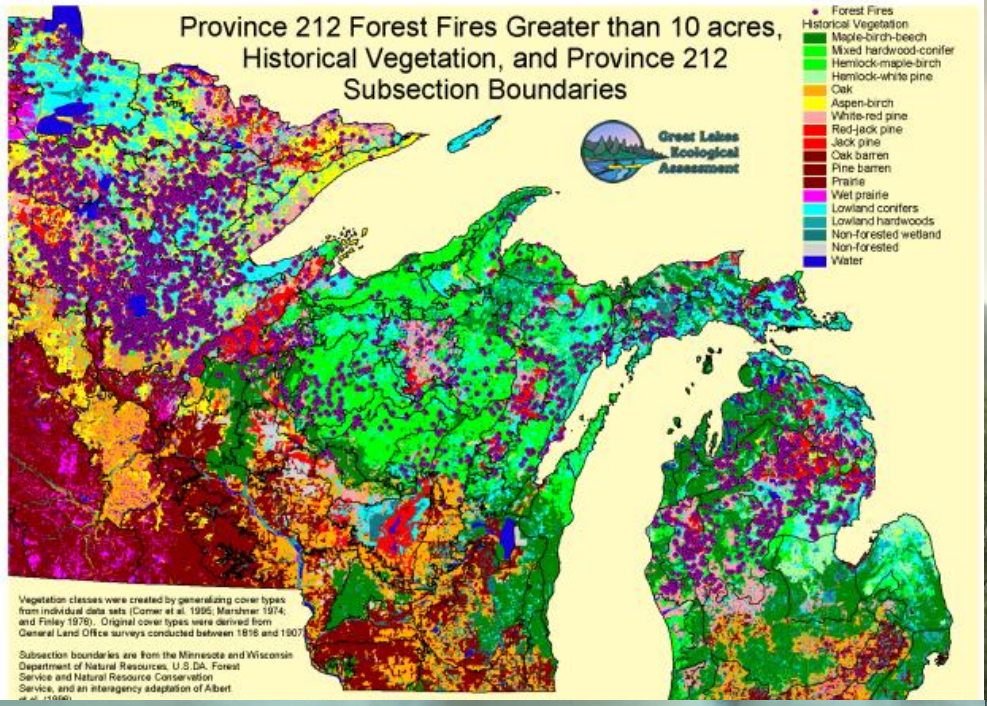


Fuel, Fuel Moisture, and Fire Potential

NFDRS Changes In 2016 for Alaska and Lake States Users




Province 212 Forest Fires Greater than 10 acres, Historical Vegetation, and Province 212 Subsection Boundaries
Great Lakes Ecological Assessment
Forest Fires
Historical Vegetation
Maple-birch-beech
Mixed hardwood-conifer
Hemlock-maple-birch
Hemlock-white pine
Oak
Aspen-birch
White-red pine
Red-jack pine
Jack pine
Oak barren
Pine barren
Prairie
Wet prairie
Lowland conifers
Lowland hardwoods
Non-forested wetland
Non-forested
Water
Vegetation classes were created by generalizing cover types from individual data sets (Comer et al. 1995; Marshner 1974; and Finley 1976). Original cover types were derived from General Land Office surveys conducted between 1816 and 1907.
Subsection boundaries are from the Minnesota and Wisconsin Department of Natural Resources, U.S.DA. Forest Service and Natural Resource Conservation Service, and an interagency adaptation of Albert


Bruno Fire (AK), June 29, 2015
15,131 Acres Burned over 2 weeks


Duck Lake (MI) Fire, May 24/25, 2012
21,135 Acres Burned

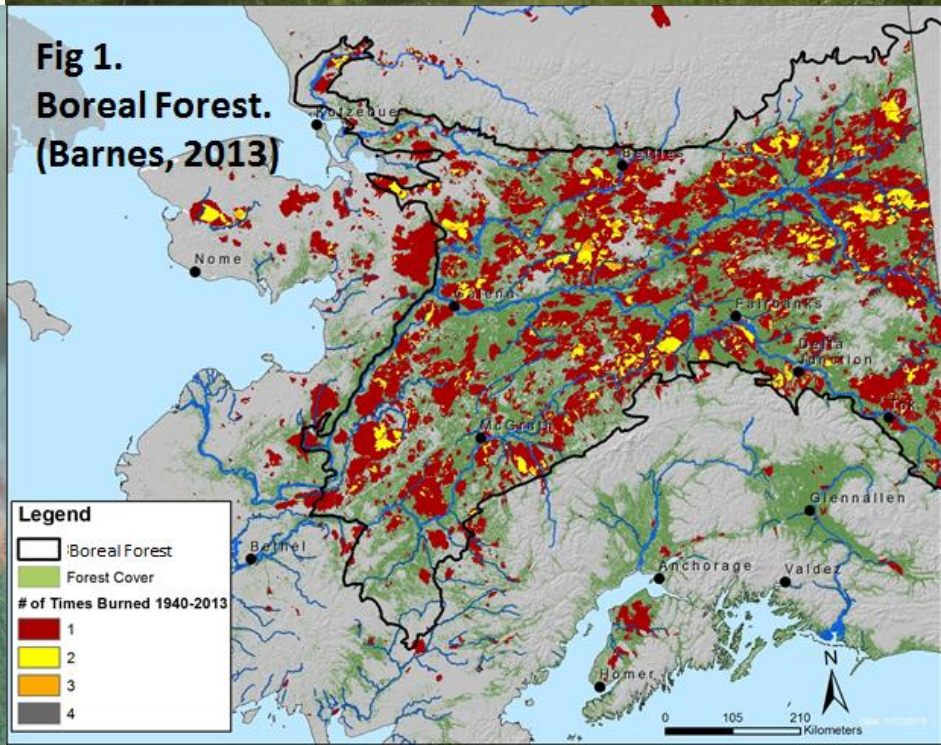
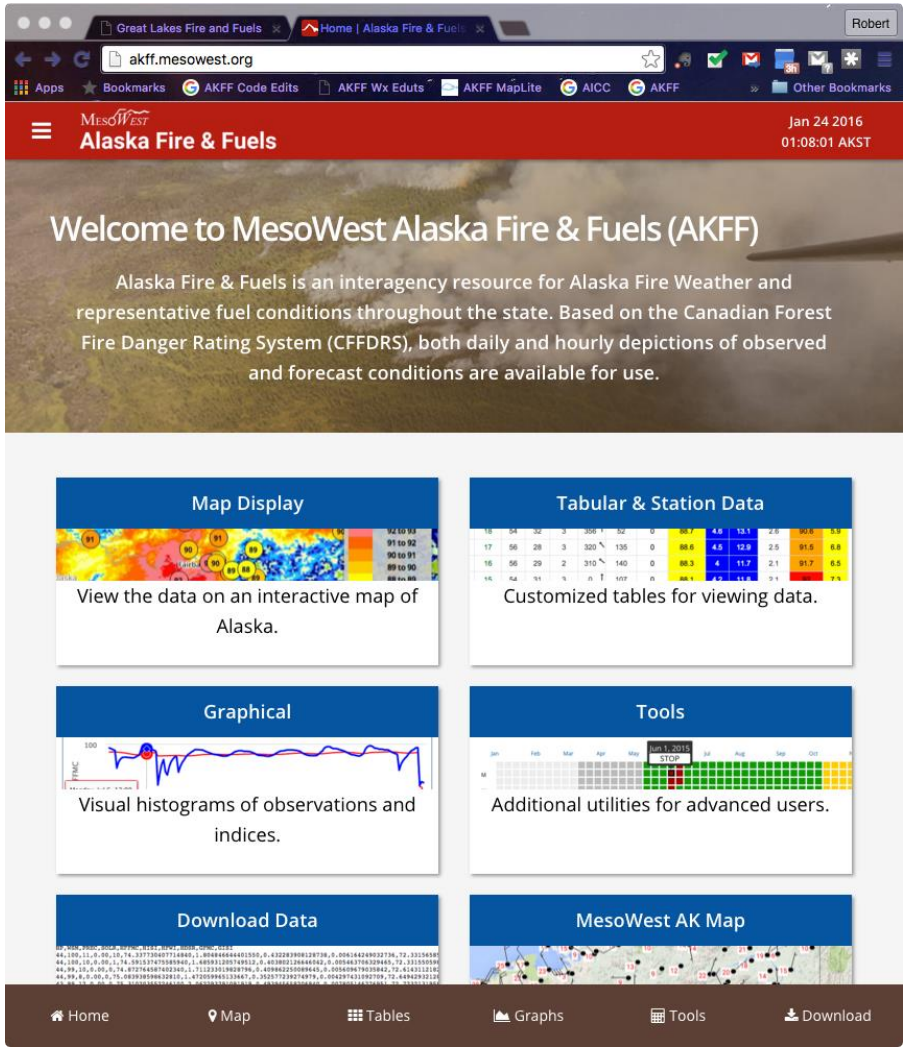


Fig 1.
Boreal Forest.
(Barnes, 2013)
Kotzebue
Nome
Fairbanks
Delta Junction
McGrath
Glennallen
Bethel
Anchorage
Valdez
Homer
Legend
Boreal Forest
Forest Cover
# of Times Burned 1940-2013
1
2
3
4
N
0
105
210
Kilometers

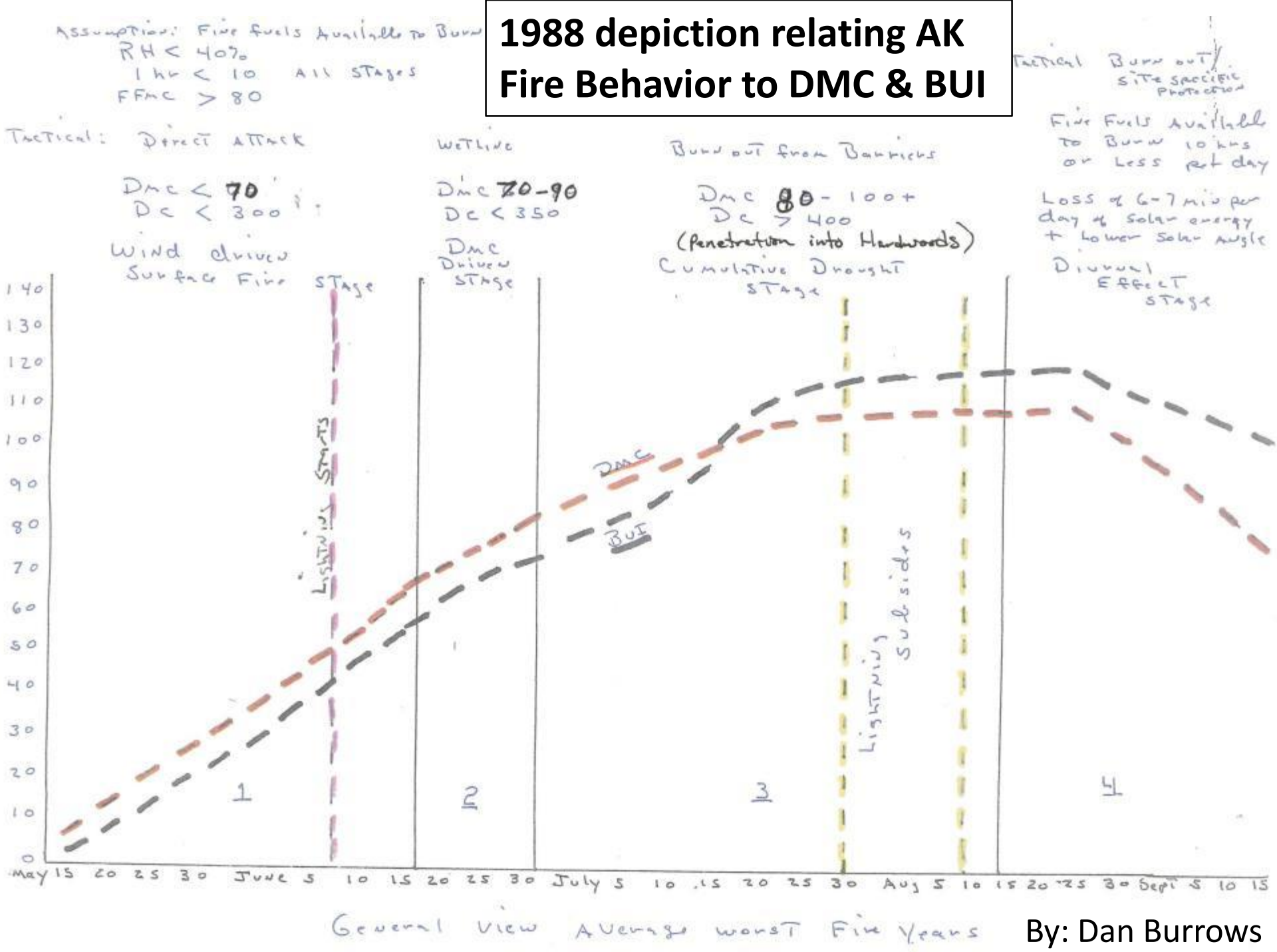
Fire Danger & Fire Behavior

In the Great Lakes and Alaska for 20 Years

glffc.utah.edu and akff.mesowest.org



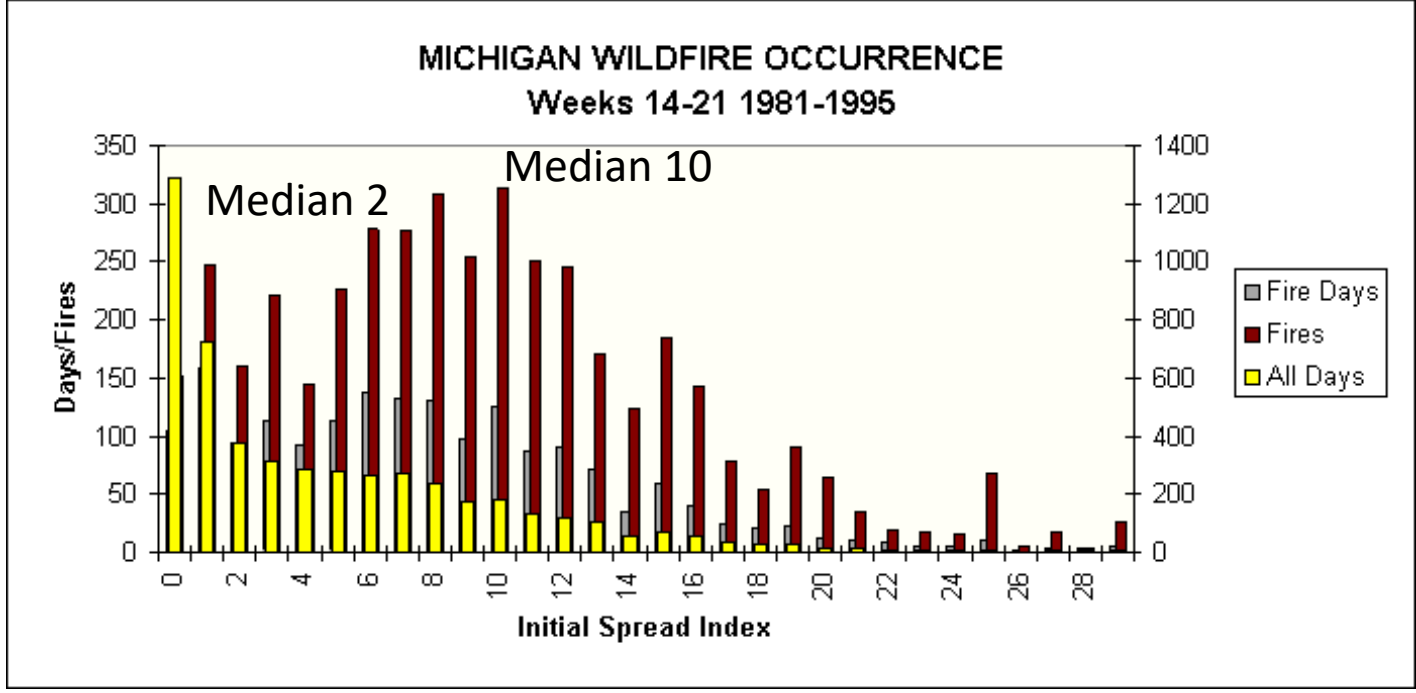
1988 depiction relating AK Fire Behavior to DMC & BUI

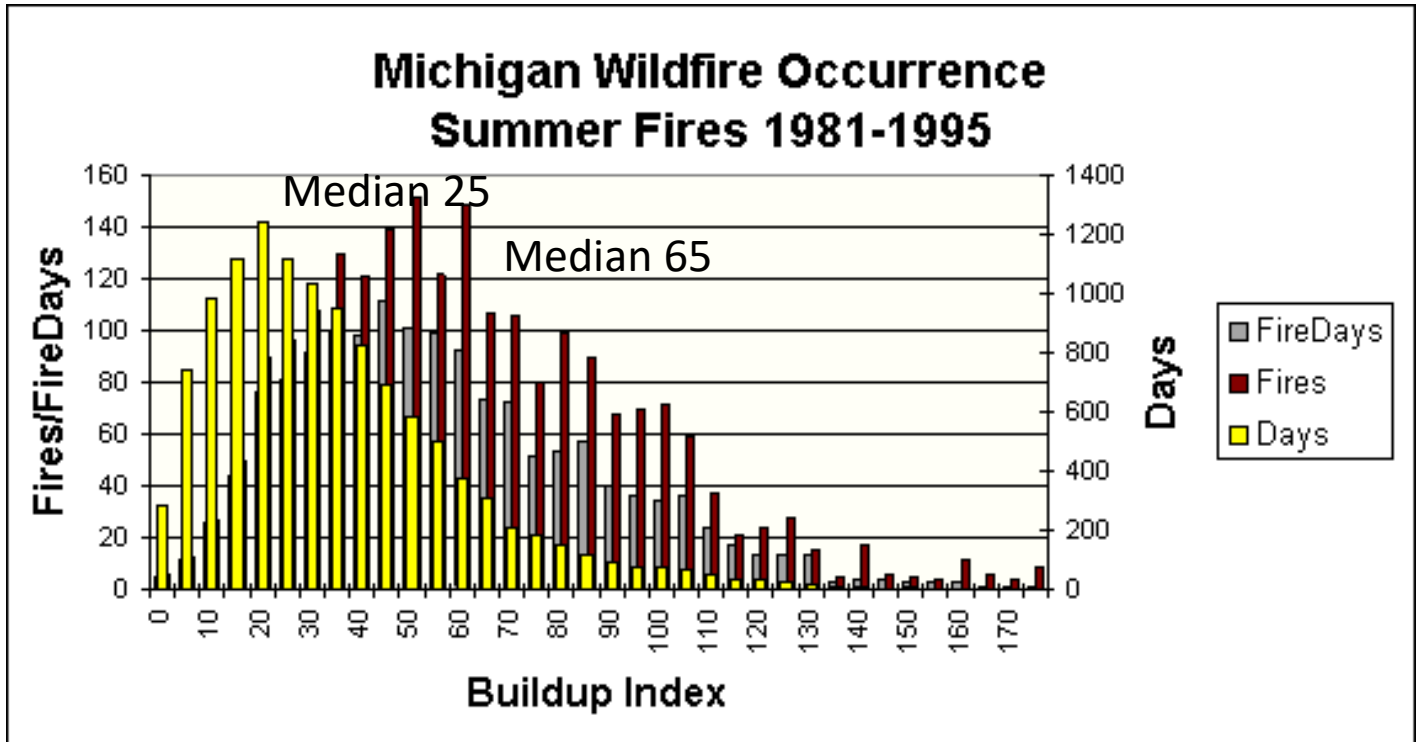


General View Average worst Fire Years

By: Dan Burrows

- **Michigan's calibration effort** in the late 1990s examined fire occurrence numbers
- **<u>Spring (pre-green) fires</u>** numbers were related to FFMC and ISI
- **<u>Summer fires</u>** were pre-disposed by BUI





MIDNR Forest, Mineral and Fire Management
ADJECTIVE CLASS MATRIX
May 19, 2004

SPRINGTIME ADJECTIVE RATINGS

Begin with Table 1. Using **Fine Fuel Moisture Code** (FFMC) and **Initial Spread Index** (ISI) calculated for today to find the appropriate adjective class. If instructed to use Table 2, determine the adjective rating using the **Fire Weather Index** (FWI) and **Fine Fuel Moisture Code** (FFMC).

TABLE 1	ISI = 0.0 to 1.9	ISI = 2.0 to 3.9	ISI = 4.0 to 7.9	ISI = 8.0+
FFMC = 0.0 to 74.9	LOW	MODERATE	HIGH	
FFMC = 75.0 to 84.9	MODERATE	MODERATE	HIGH	SEE TABLE 2
FFMC = 85.0+		HIGH	HIGH	SEE TABLE 2

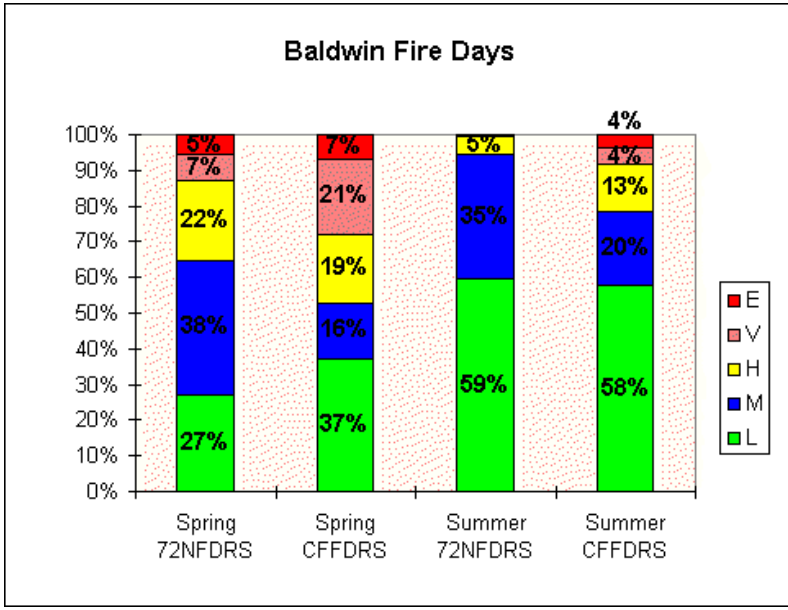
TABLE 2	FFMC < 92	FFMC = 92+
FWI Less Than 30.0	VERY HIGH	VERY HIGH
FWI = 30.0+	VERY HIGH	EXTREME

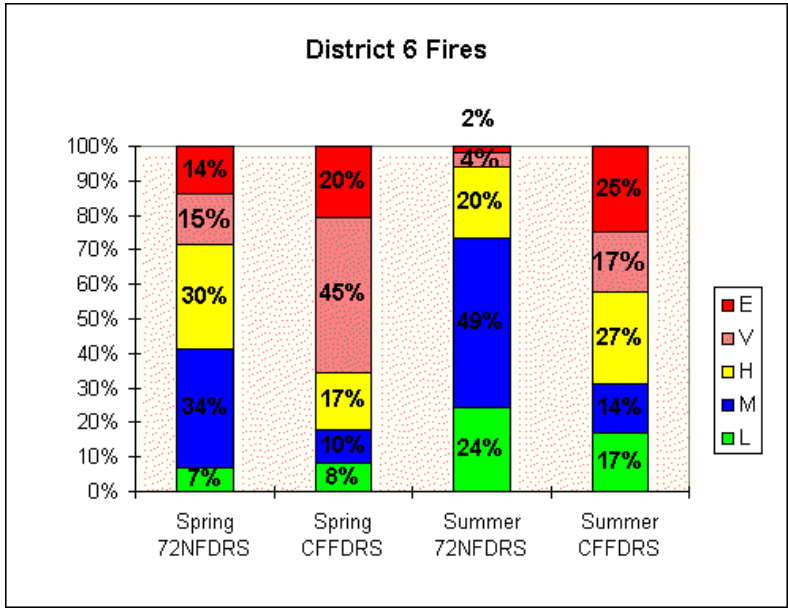
SUMMERTIME ADJECTIVE RATINGS

Generally, begin using the summer criteria on June 1. Begin with Table 3. Using **Buildup Index** (BUI) and **Initial Spread Index** (ISI), find the appropriate adjective class. If instructed to use Table 4, determine adjective class using the **Fire Weather Index** (FWI) and **Fine Fuel Moisture Code** (FFMC).

TABLE 3	ISI 0.0 to 1.9	ISI 2 to 2.9	ISI 3 to 3.9	ISI 4.0 to 5.9	ISI 6.0 to 7.9	ISI 8.0 to 9.9	ISI 10.0+
BUI=0.0 to 44.9	LOW			MODERATE		HIGH	
BUI=45.0 69.9	LOW		MODERATE		HIGH		VERY HIGH
BUI=70.0 to 99.9	LOW	MODERATE		HIGH		SEE TABLE 4	
BUI=100.0+	USE SPRING CRITERIA						

TABLE 4	FFMC < 92	FFMC = 92+
FWI Less Than 35.0	VERY HIGH	VERY HIGH
FWI = 35.0+	VERY HIGH	EXTREME





Minnesota "Pocket Card" puts interpretations in firefighter hands

Minnesota DEPARTMENT OF NATURAL RESOURCES

FFMC-Fine Fuel Moisture Code

0-80	Low
81-87	Moderate
88-90	High
91-92	Very High
93+	Extreme

75 Some surface fire spread.
80 Continuous fire spread.
90 Spot fires likely, easy ignition.
92 Extreme fire behavior

ISI-Initial Spread Index

0-4	Low
5-8	Moderate
9-11	High
12-18	Very High
19+	Extreme

<7 Primarily surface fire.
10 High rates of spread likely.
12 Torching more frequent.
20 Extreme fire behavior.

DMC-Duff Moisture Code

0-12	Low
13-27	Moderate
28-41	High
42-62	Very High
63+	Extreme

25 Duff burns, lightning starts become likely.
40 Moderate fire intensity.
50 Extreme fire behavior.
150 Most available fuel moisture is gone.

BUI-Build Up Index

0-19	Low
20-34	Moderate
35-54	High
55-76	VeryHigh
77+	Extreme

30 Heavier fuels involved in combustion.
60 Extended mop-up.
80 Extreme fire behavior in medium and heavier fuels, even with low ISI.
100 Lowland spruce can crown.

DC-Drought Code

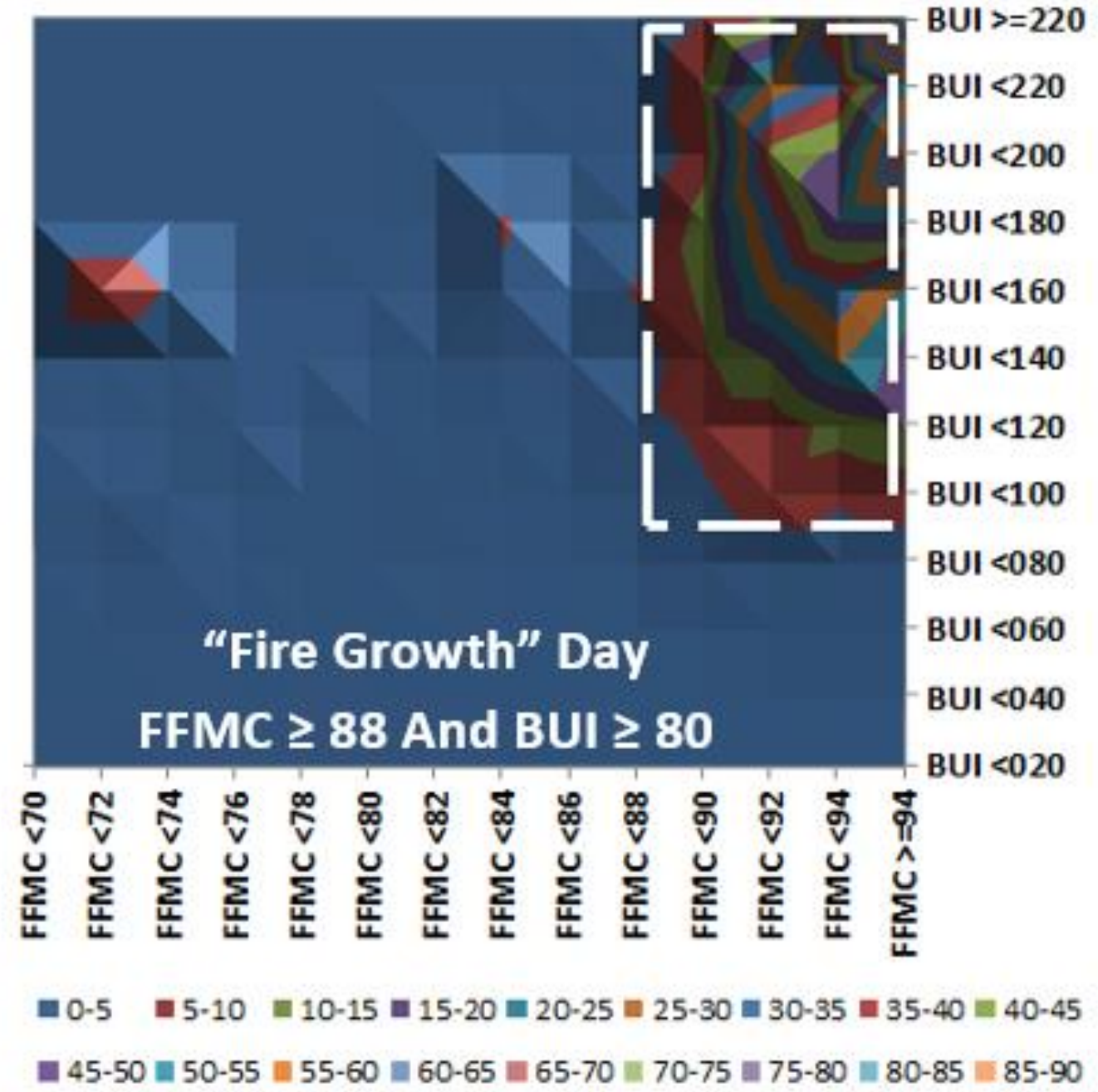
0-79	Low
80-209	Moderate
210-274	High
275-359	VeryHigh
360+	Extreme

15 Deep organic layers are saturated.
250 Extended mop-up, peat will burn.
300 Deep burning, more persistent fires.

FWI-Fire Weather Index

0-5	Low	Creeping surface fire
6-14	Moderate	Low to moderate spread
15-21	High	Torching, spotting, intermittent crowning.
22-32	VeryHigh	Active crowning possible
33+	Extreme	Major fire development possible

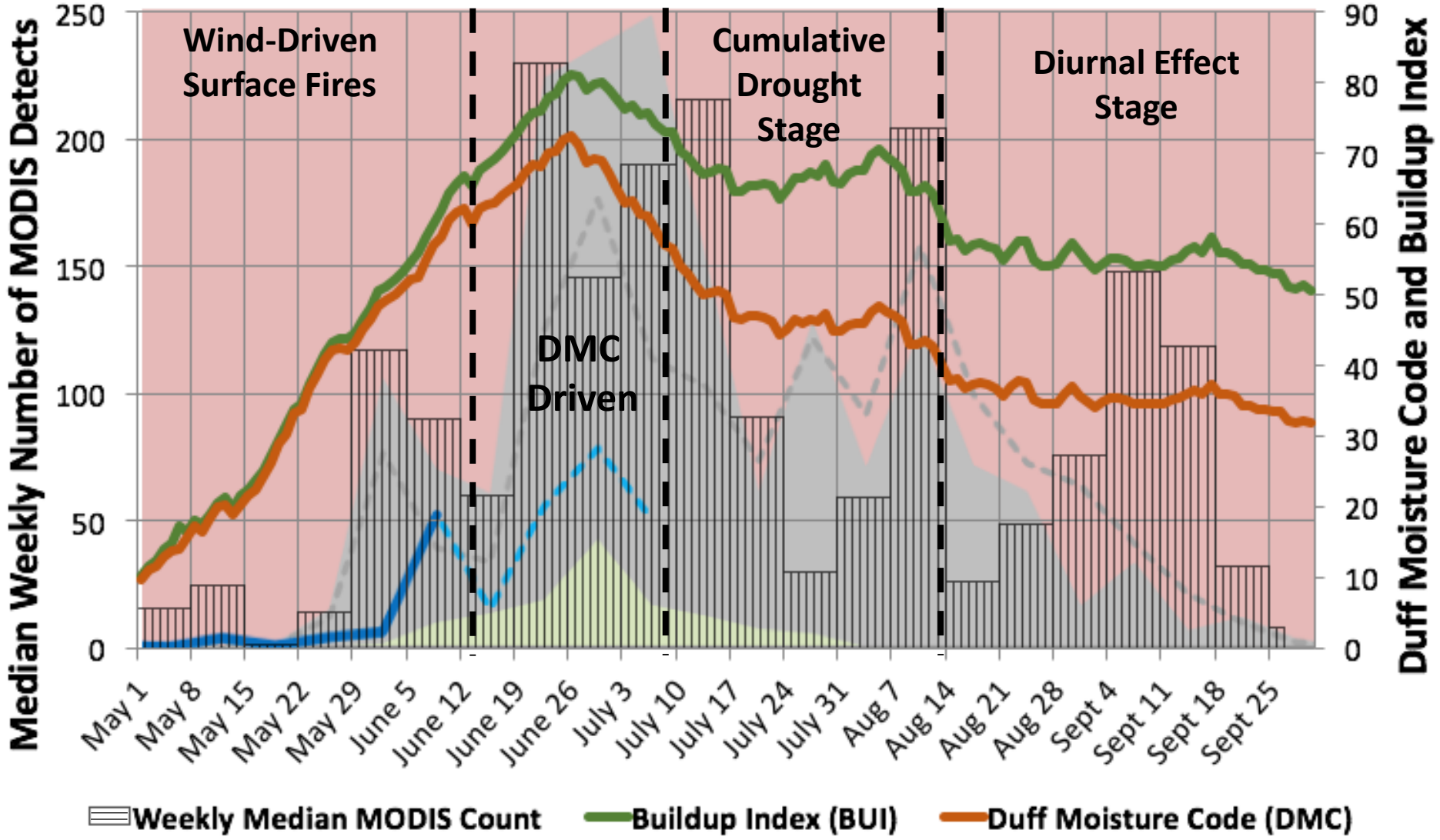
BUI & FFMC: MODIS Fire Detection Likelihood in AK



Both ***cumulative drying*** of fuel beds (as represented by Buildup Index or BUI) and ***current weather*** (as represented by Fine Fuel Moisture Code or FFMC), contribute to the onset and size of Growth Events in this Boreal Landscape

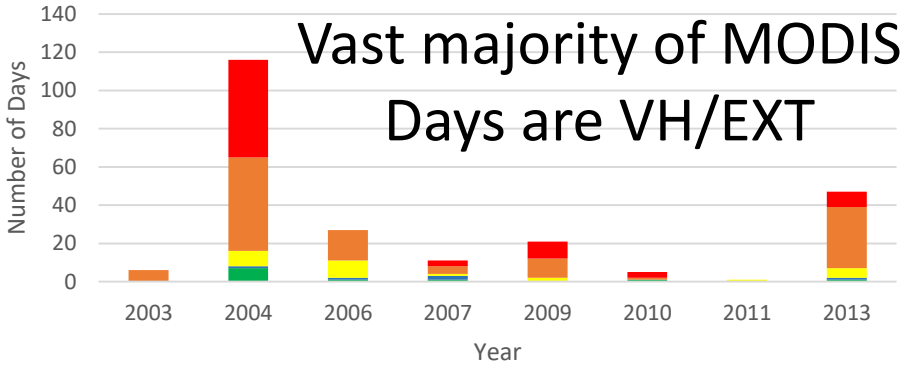
Daily Average DMC and BUI, 1994-2013

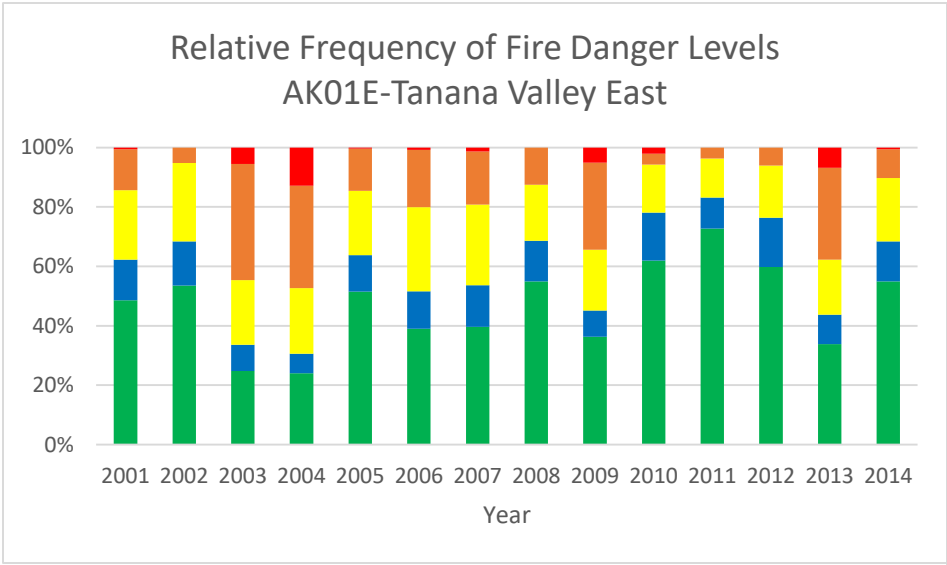
AK02 (Yukon Flats & Surrounding Uplands)

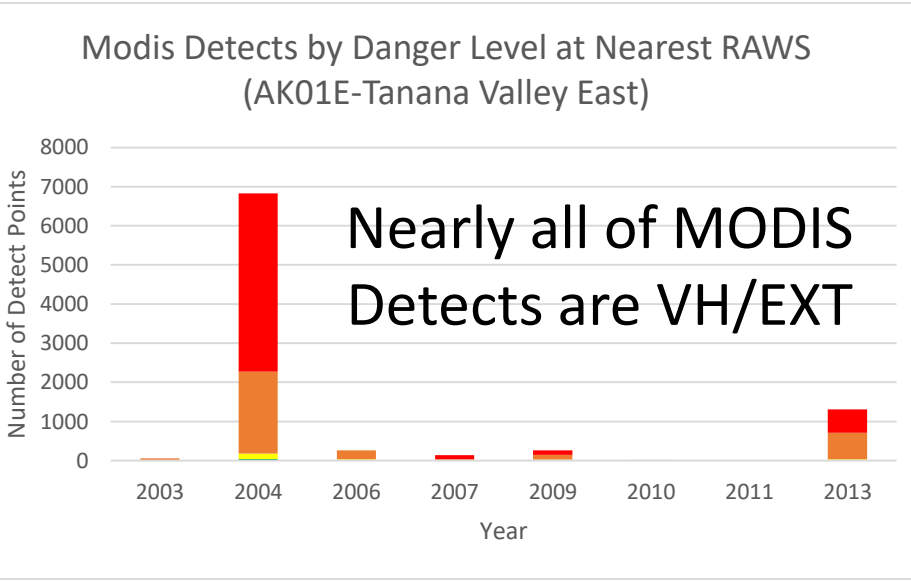


AK Summer (or Spruce) Adjectives

SPRUCE (Summer)	BUI < 40.0	BUI 40.0 to 59.9	BUI 60.0 to 89.9	BUI 90.0 to 109.9	BUI 110.0+
FFMC Less than 80.0	LOW	LOW	LOW	LOW	LOW
FFMC 80.0 to 81.9					MODERATE
FFMC 82.0 to 83.9				MODERATE	
FFMC 84.0 to 85.9		MODERATE	MODERATE		HIGH
FFMC 86.0 to 88.9	MODERATE		HIGH	HIGH	
FFMC 89.0 to 89.9	HIGH	HIGH		VERY HIGH	VERY HIGH
FFMC 90.0 to 91.9			VERY HIGH		
FFMC 92.0 to 92.9					
FFMC 93.0+ and Temp < 75.0			VERY HIGH if FWI is less than 36.0	VERY HIGH if FWI is less than 36.0	VERY HIGH if FWI is less than 28.0
FFMC 93.0+ and Temp 75.0 to 79.9		VERY HIGH if FWI is less than 40.0	EXTREME if FWI is at least 36.0	EXTREME if FWI is at least 36.0	EXTREME if FWI is at least 28.0
FFMC 93.0+ And Temp 80.0+	VERY HIGH if FWI <40	EXTREME if FWI is at least 40.0			
	EXTREME if FWI is at least 40.0				

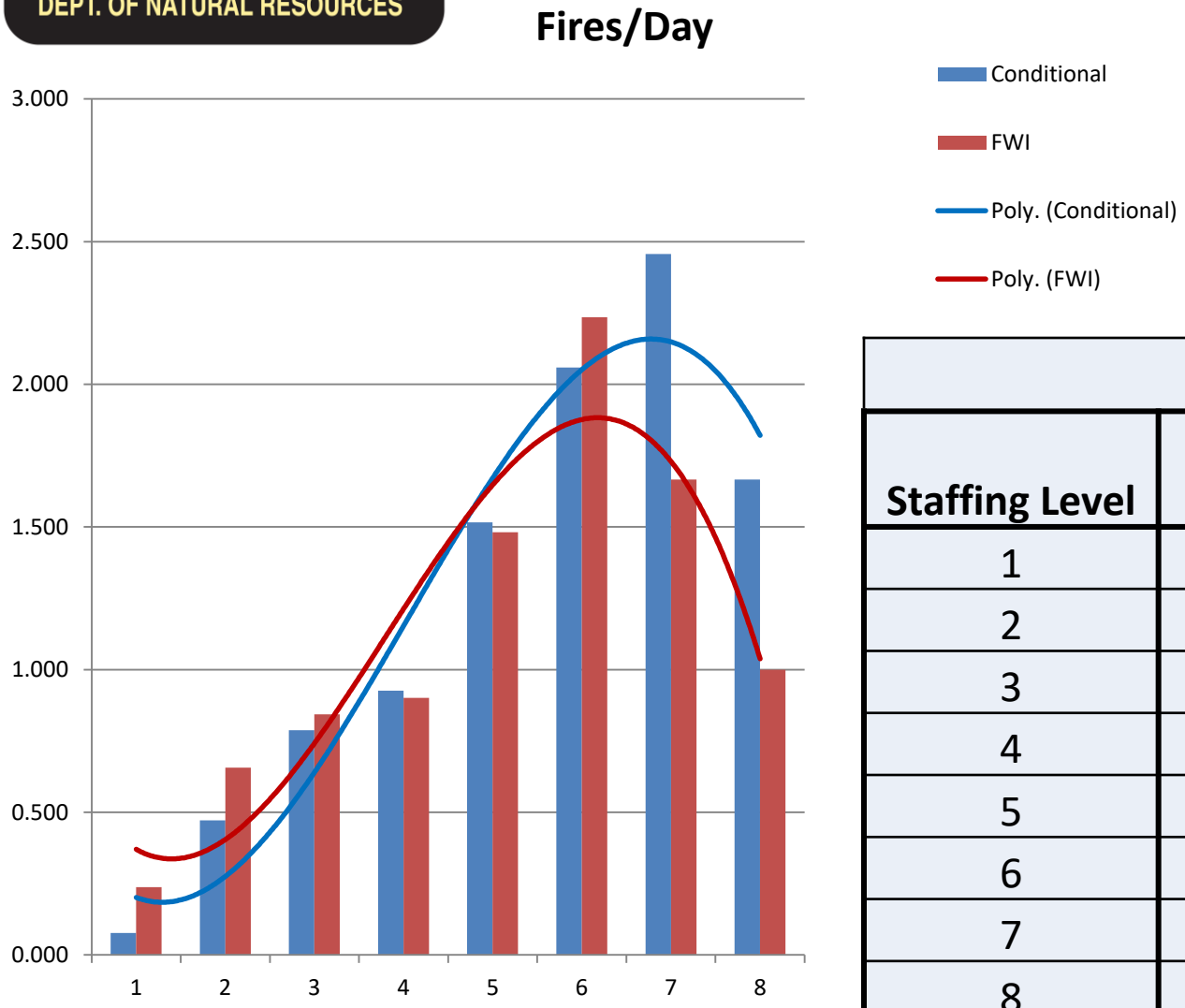






Wisconsin Calibration

Identifies 8 level readiness and response system



Fires/Day		
Staffing Level	**Conditional**	**FWI**
1	0.077	0.238
2	0.472	0.656
3	0.788	0.844
4	0.926	0.901
5	1.516	1.481
6	2.059	2.235
7	2.457	1.667
8	1.667	1.000

Integration of FWI Indices in Fire Behavior Prediction (FBP) Tools

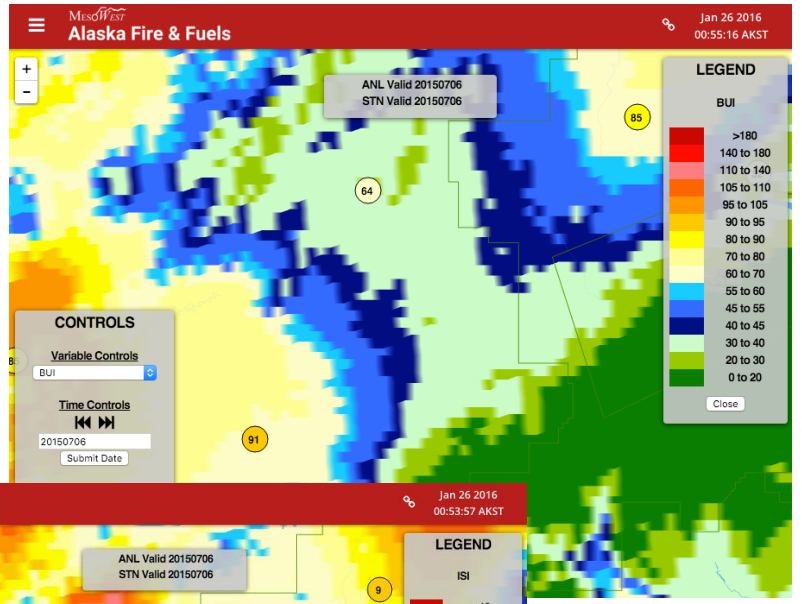
2.5.5 C-2, Boreal Spruce

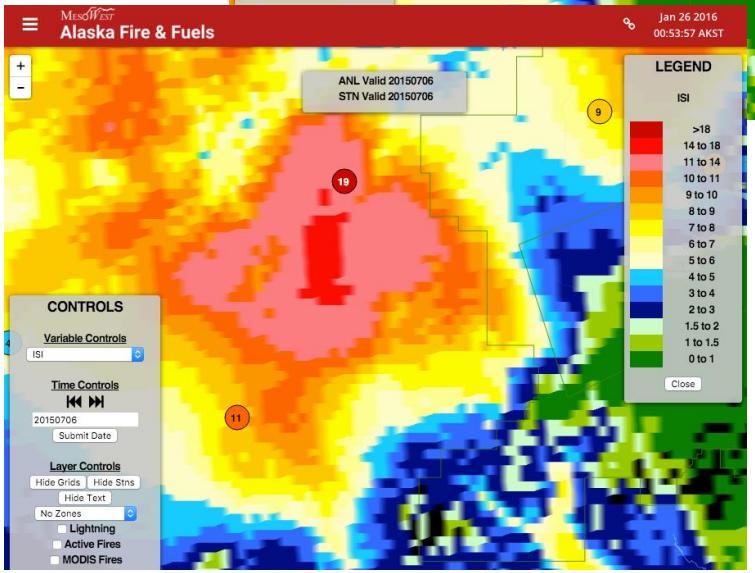
Open, Rate of Spread in ch/hr
Multiply by 1.1 to get feet/min
Divide by 80 to get miles/hour
Divide by 3 to get meters/min
Torching, **Active Crown Fire**

Intensity Class		Flame Length	FLI kW/m	FLI BTU/ft/sec
1	up to	1	10	3
2	up to	4	500	145
3	up to	8	2000	578
4	up to	12	4000	1156
5	up to	18	10000	2891
6	> than	18	10000	2891

ISI \ Buildup Index (BUI)	10	30	50	70	90	110	130	150	170	190
1	0.3	1	1	2	2	2	2	2	2	2
2	0.9	3	4	4	5	5	5	5	5	5
3	2	6	7	8	8	9	9	9	9	9
4	3	8	11	12	12	13	13	13	14	14
5	4	11	15	16	17	18	18	18	19	19
6	5	15	19	21	22	23	23	24	24	24
7	6	18	23	26	27	28	29	29	30	30
8	7	22	28	31	32	34	34	35	35	36
9	8	25	32	36	38	39	40	41	41	42
10	9	29	37	41	43	45	46	47	48	48
11	10	33	42	46	49	51	52	53	54	54
12	11	37	47	52	55	57	58	59	60	61
13	12	41	52	57	61	63	64	66	66	67
14	14	45	57	63	66	69	70	72	73	74
15	15	49	62	68	72	75	77	78	79	80
16	16	52	66	74	78	81	83	84	85	86
17	17	56	71	79	84	87	89	91	92	93
18	18	60	76	84	89	93	95	97	98	99
19	20	64	81	90	95	99	101	103	104	105
20	21	68	86	95	101	104	107	109	111	112
21	22	72	91	100	106	110	113	115	117	118
22	23	75	95	106	112	116	119	121	123	124
23	24	79	100	111	117	122	125	127	129	130
24	25	83	105	116	123	127	130	133	135	136
25	26	86	109	121	128	133	136	139	141	142
26	27	90	114	126	133	138	142	144	146	148
27	28	93	118	131	138	143	147	150	152	154
28	29	97	122	136	144	149	153	155	158	159
29	30	100	127	140	149	154	158	161	163	165
30	31	103	131	145	153	159	163	166	168	170
31	32	106	135	150	158	164	168	171	174	176
32	33	110	139	154	163	169	173	176	179	181
33	34	113	143	158	168	174	178	181	184	186
34	35	116	147	163	172	179	183	186	189	191
35	36	119	151	167	177	183	188	191	194	196
36	37	122	155	171	181	188	193	196	199	201
37	38	125	158	175	185	192	197	201	204	206
38	39	128	162	179	190	197	202	205	208	210
39	40	130	165	183	194	201	206	210	213	215
40	41	133	169	187	198	205	210	214	217	220

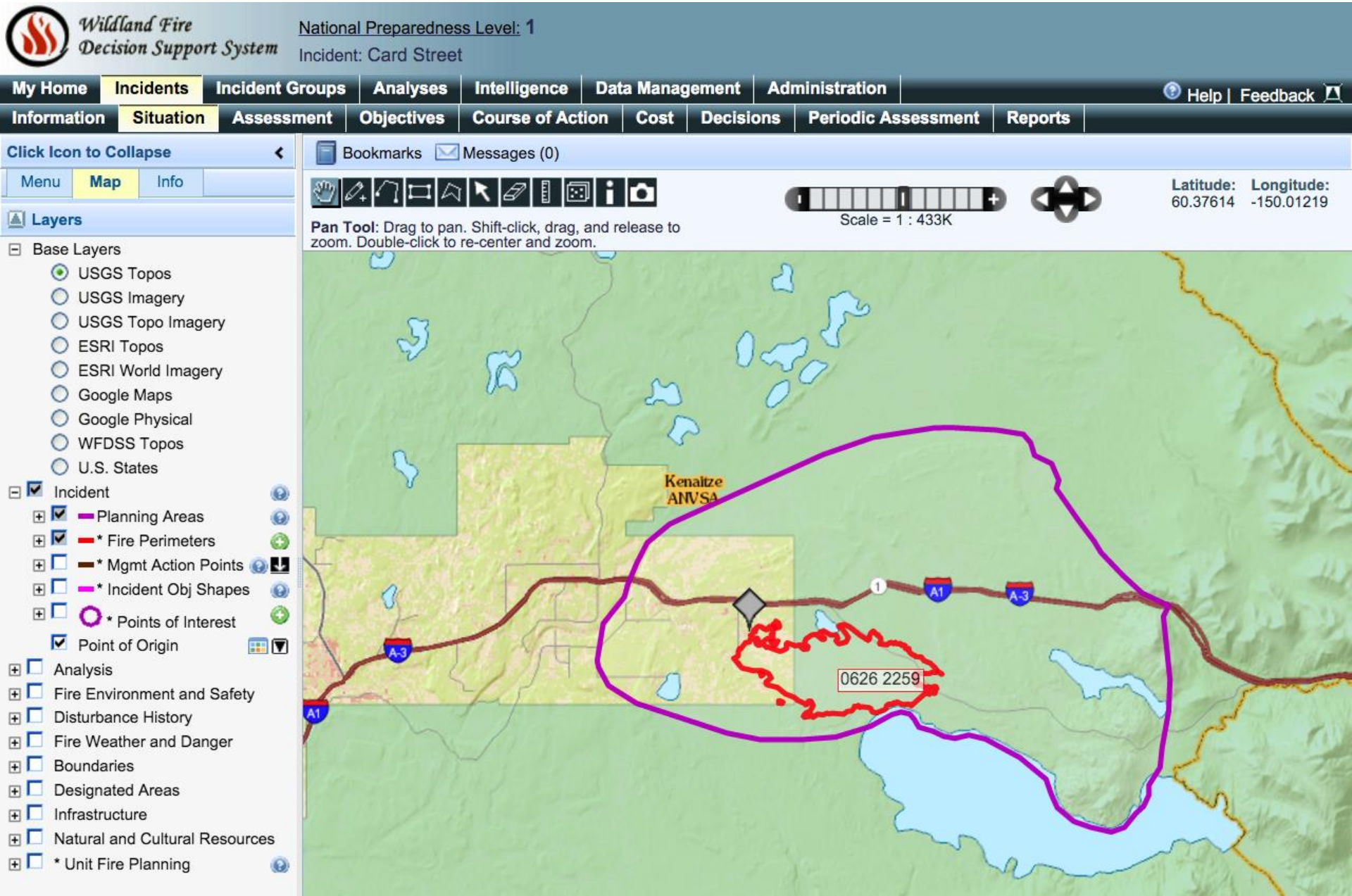
BUI and ISI are direct inputs to FBP Tables





Inputs from daily FWI reports serve prediction

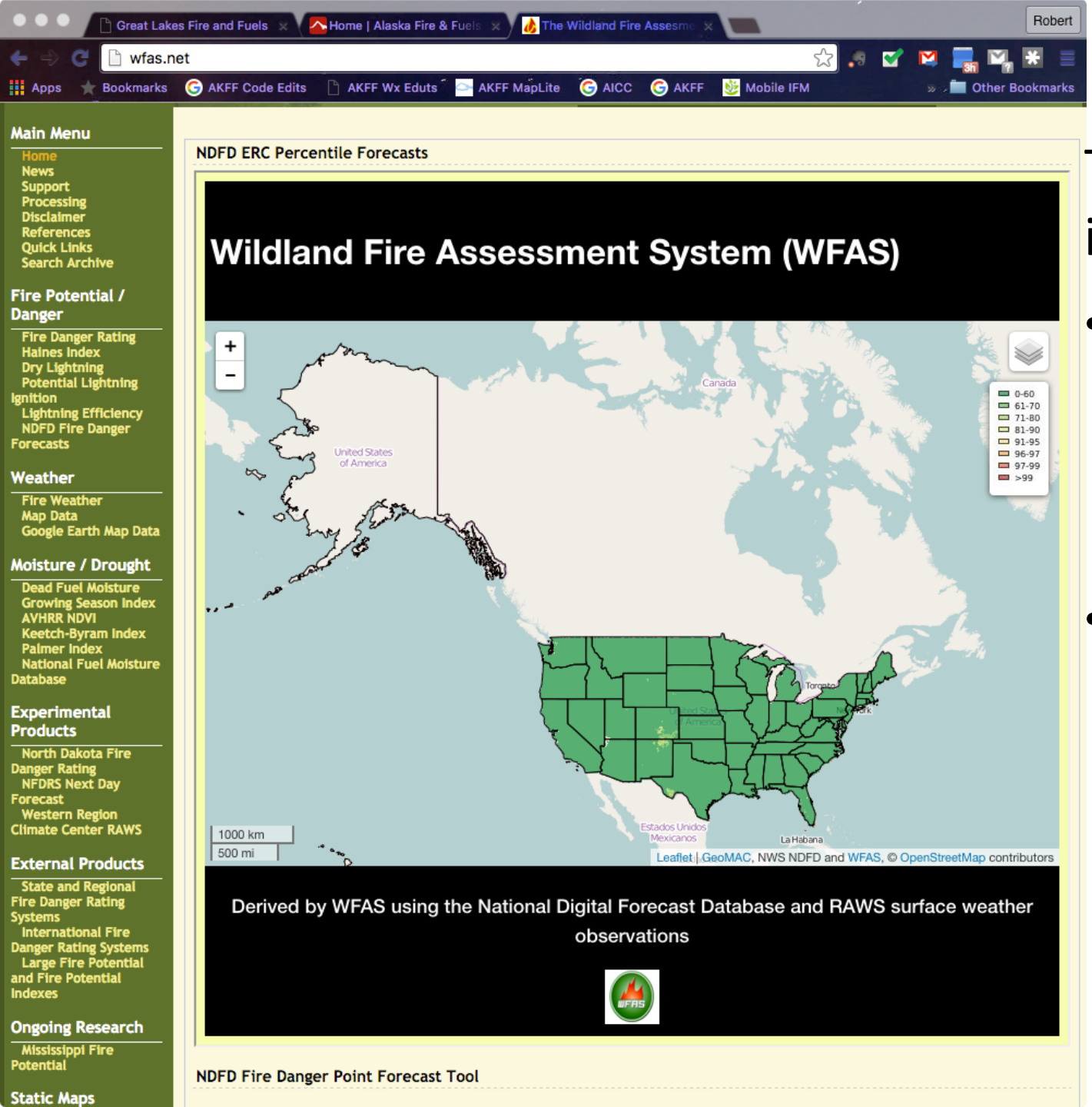
Wildland Fire Decision Support System (WFDSS)



NFDRS 2016

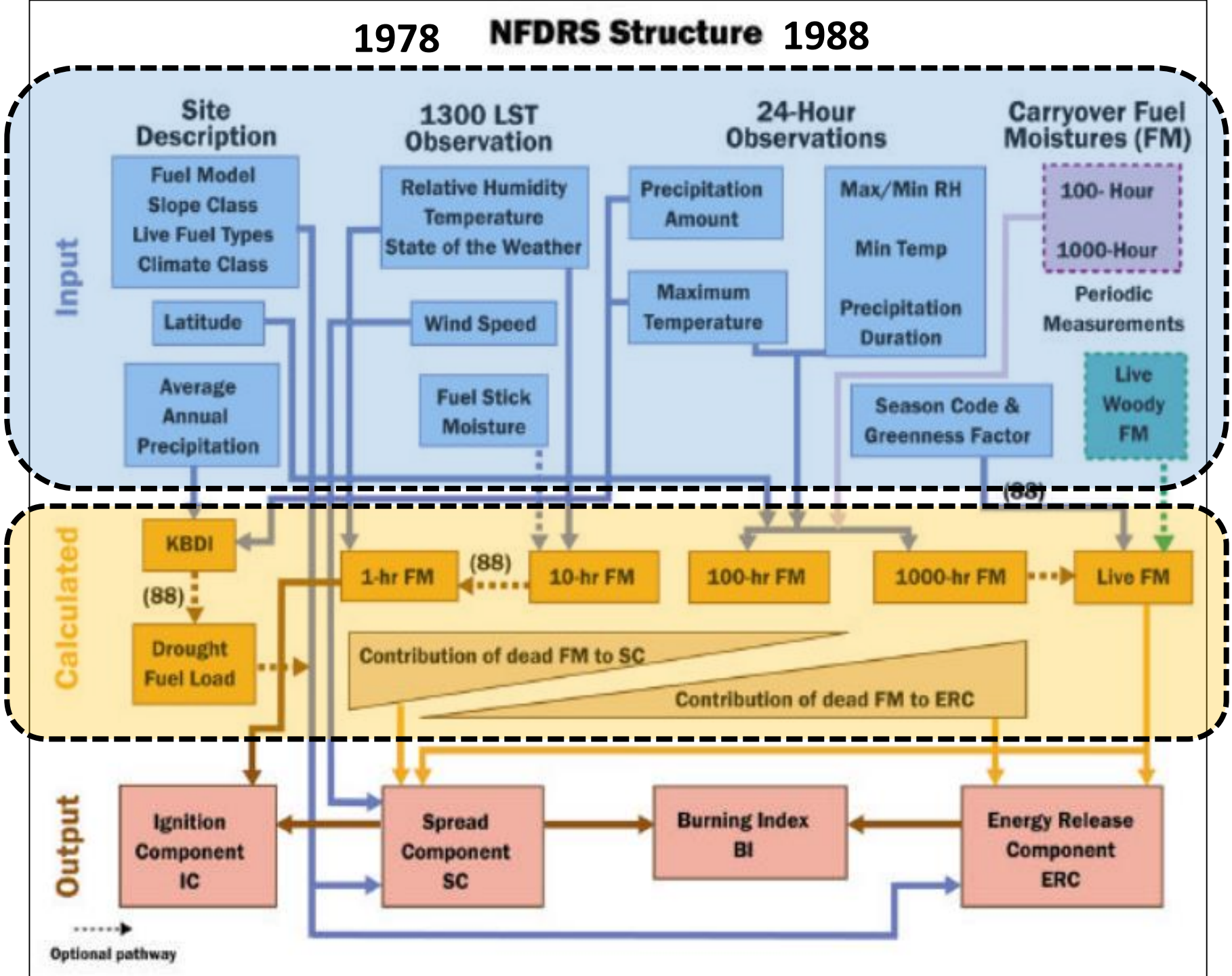
- Important revisions to our national system
- Expected online this year
- 78/88 NFDRS systems to be discontinued

NFDRS



The new system is of interest.

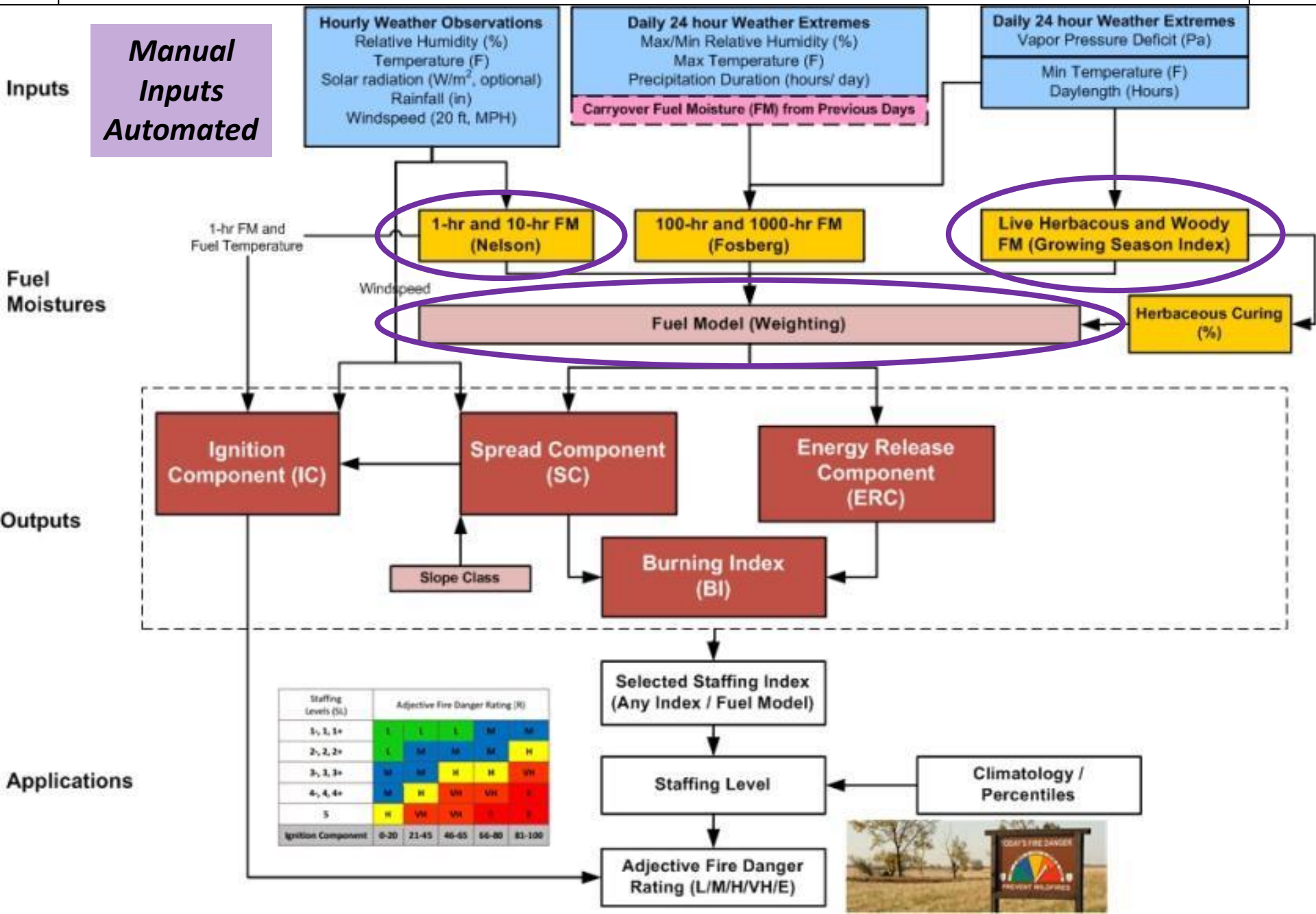
- We already use NFDRS fuel moistures in every **WFDSS analysis**
- When we travel to other states, we hear **NFDRS indices** in daily reports and interpret **pocket cards** that use ERC and BI

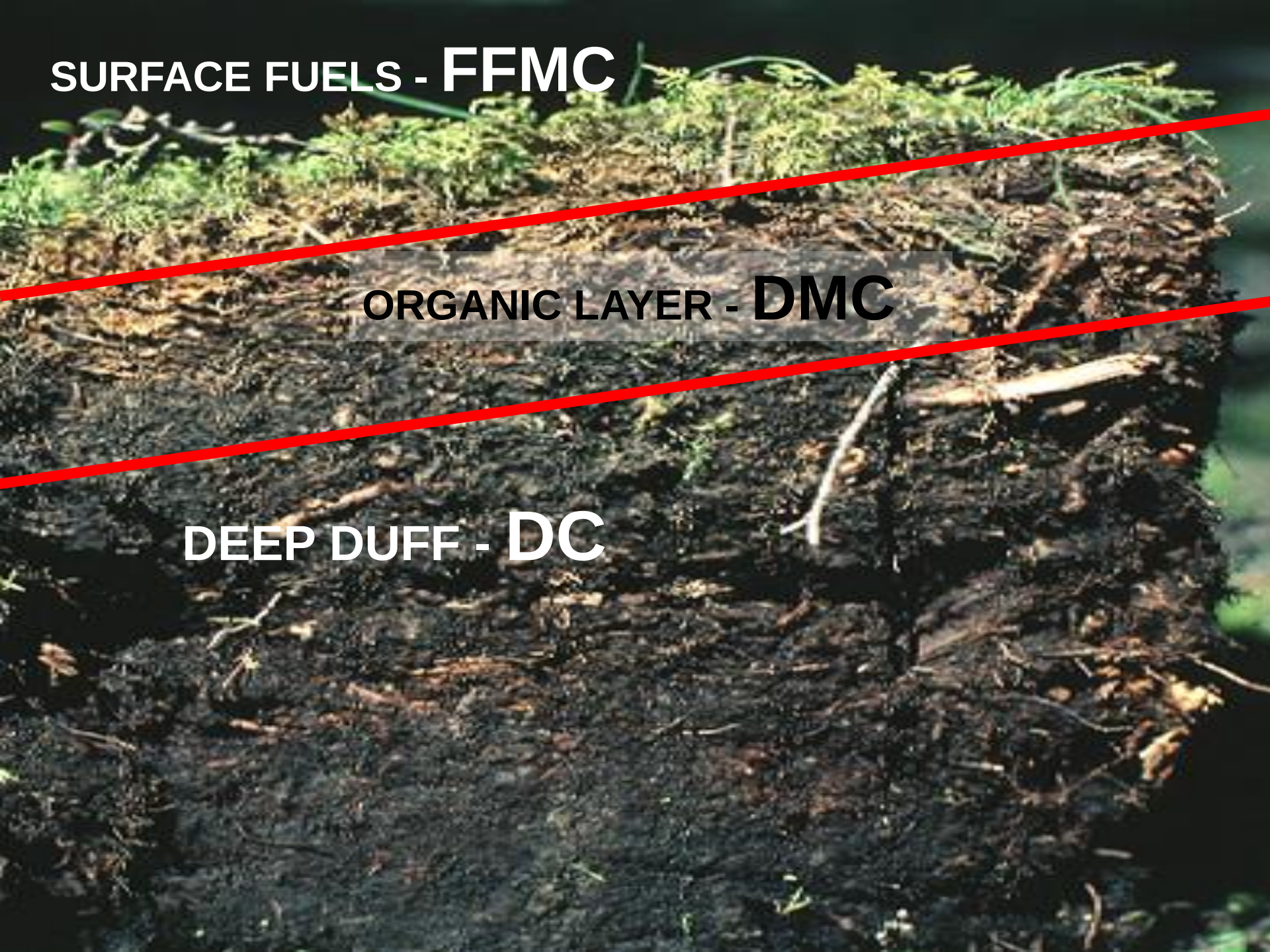

1978 NFDRS Structure 1988
Input
Site Description
Fuel Model
Slope Class
Live Fuel Types
Climate Class
Latitude
Average Annual Precipitation
1300 LST Observation
Relative Humidity
Temperature
State of the Weather
Wind Speed
Fuel Stick Moisture
24-Hour Observations
Precipitation Amount
Maximum Temperature
Max/Min RH
Min Temp
Precipitation Duration
Carryover Fuel Moistures (FM)
100- Hour
1000-Hour
Periodic Measurements
Season Code & Greenness Factor
Live Woody FM
(88)
Calculated
KBDI
(88)
Drought Fuel Load
1-hr FM
(88)
10-hr FM
100-hr FM
1000-hr FM
Live FM
Contribution of dead FM to SC
Contribution of dead FM to ERC
Output
Ignition Component IC
Spread Component SC
Burning Index BI
Energy Release Component ERC
Optional pathway

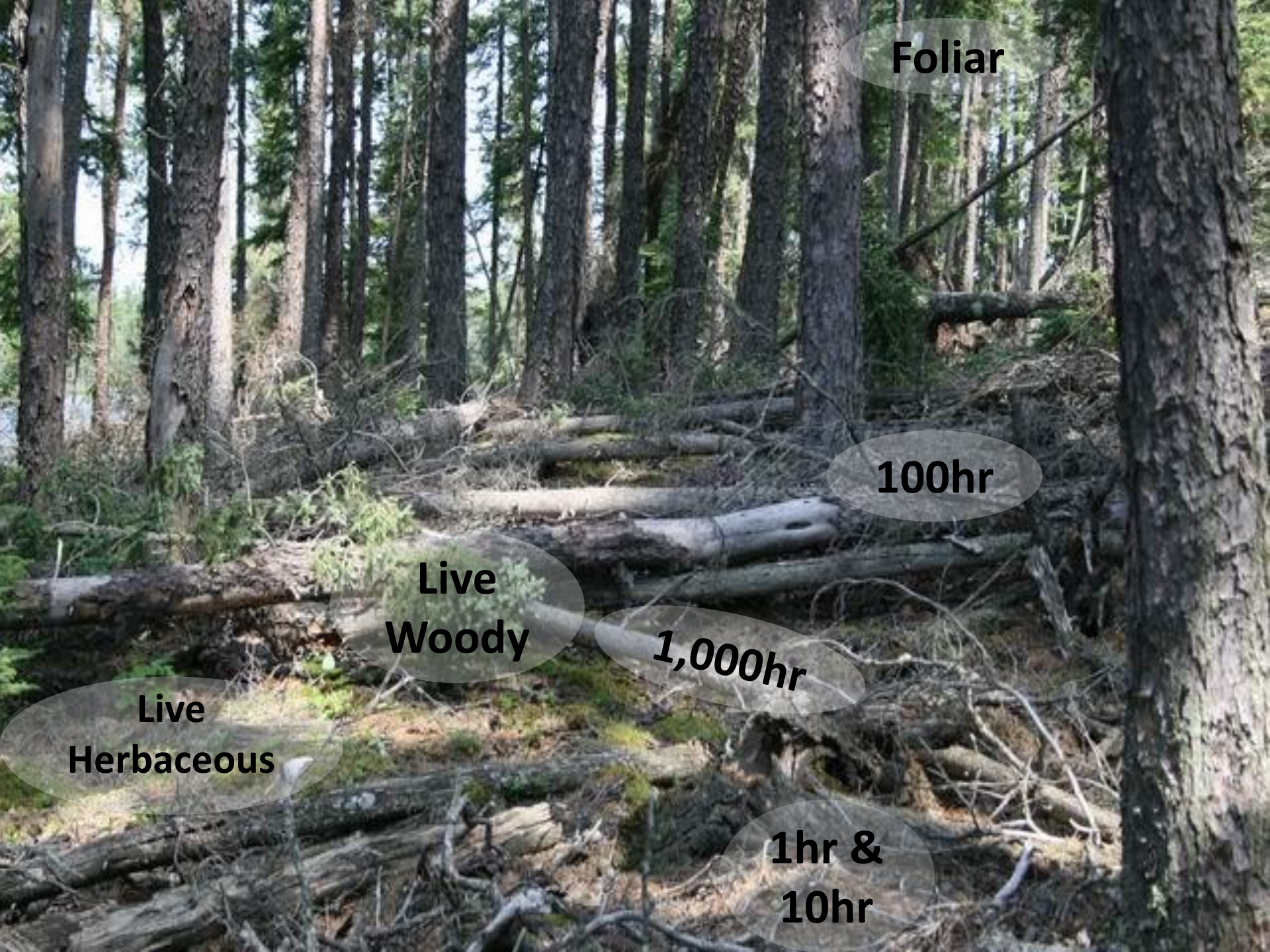
NFDRS 2016 Revision
Significant Changes

- **Dead Fuel Moisture Model Change**: Fosberg Model replaced by Nelson Model for at least the 1hr and 10hr fuel moistures. *Already in WFDSS STFB & NTFB*
- **Live Fuel Moisture Model Changes**: Herbaceous and Woody Fuel Moistures now based on Growing Season Index (GSI), which is calculated directly from Daylength, Minimum Daily Temperature, and Vapor Pressure Deficit. *Already in all WFDSS analyses*
- **Fire Danger Fuel Model Changes**: Reduction in the number of fuel models from 40 to 5.
- **Elimination of Manual Inputs** to reduce errors and facilitate automated calculation of outputs on gridded basis

NFDRS 2016 Revision




SURFACE FUELS - FFMC
ORGANIC LAYER - DMC
DEEP DUFF - DC


Foliar
100hr
Live
Woody
1,000hr
Live
Herbaceous
1hr &
10hr

Fire Weather Index (FWI) System	Fuel Moisture	National Fire Danger Rating System (NFDRS)
Fine Fuel Moisture Code (FFMC), offers both daily and hourly versions ***Grass Fuel Moisture [Code] (GFM or GFMC),*** is not in daily FWI. It adds solar radiation to hourly calcs	**Dead Fine Fuel Moisture Categories**	***1-hr Fuel Moisture (%)*** and ***10-hr Fuel Moisture (%);*** new calculations require hourly input including solar radiation.

Fire Weather Index (FWI) System	Fuel Moisture	National Fire Danger Rating System (NFDRS)
Fine Fuel Moisture Code (FFMC), offers both daily and hourly versions ***Grass Fuel Moisture [Code] (GFM or GFMC),*** is not in daily FWI. It adds solar radiation to hourly calcs	**Dead Fine Fuel Moisture Categories**	***1-hr Fuel Moisture (%)*** and ***10-hr Fuel Moisture (%);*** new calculations require hourly input including solar radiation.
Duff Moisture Code (DMC), has a timelag of 15 days, analogous to a 300 hr timelag fuel moisture	**Intermediate Fuel Moisture Categories**	***100-hr Fuel Moisture (%)***, may employ the Nelson Model. ***Herbaceous Fuel Moisture (%)***, uses GSI (or LFI) to signal greenup and moisture content.

Fire Weather Index (FWI) System	Fuel Moisture	National Fire Danger Rating System (NFDRS)
Fine Fuel Moisture Code (FFMC), offers both daily and hourly versions ***Grass Fuel Moisture [Code] (GFM or GFMC),*** is not in daily FWI. It adds solar radiation to hourly calcs	**Dead Fine Fuel Moisture Categories**	***1-hr Fuel Moisture (%)*** and ***10-hr Fuel Moisture (%);*** new calculations require hourly input including solar radiation.
Duff Moisture Code (DMC), has a timelag of 15 days, analogous to a 300 hr timelag fuel moisture	**Intermediate Fuel Moisture Categories**	***100-hr Fuel Moisture (%)***, may employ the Nelson Model. ***Herbaceous Fuel Moisture (%)***, uses GSI (or LFI) to signal greenup and moisture content.
Drought Code (DC) has a timelag of 52 days, analogous to a 1200 hr timelag fuel moisture	**Slowly Changing Fuel Moisture Categories**	***1000-hr Fuel Moisture (%),*** may use Nelson too. ***Woody Fuel Moisture (%),*** will use GSI/LFI too ***Keetch-Byram Drought Index (KBDI),*** used to add fuel loads.

WFDSS Analysis Fuel Moisture Inputs

- All models use the old Fosberg model to initialize dead fuel moistures
- STFB and NTFB use the new NFDRS Nelson Model for conditioning fine fuels
- All the models use the new NFDRS GSI based live fuel moistures

Model	1 Hour FM	10 Hour FM	100 Hour FM	Herb FM	Woody FM
default	5	7	16	16[illegible]	18[illegible]

Delete

Wildland Fire Decision Support System — Help

Incident	Analysis	Analysis Date	Time
Pagami Creek	09-11 Review 8h S/R v2 1 conditioning day	09/11/2011	16:00

Wind Speed	Direction	RAWS Station
8 mph	328° azimuth	210509 - ELY MN

1 Hr Fuel Moisture Legend

Resolution: 60 meters Units: percent

Value	Freq
Non-burnable	49,923
6.00 - 7.00	50
7.00 - 8.00	19,791
8.00 - 9.00	165,792
9.00 - 10.00	282,585
10.00 - 11.00	277
No Data	2,466

Wildland Fire Decision Support System — Help

Incident	Analysis	Analysis Date	Time
Pagami Creek	09-11 Review 8h S/R v2 1 conditioning day	09/11/2011	16:00

Wind Speed	Direction	RAWS Station
8 mph	328° azimuth	210509 - ELY MN

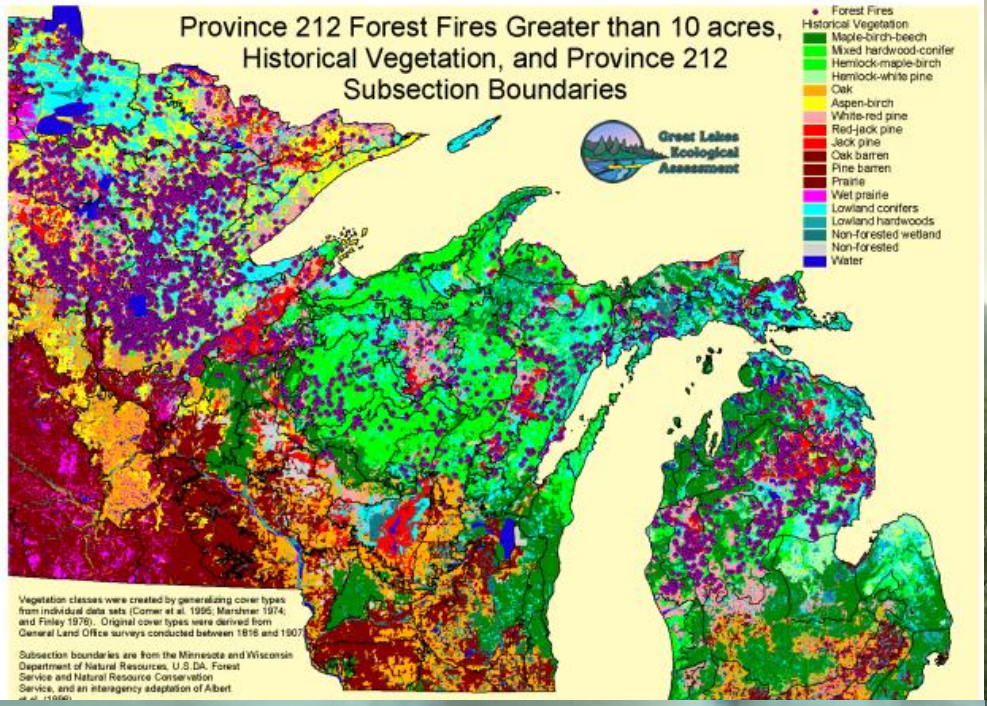
10 Hr Fuel Moisture Legend

Resolution: 60 meters Units: percent

Value	Freq
Non-burnable	49,923
11.00 - 12.00	10,310
12.00 - 13.00	26,676
13.00 - 14.00	312,387
14.00 - 15.00	119,121
15.00 - 16.00	1
No Data	2,466

Generate ERC Classes

%ile	Min ERC	1 Hour FM	10 Hour FM	100 Hour FM	Herb FM	Woody FM	Burn Period	Spot Prob	Delay
96	33	6.7	7.9	14.0	166.	178.	360	0.15	0
89	30	7.6	9.1	15.2	174.	184.	300	0.10	0
76	26	8.2	10.1	15.9	170.	180.	240	0.05	0
67	24	8.9	11.0	16.7	171.	182.	180	0.01	0
58	22	9.7	12.2	17.3	170.	181.	120	0.00	0


Province 212 Forest Fires Greater than 10 acres, Historical Vegetation, and Province 212 Subsection Boundaries
Great Lakes Ecological Assessment
Forest Fires
Historical Vegetation
Maple-birch-beech
Mixed hardwood-conifer
Hemlock-maple-birch
Hemlock-white pine
Oak
Aspen-birch
White-red pine
Red-jack pine
Jack pine
Oak barren
Pine barren
Prairie
Wet prairie
Lowland conifers
Lowland hardwoods
Non-forested wetland
Non-forested
Water
Vegetation classes were created by generalizing cover types from individual data sets (Comer et al. 1995; Marshner 1974; and Finley 1976). Original cover types were derived from General Land Office surveys conducted between 1816 and 1907.
Subsection boundaries are from the Minnesota and Wisconsin Department of Natural Resources, U.S.DA. Forest Service and Natural Resource Conservation Service, and an interagency adaptation of Albert


Bruno Fire (AK), June 29, 2015
15,131 Acres Burned over 2 weeks


Duck Lake (MI) Fire, May 24/25, 2012
21,135 Acres Burned

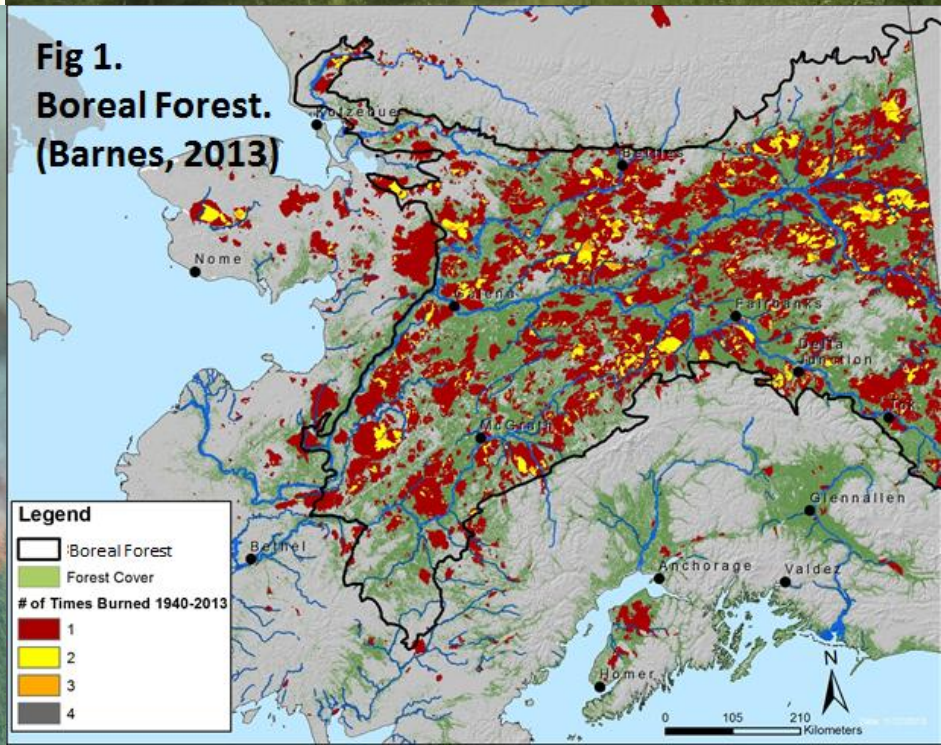
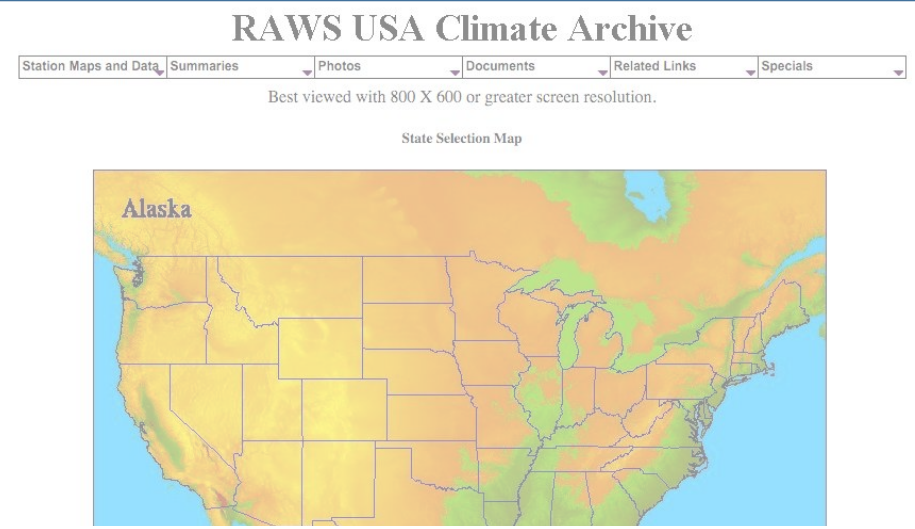
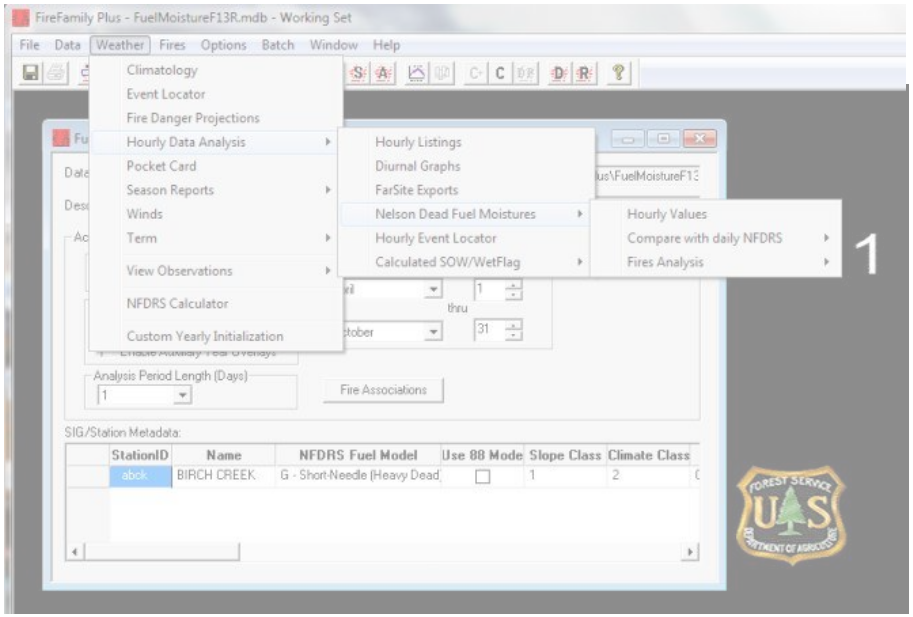


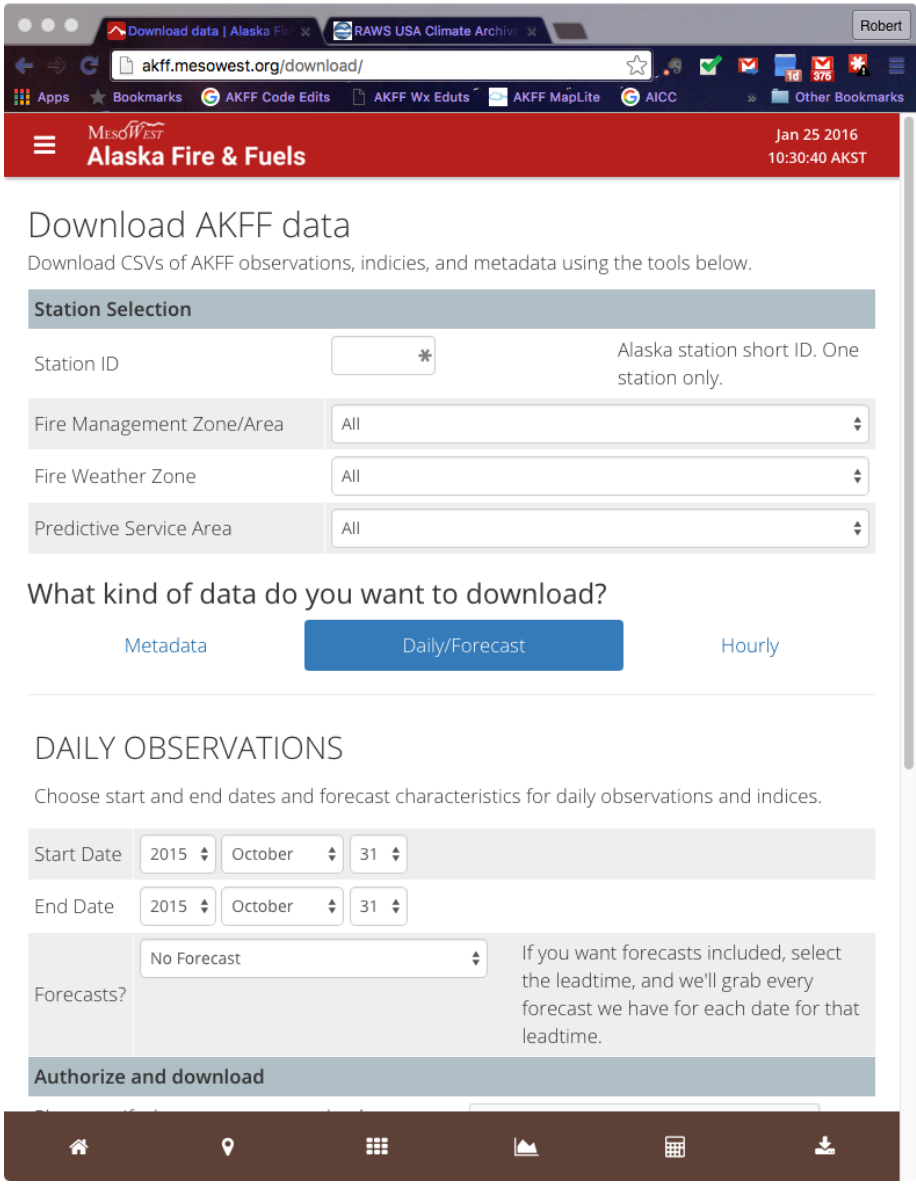
Fig 1.
Boreal Forest.
(Barnes, 2013)
Kotzebue
Nome
Fairbanks
Delta Junction
McGrath
Glennallen
Bethel
Anchorage
Valdez
Homer
Legend
Boreal Forest
Forest Cover
# of Times Burned 1940-2013
1
2
3
4
N
0
105
210
Kilometers

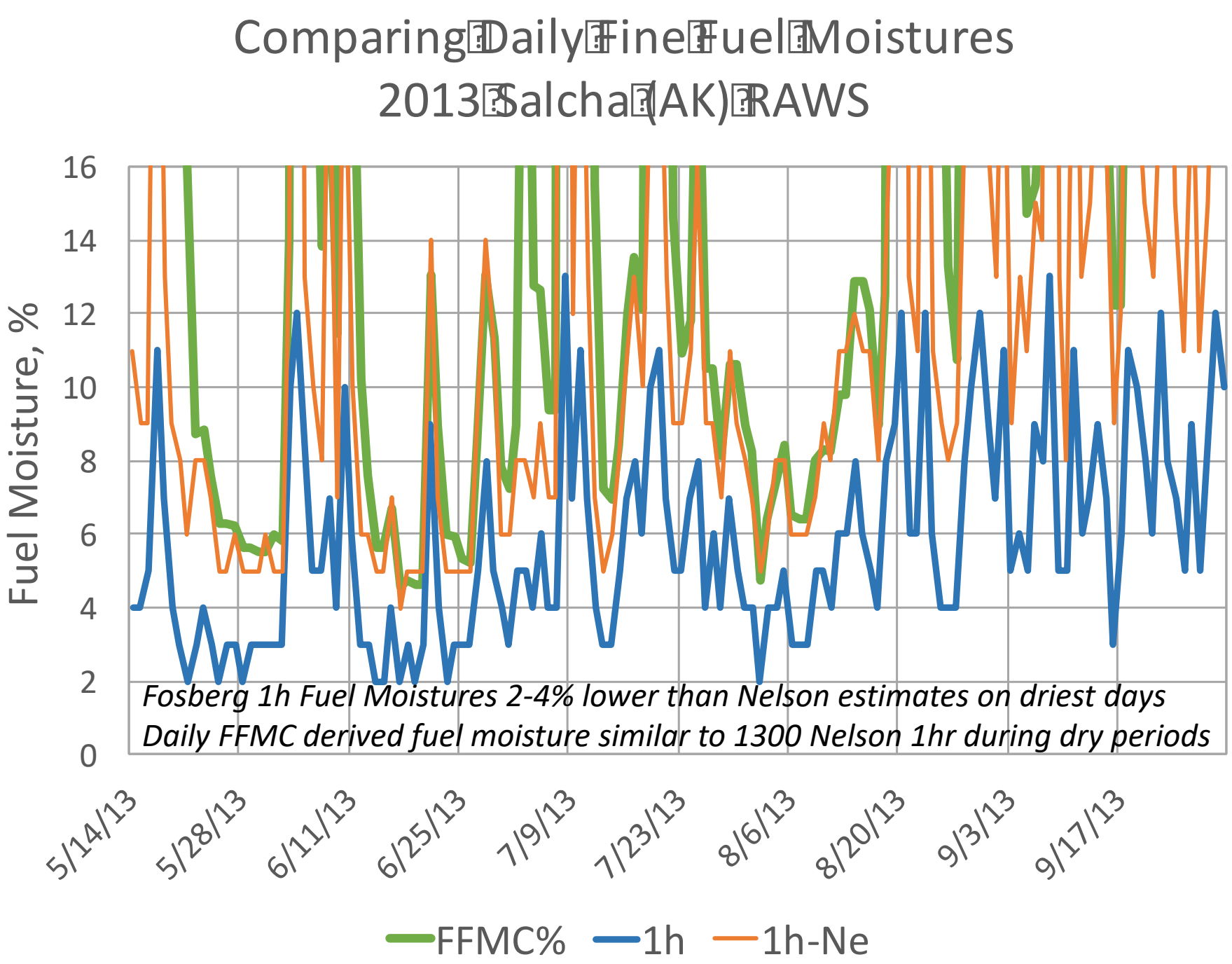


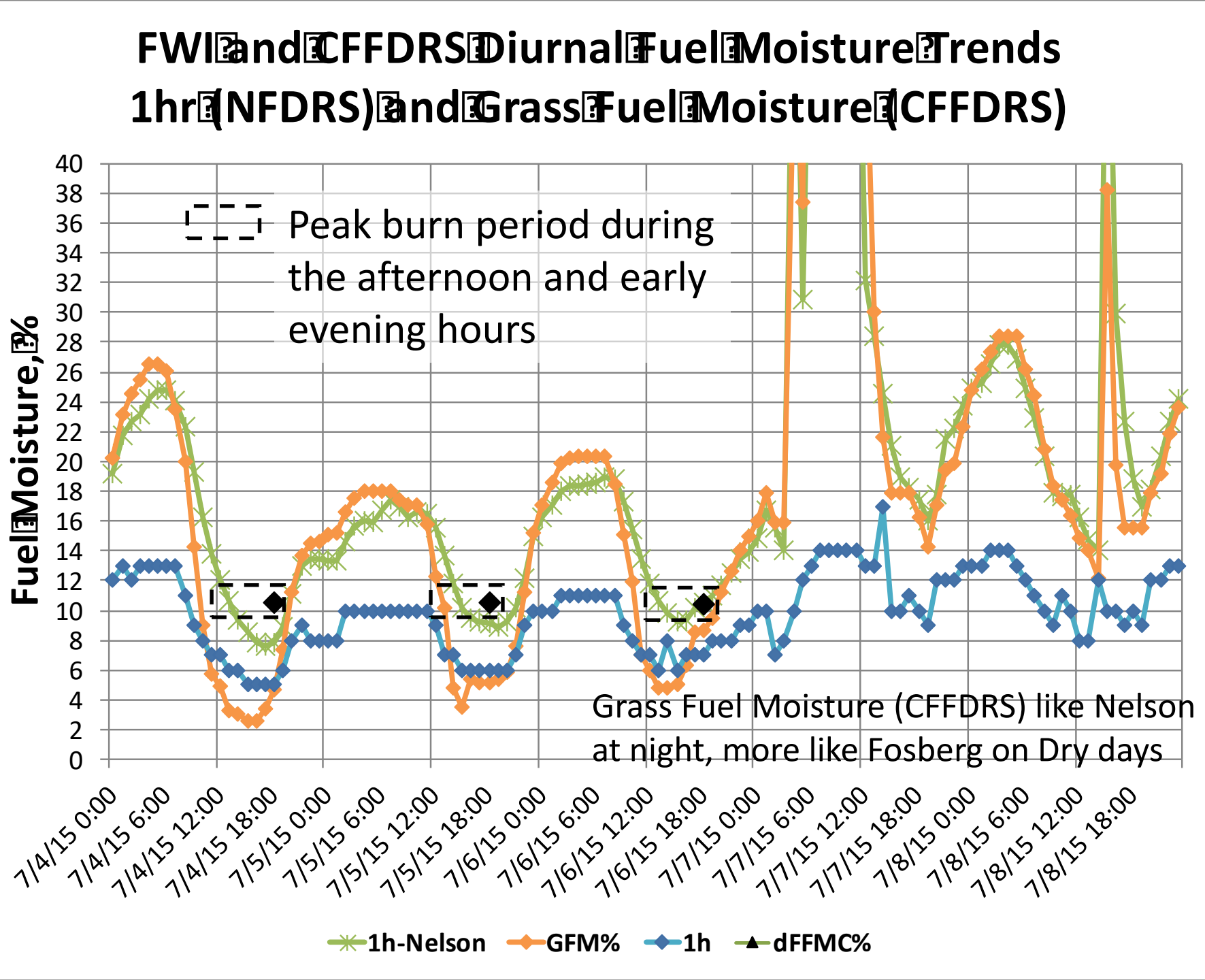
Hourly RAWS data downloaded from wrcc.dri.edu/wraws, edited to insure proper hour used as daily obs ("O" record) and processed with FFPlus 4.1

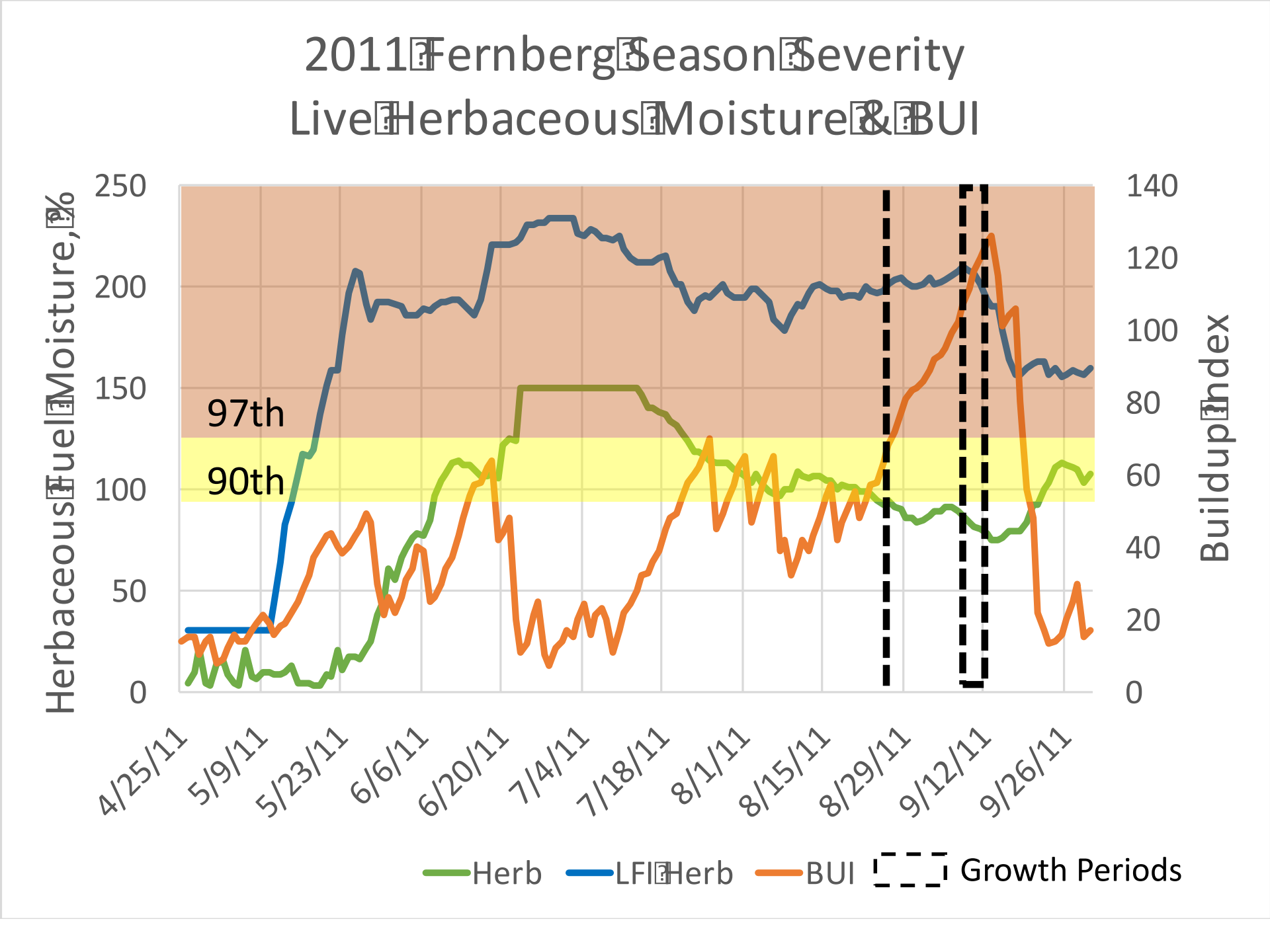


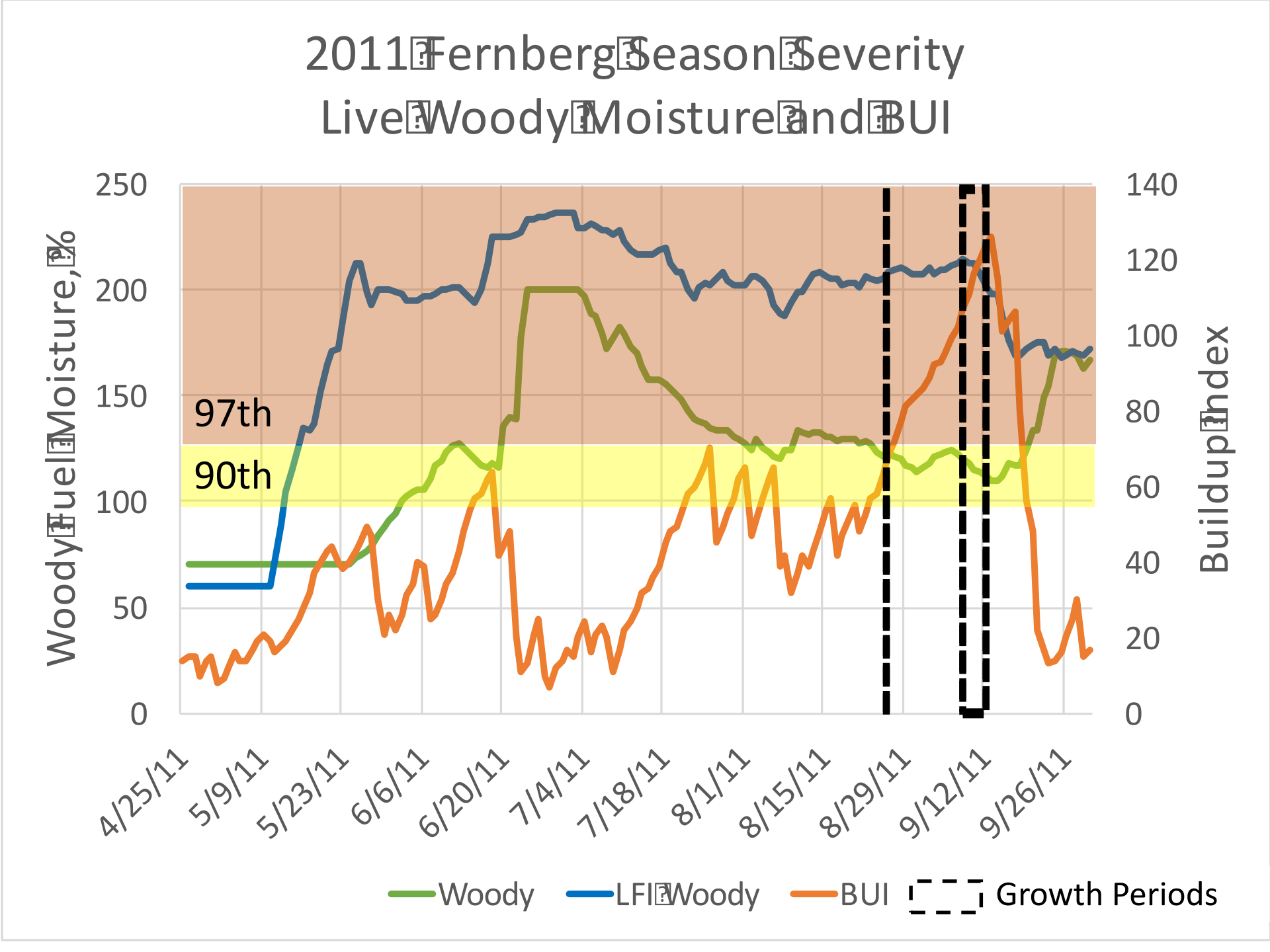
FWI Daily and Hourly data downloaded from akff.mesowest.org




Comparing Daily Fine Fuel Moistures
2013 Salcha (AK) RAWS
Fuel Moisture, %
16
14
12
10
8
6
4
2
0
5/14/13
5/28/13
6/11/13
6/25/13
7/9/13
7/23/13
8/6/13
8/20/13
9/3/13
9/17/13
Fosberg 1h Fuel Moistures 2-4% lower than Nelson estimates on driest days
Daily FFMC derived fuel moisture similar to 1300 Nelson 1hr during dry periods
FFMC%
1h
1h-Ne


FWI and CFFDRS Diurnal Fuel Moisture Trends
1hr (NFDRS) and Grass Fuel Moisture (CFFDRS)
Fuel Moisture, %
Peak burn period during the afternoon and early evening hours
Grass Fuel Moisture (CFFDRS) like Nelson at night, more like Fosberg on Dry days
1h-Nelson
GFM%
1h
dFFMC%

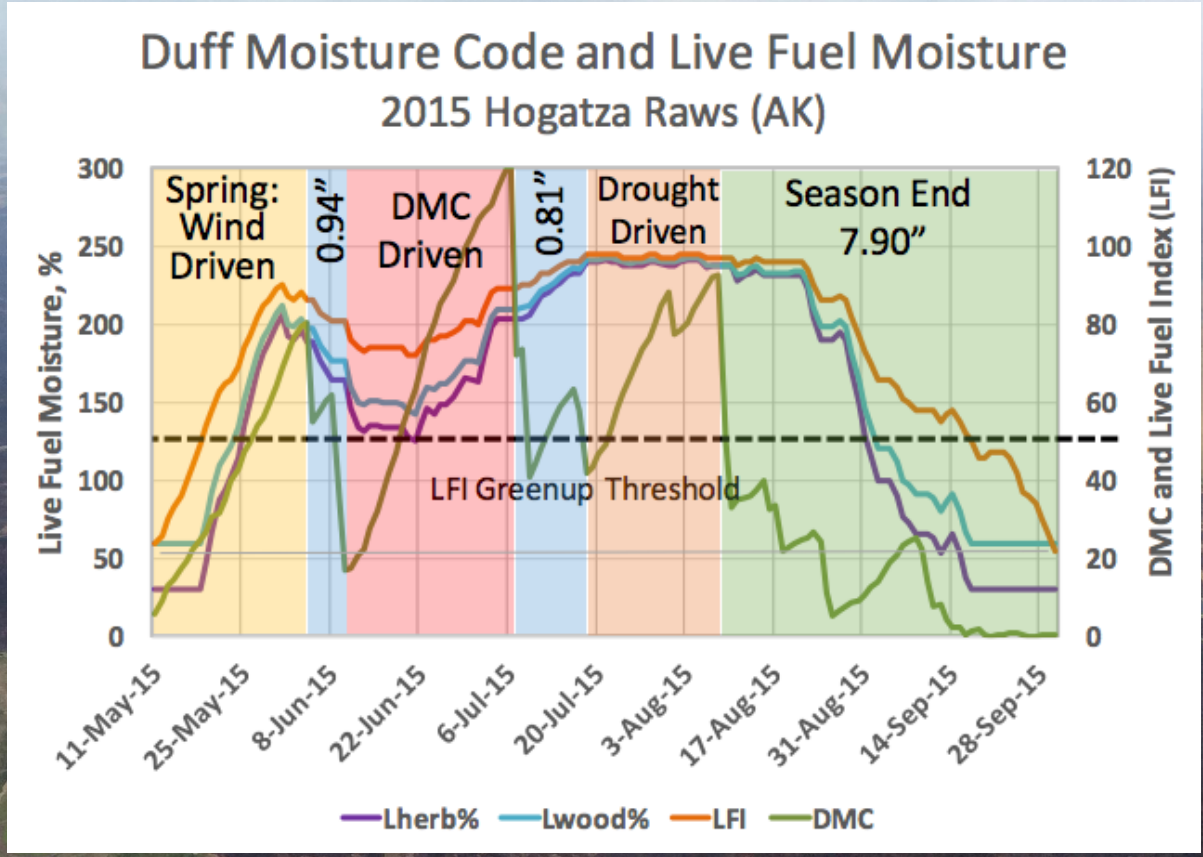

2011 Fernberg Season Severity
Live Herbaceous Moisture & BUI
Herbaceous Fuel Moisture, %
Buildup Index
250
200
150
100
50
0
140
120
100
80
60
40
20
0
97th
90th
4/25/11
5/9/11
5/23/11
6/6/11
6/20/11
7/4/11
7/18/11
8/1/11
8/15/11
8/29/11
9/12/11
9/26/11
Herb
LFI Herb
BUI
Growth Periods


2011 Fernberg Season Severity
Live Woody Moisture and BUI
Woody Fuel Moisture, %
Buildup Index
250
200
150
100
50
0
140
120
100
80
60
40
20
0
97th
90th
4/25/11
5/9/11
5/23/11
6/6/11
6/20/11
7/4/11
7/18/11
8/1/11
8/15/11
8/29/11
9/12/11
9/26/11
Woody
LFI Woody
BUI
Growth Periods

Live Fuel Moisture

Bogus Creek Fire
June 6, 2015

GSI/LFI Identifies a greenup threshold and estimates greenup date from weather observations



How do changes in Dead and Live Fuel Moisture Estimates Affect Fire Behavior Predictions

Dead Fine Fuel Moisture

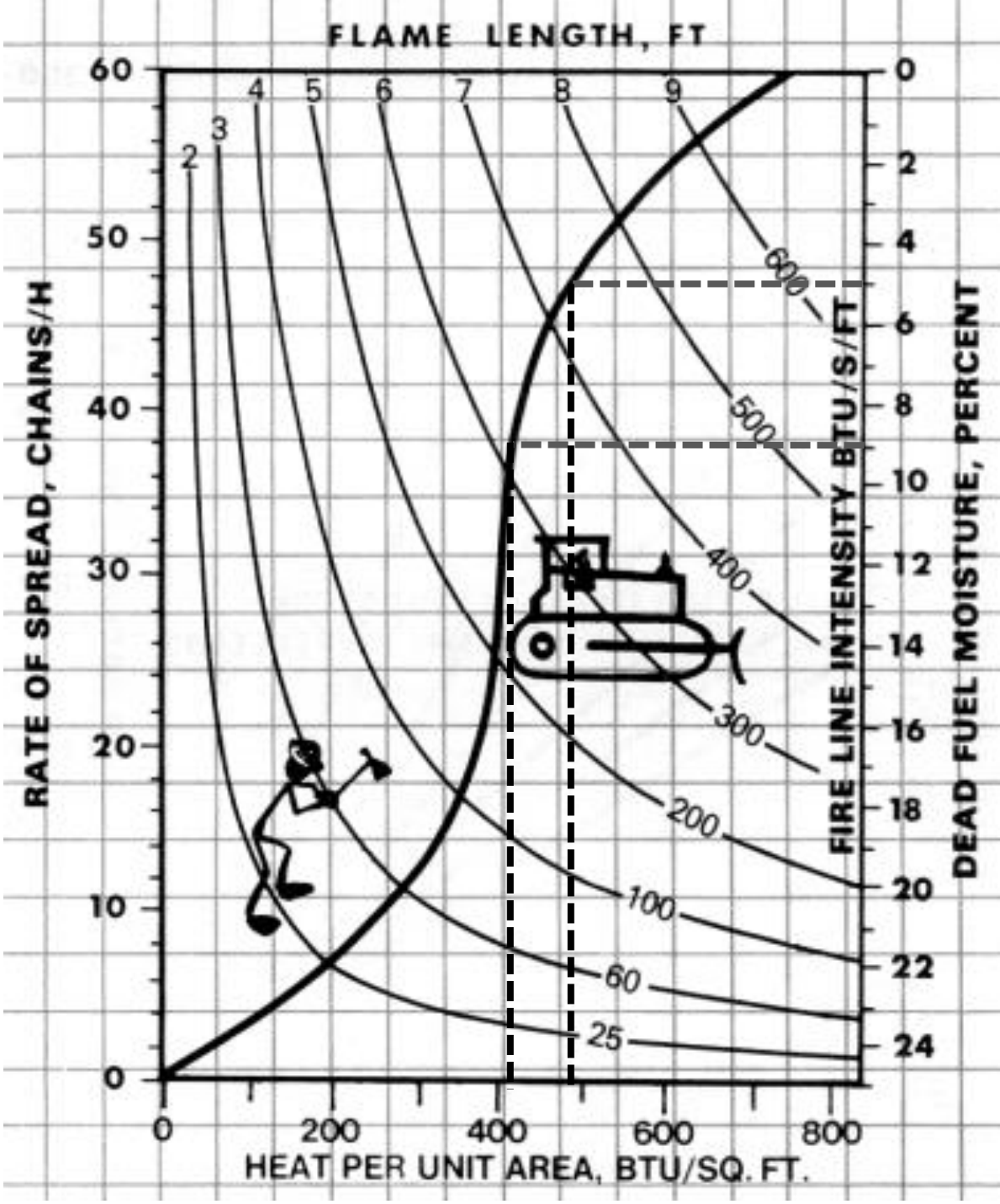
- 2-4% increase in 1hr fuel moisture by changing from Fosberg to Nelson in our regions, before any adjustments due to canopy shading
- Especially important for fuel models with low moisture of extinction

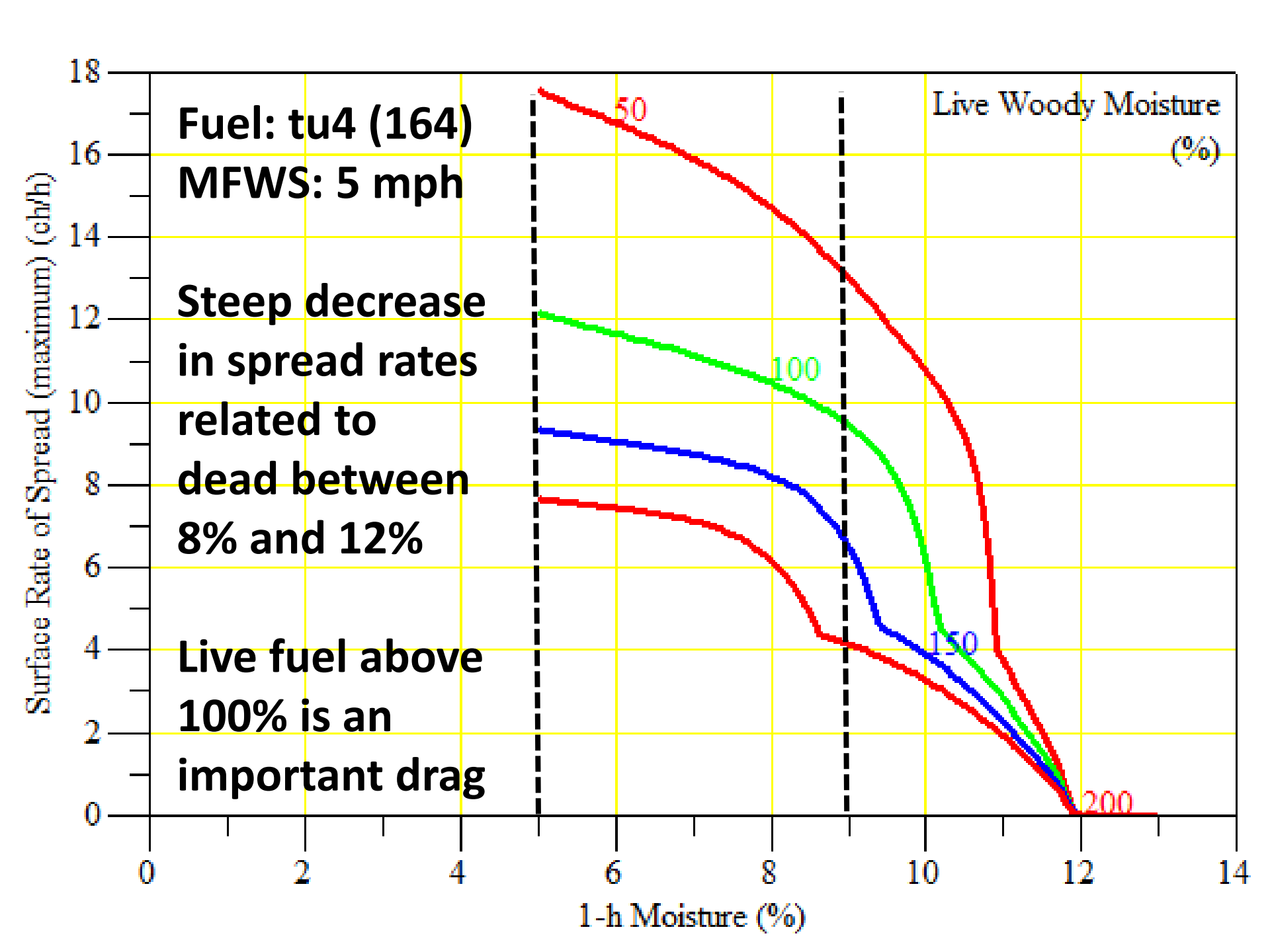
Live Fuel Moisture

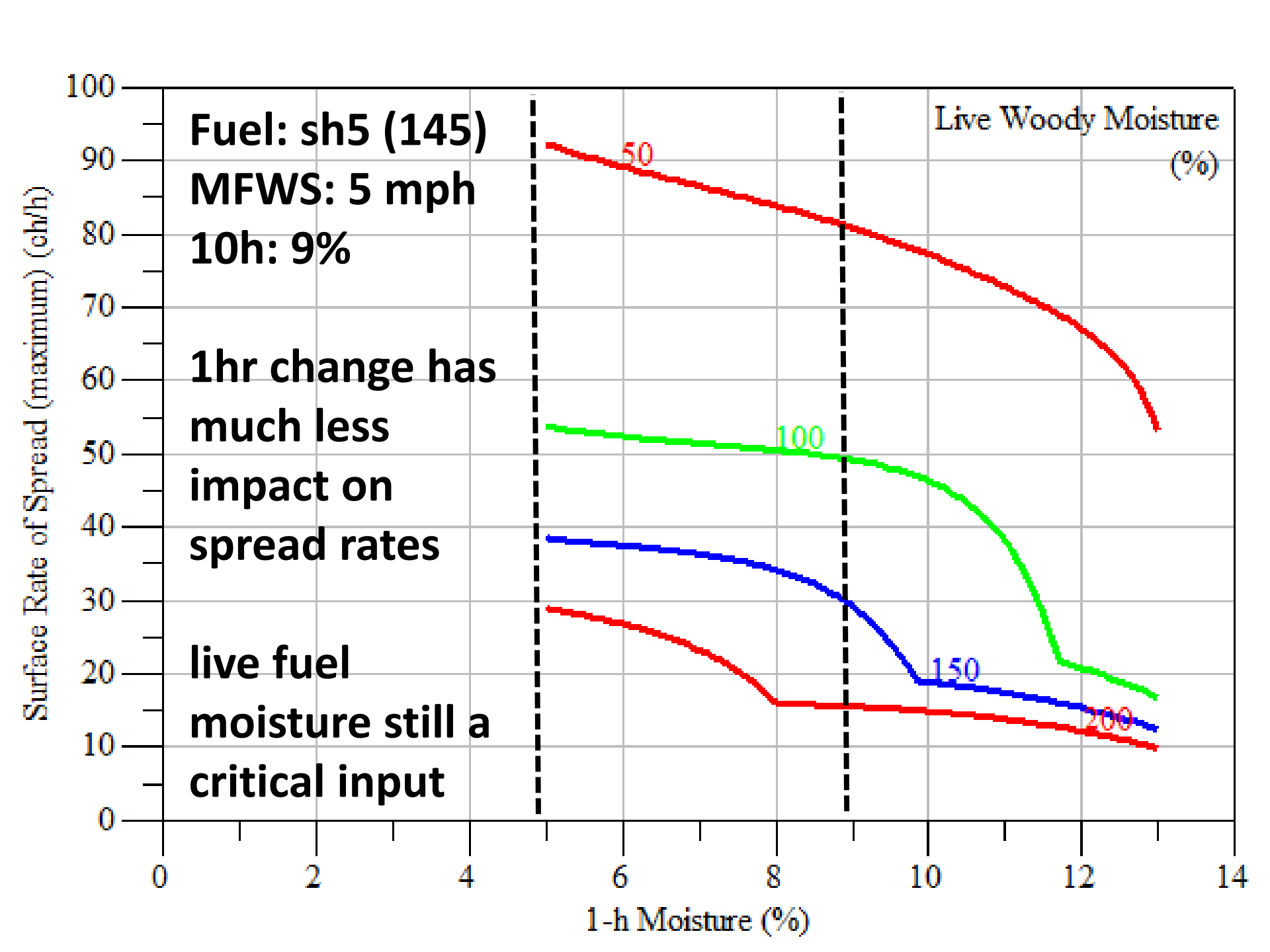
- Estimates for Woody Live Fuel Moistures generally above measured values during the growing season
- Herbaceous moistures much higher than common inputs for fire behavior analysis
- Especially important factor above or below critical threshold of 90% to 95% for dynamic fuel models.

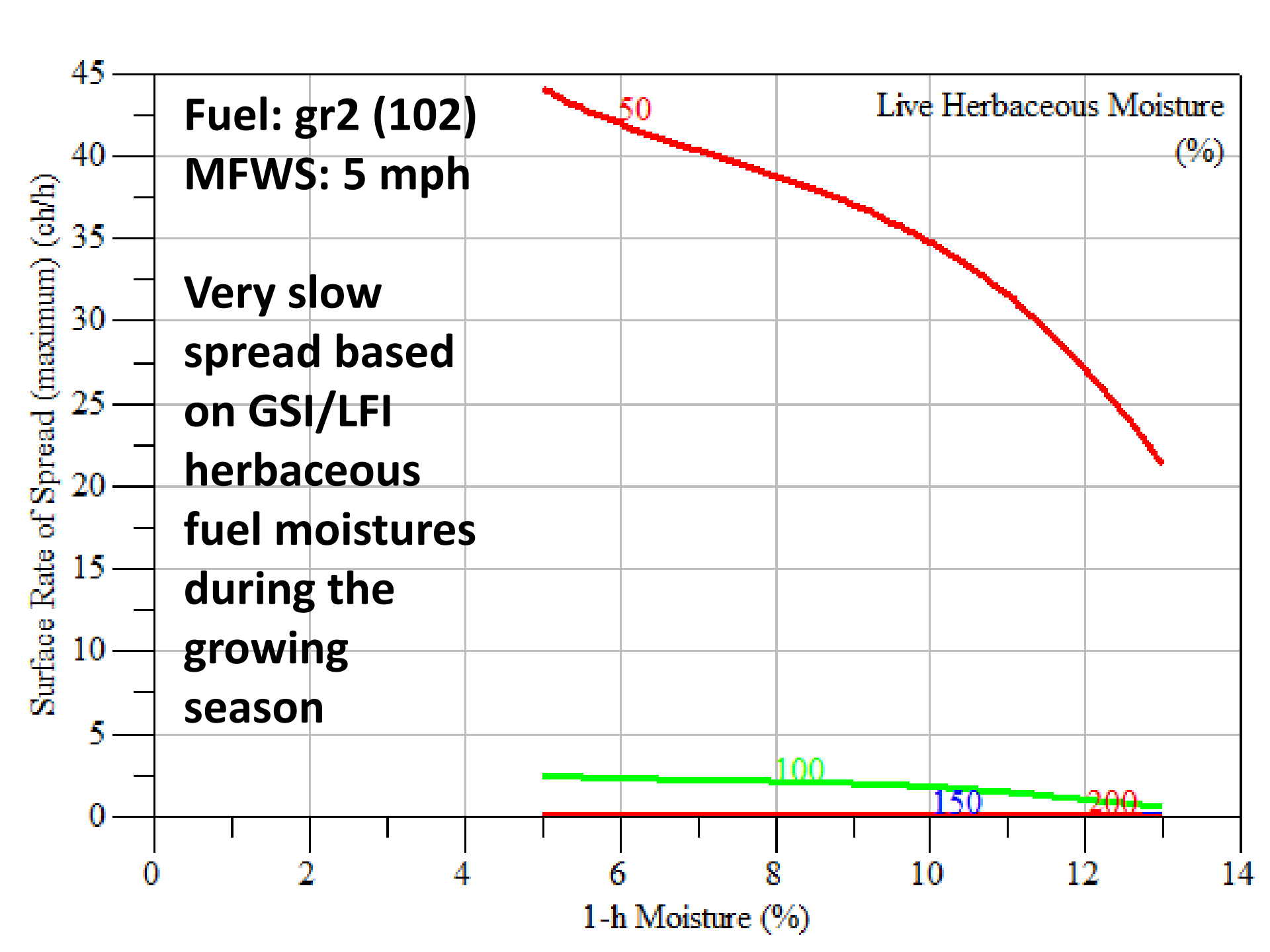
Nomogram for Fuel Model 6

- 4% change in dead fuel moisture, due primarily to change to the Nelson Model, would decrease HPA by nearly 20% alone
- Additional shading factors could add 2-4% more
- What does that do to spread rates in WFDSS analyses




Fuel: tu4 (164)
MFWS: 5 mph
Steep decrease in spread rates related to dead between 8% and 12%
Live fuel above 100% is an important drag
Live Woody Moisture (%)
50
100
150
200
Surface Rate of Spread (maximum) (ch/h)
1-h Moisture (%)
0
2
4
6
8
10
12
14
16
18


Fuel: sh5 (145)
MFWS: 5 mph
10h: 9%
1hr change has much less impact on spread rates
live fuel moisture still a critical input
Live Woody Moisture (%)
50
100
150
200
Surface Rate of Spread (maximum) (ch/h)
1-h Moisture (%)
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
10
12
14

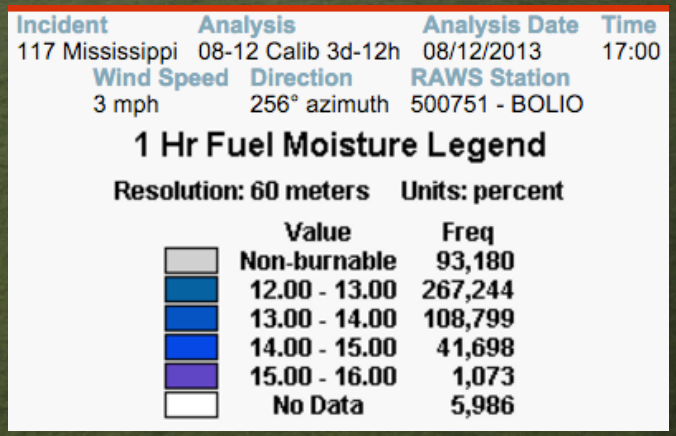

Fuel: gr2 (102)
MFWS: 5 mph
Very slow spread based on GSI/LFI herbaceous fuel moistures during the growing season
Live Herbaceous Moisture (%)
50
100
150
200
Surface Rate of Spread (maximum) (ch/h)
1-h Moisture (%)
0
5
10
15
20
25
30
35
40
45
0
2
4
6
8
10
12
14

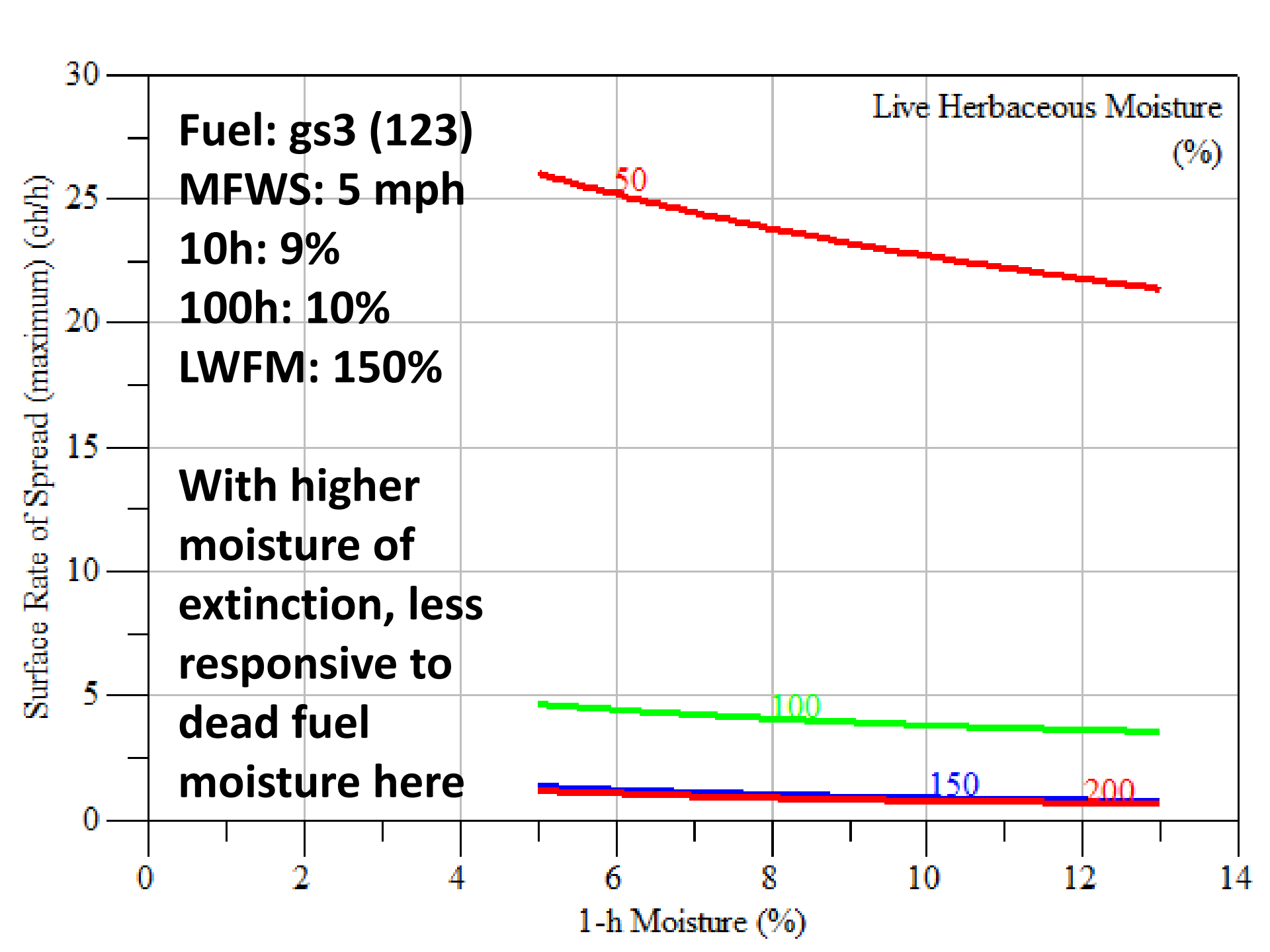
Mississippi Fire, AK

52,539 ac, August 12, 2013

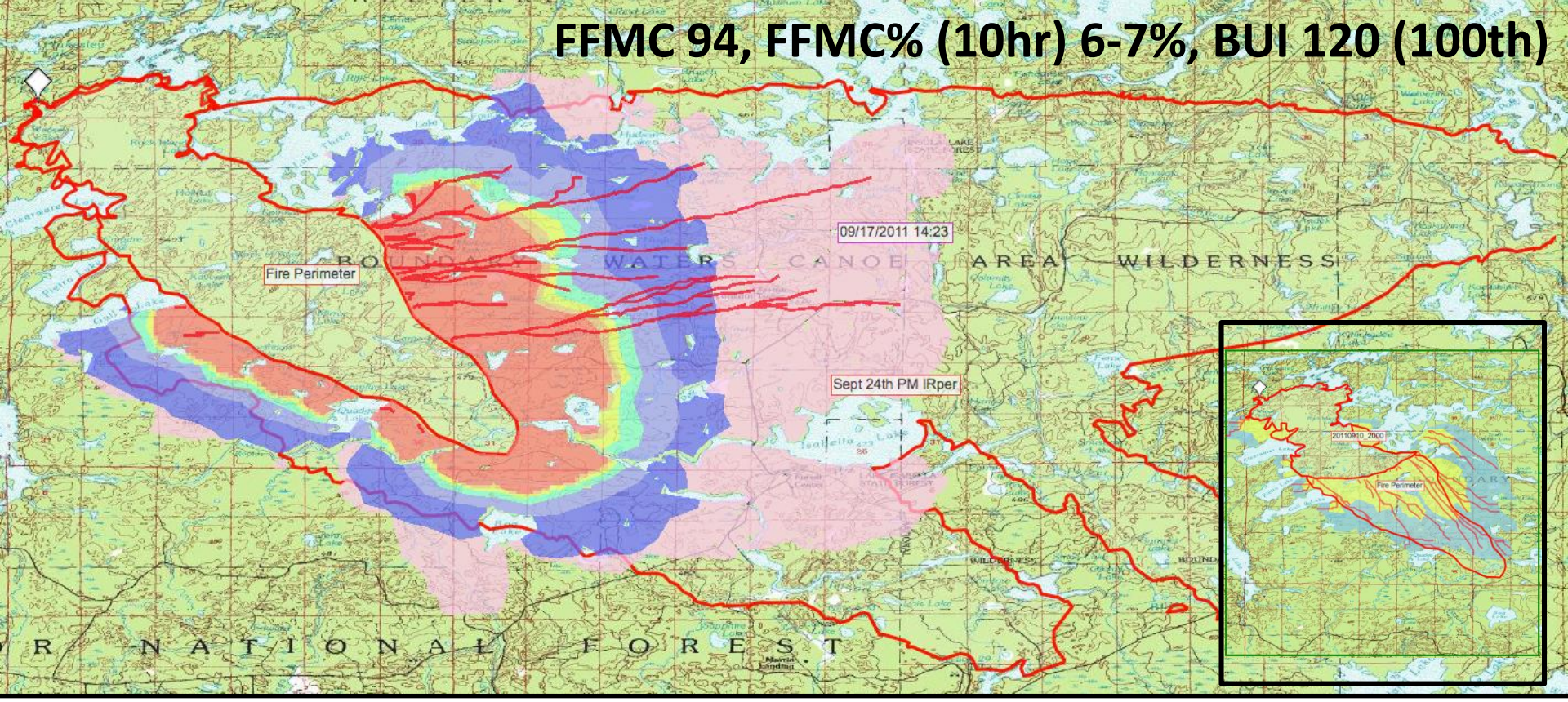
FFMC **90 (9%)**, DMC **80 (65%)**, DC **497**

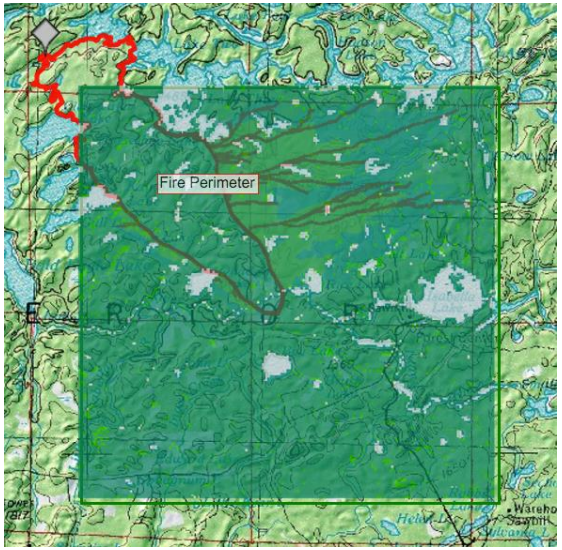
HFM **112%,** WFM **130%**




Fuel: gs3 (123)
MFWS: 5 mph
10h: 9%
100h: 10%
LWFM: 150%
With higher moisture of extinction, less responsive to dead fuel moisture here
Live Herbaceous Moisture (%)
50
100
150
200
Surface Rate of Spread (maximum) (ch/h)
1-h Moisture (%)
0
5
10
15
20
25
30
0
2
4
6
8
10
12
14

FFMC 94, FFMC% (10hr) 6-7%, BUI 120 (100th)





1 Hr Fuel Moisture Legend

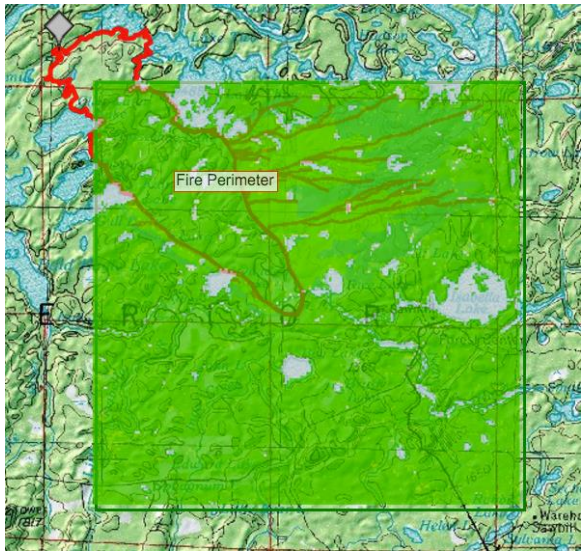
Resolution: 90 meters **Units: percent**

Value	Freq
Non-burnable	2,866
7.00 - 8.00	1,364
8.00 - 9.00	36,372

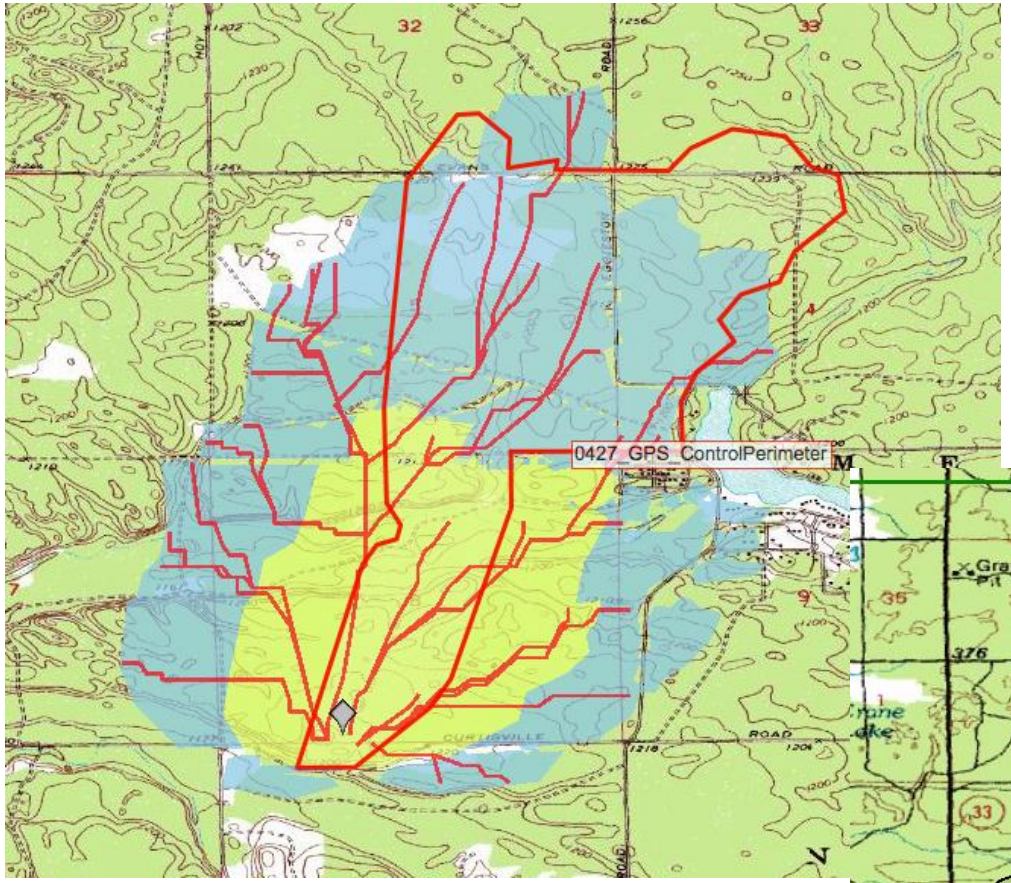
10 Hr Fuel Moisture Legend

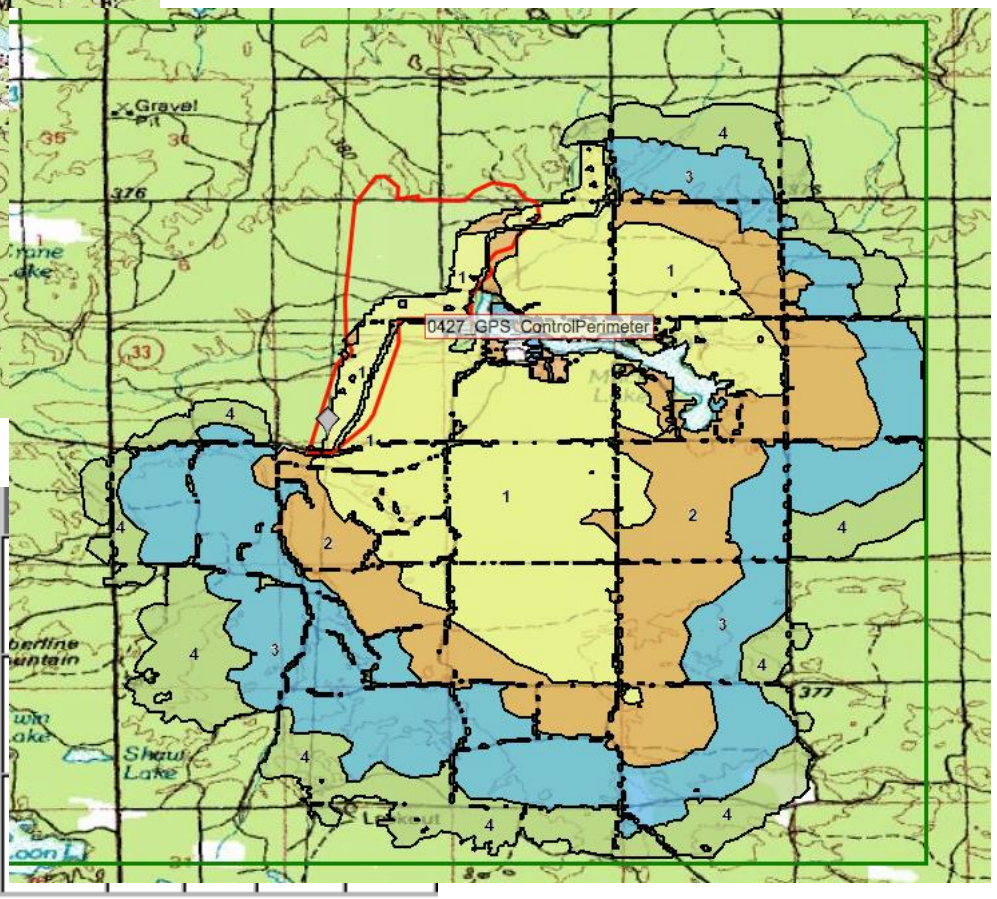
Resolution: 90 meters **Units: percent**

Value	Freq
Non-burnable	2,866
9.00 - 10.00	1,248
10.00 - 11.00	35,869
11.00 - 12.00	619



Little Mack Lake
4/25 and 4/26, 2012

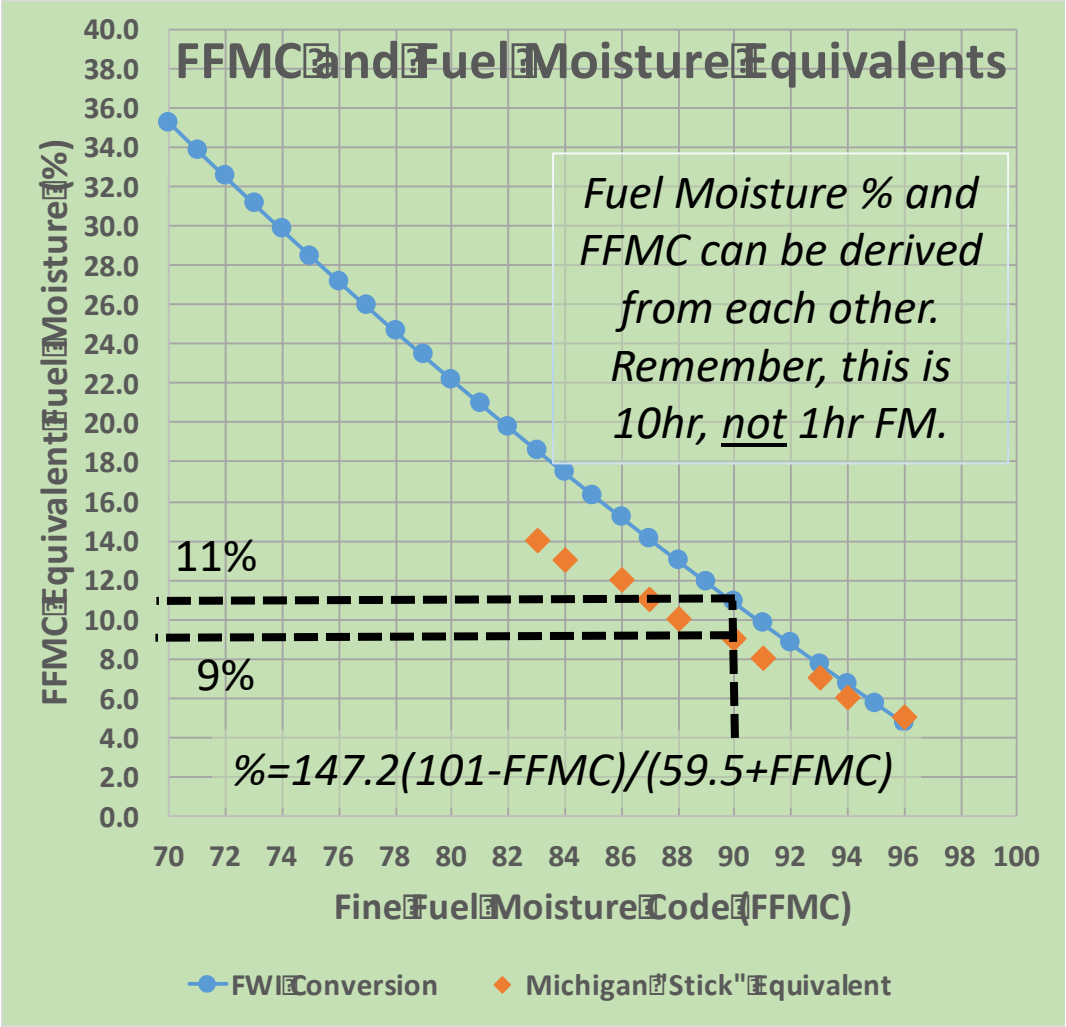




Station	Date	Temp ↑	RH	Wspd	Pcp	FFMC
SILVER CREEK	2012/4/26	51	58	15	0.05	81
	2012/4/25	61	30	9	0	92.2
	2012/4/24	58	17	16	0	92.7
MIO	2012/4/26	46	65	14	0.07	75.4
	2012/4/25	60	14	4	0	93.9
	2012/4/24	56	18	17	0	92.5
BARTON CITY	2012/4/26	47	60	13	0.06	78.1
	2012/4/25	61	17	7	0	92.9
	2012/4/24	55	23	12	0	90.7

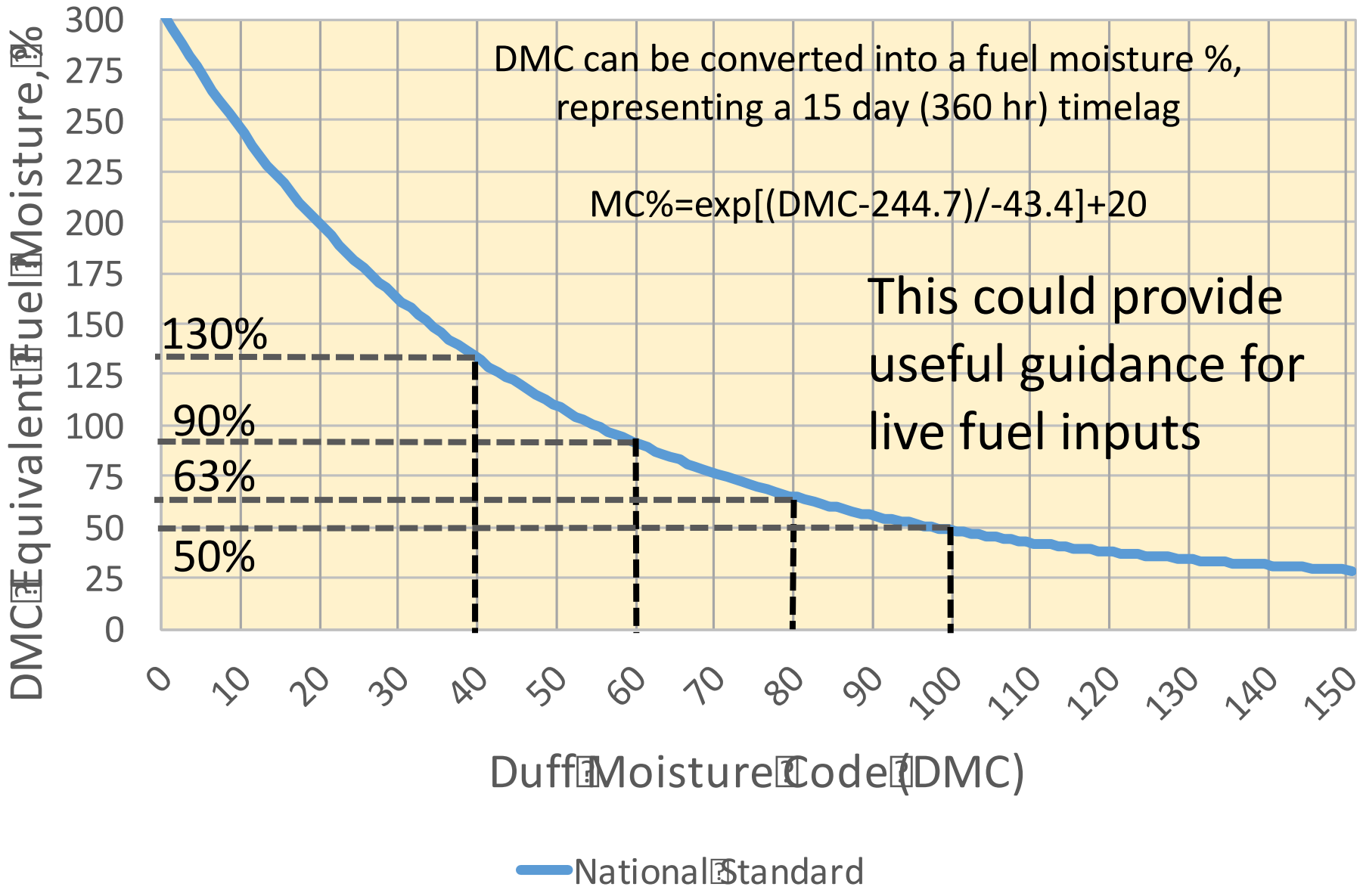
FFMC and Timelag Fuel Moisture

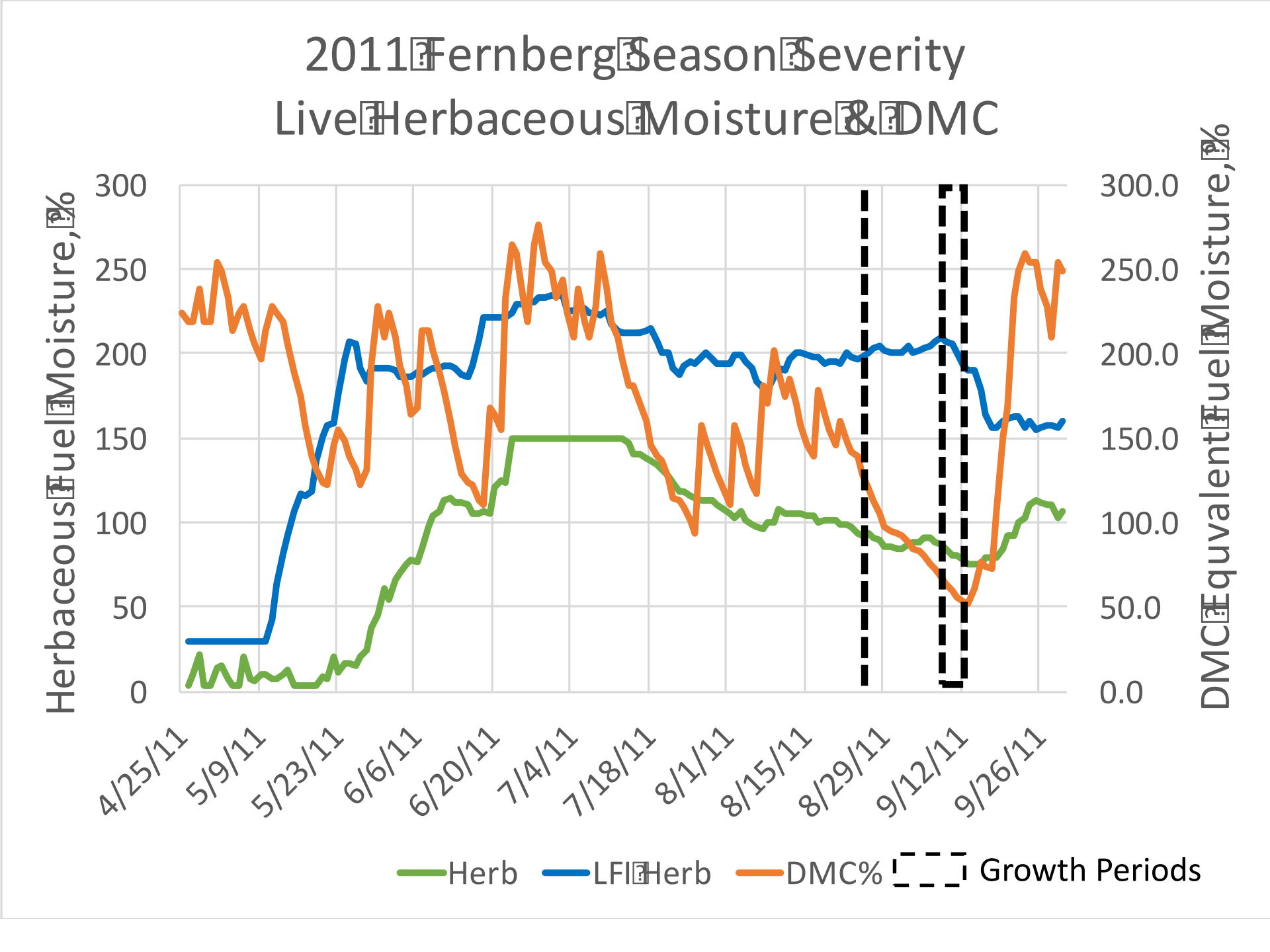
- FFMC represents shaded litter fuels with about a 10 hr timelag (5 to 16 hrs)
- An equivalent fuel moisture % can be estimated and used in predictions.

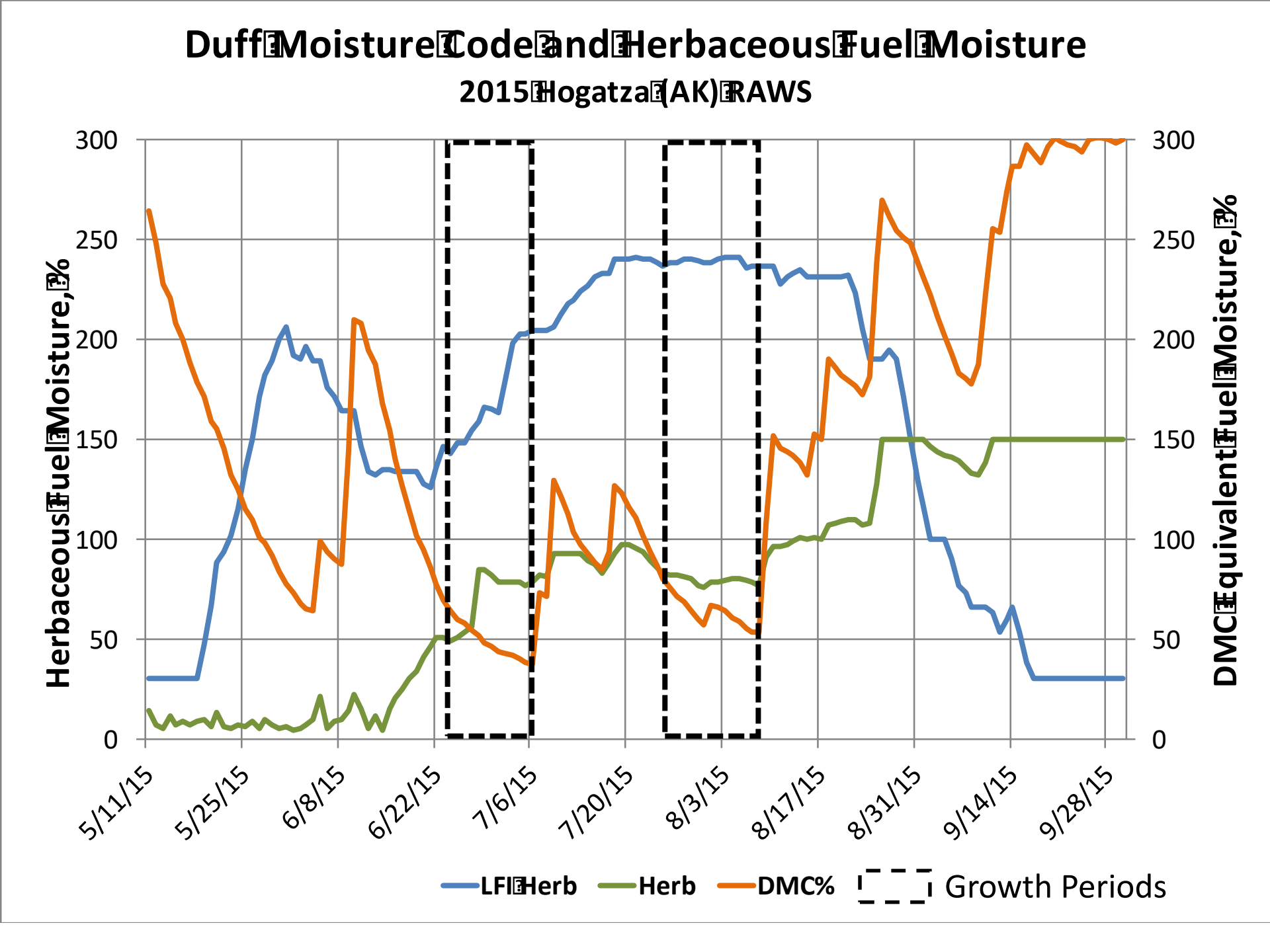


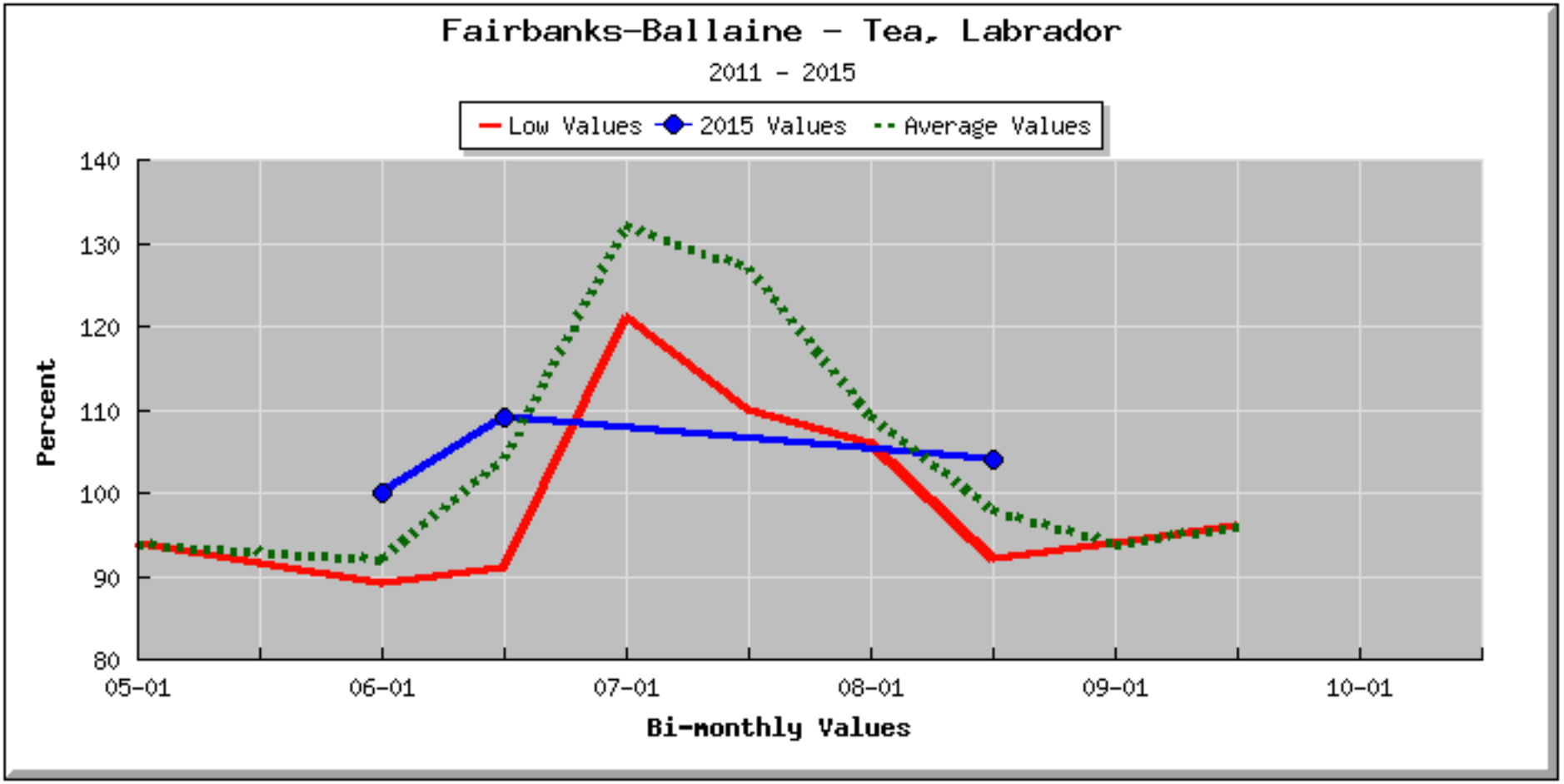
10 Hr	5	6	7	8	9	10	11	12	13	14
FFMC	96	94	93	91	90	88	87	86	84	83

Based on 20 years of daily estimates of FFMC values and manual measurement of NFDRS 10hr “Sticks” in Michigan (1975-1995)


DMC to Fuel Moisture Equivalent Conversion
DMC can be converted into a fuel moisture %, representing a 15 day (360 hr) timelag
MC%=exp[(DMC-244.7)/-43.4]+20
This could provide useful guidance for live fuel inputs
130%
90%
63%
50%
DMC Equivalent Fuel Moisture, %
300
275
250
225
200
175
150
125
100
75
50
25
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Duff Moisture Code (DMC)
National Standard


2011 Fernberg Season Severity
Live Herbaceous Moisture & DMC
Herbaceous Fuel Moisture, %
DMC Equivalent Fuel Moisture, %
300
250
200
150
100
50
0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
4/25/11
5/9/11
5/23/11
6/6/11
6/20/11
7/4/11
7/18/11
8/1/11
8/15/11
8/29/11
9/12/11
9/26/11
Herb
LFI Herb
DMC%
Growth Periods


Duff Moisture Code and Herbaceous Fuel Moisture
2015 Hogatza (AK) RAWS
Herbaceous Fuel Moisture, %
DMC Equivalent Fuel Moisture, %
300
250
200
150
100
50
0
5/11/15
5/25/15
6/8/15
6/22/15
7/6/15
7/20/15
8/3/15
8/17/15
8/31/15
9/14/15
9/28/15
LFI Herb
Herb
DMC%
Growth Periods



Fairbanks-Ballaine - Tea, Labrador

	05-01	05-15	06-01	06-15	07-01	07-15	08-01	08-15	09-01	09-15	10-01	10-15
2015			100	109				104				
Avg	94		92	104	132	127	109	98	94	96		
Low	94		89	91	121	110	106	92	94	96		

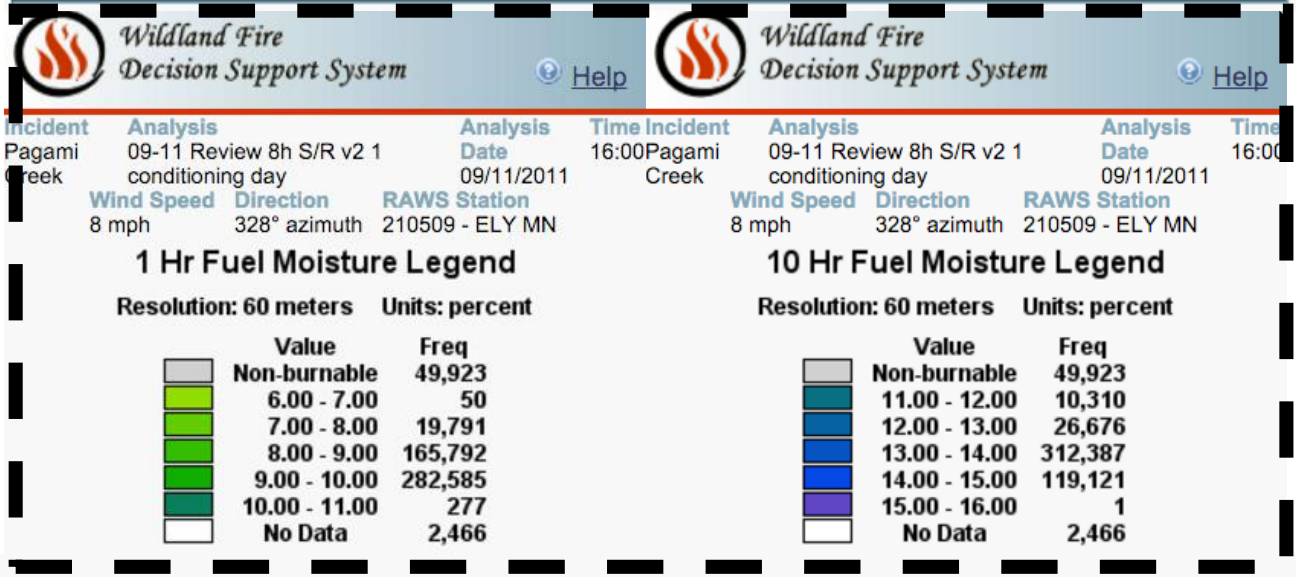
FFMC and DMC can help inform inputs

FFMC, converted to fuel moisture could inform 10hr, with 1 hr 2% lower

DMC, converted to a fuel moisture, could help suggest current Herbaceous fuel moisture inputs

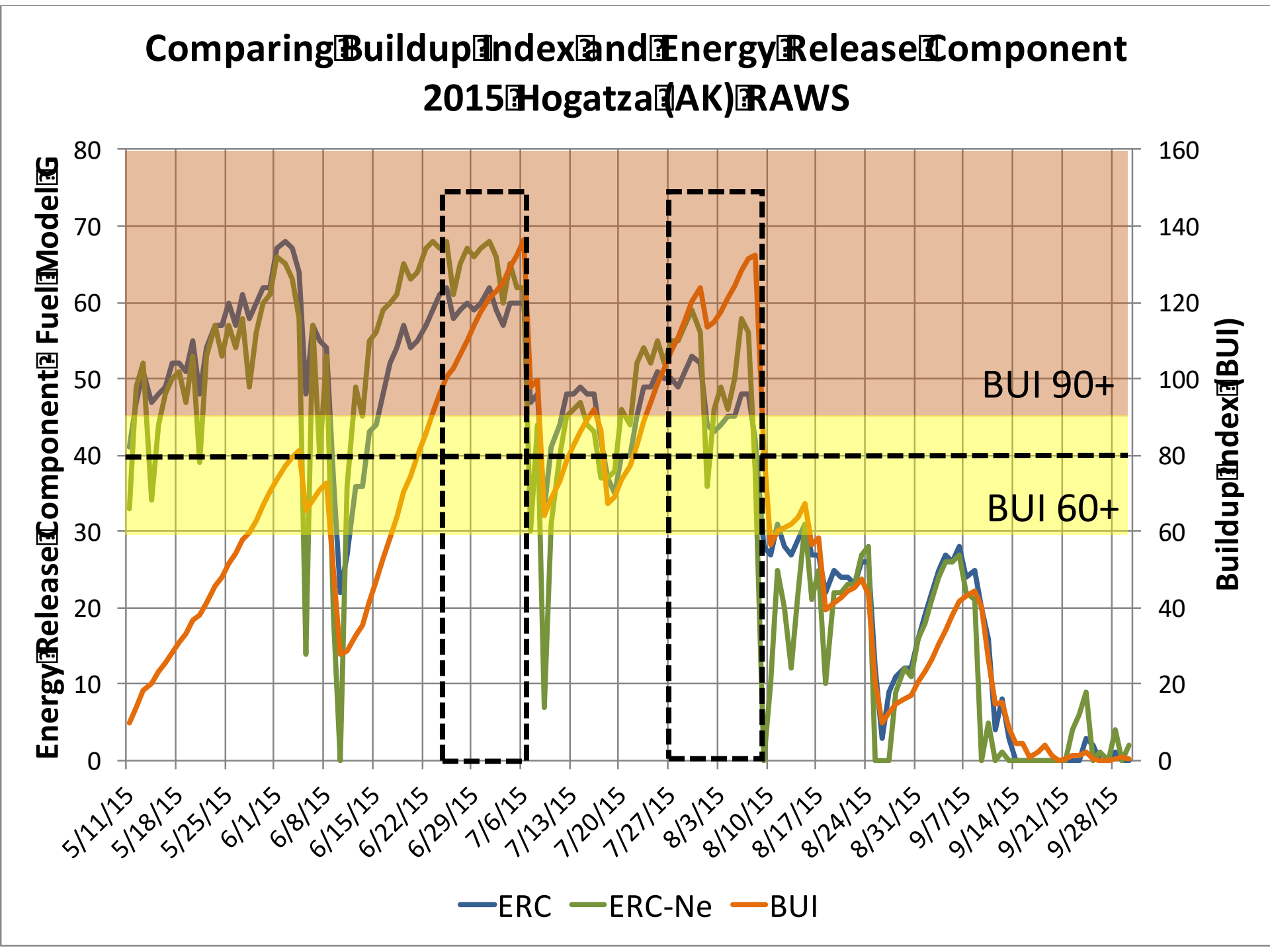
Model	1 Hour FM	10 Hour FM	100 Hour FM	Herb FM	Woody FM
default	5	7	16	16	18

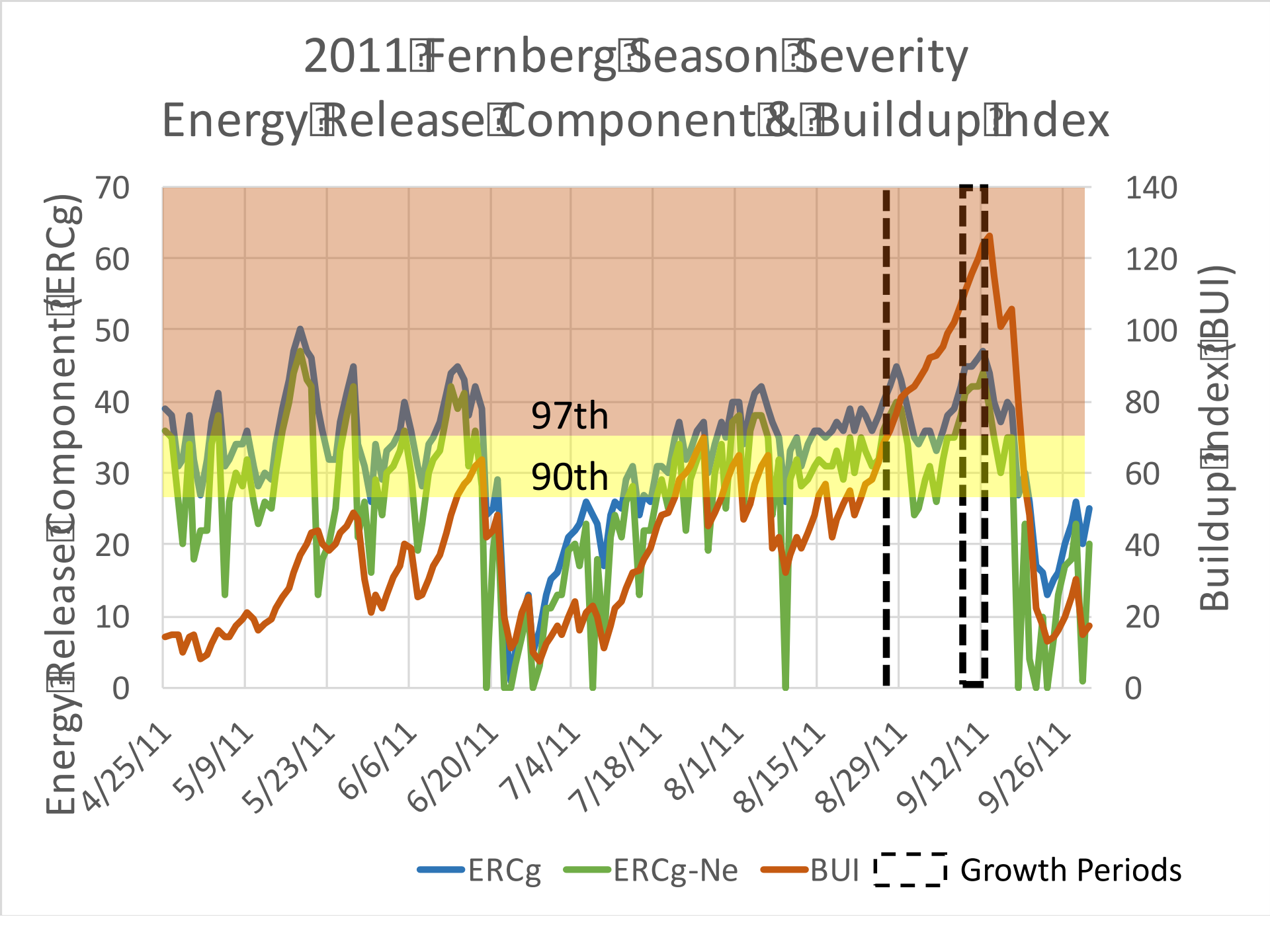
FFMC 94, FFMC% (10hr) 6-7%, BUI 120 (100th)

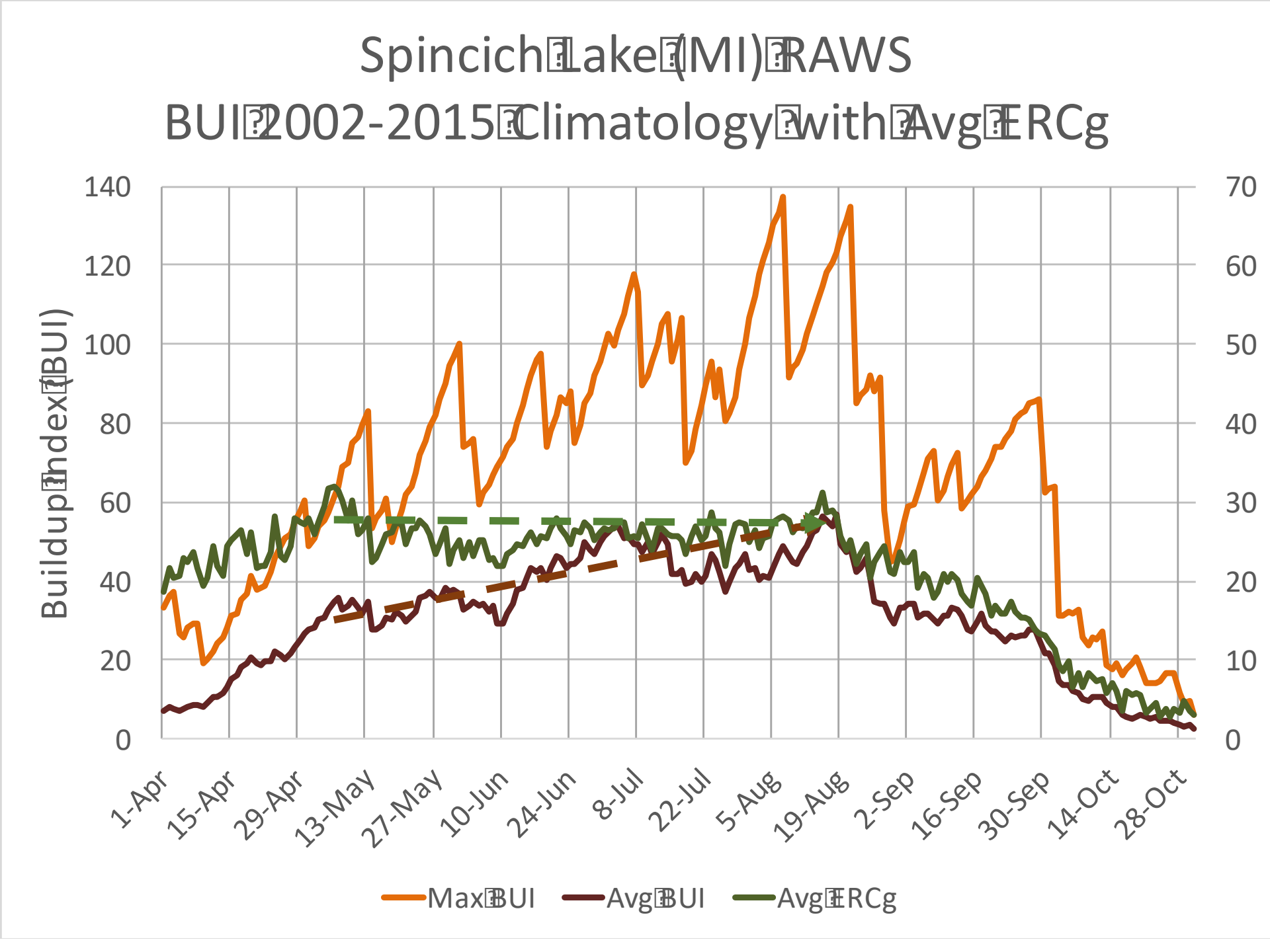


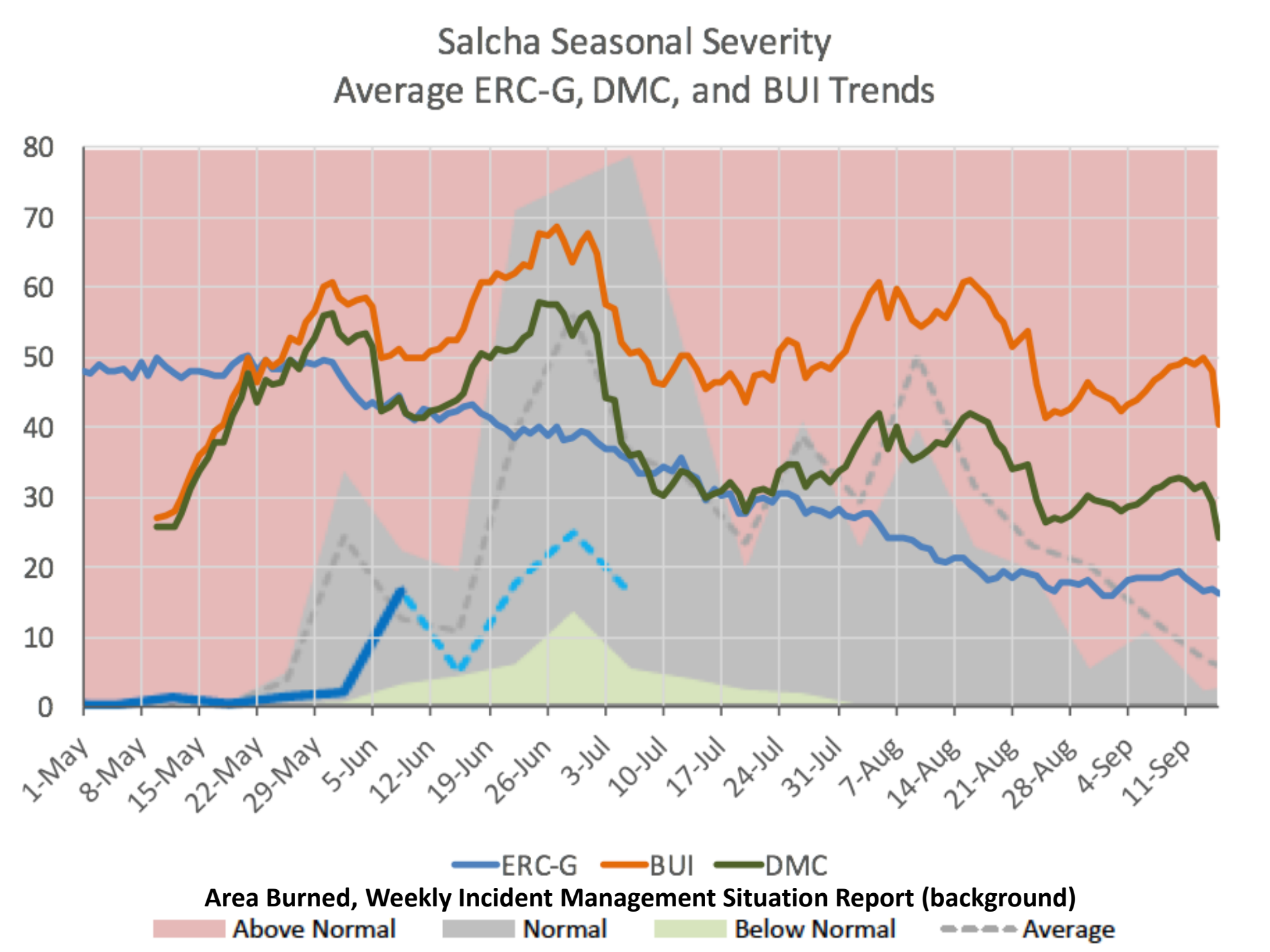
Generate ERC Classes

%ile	Min ERC	1 Hour FM	10 Hour FM	100 Hour FM	Herb FM	Woody FM	Burn Period	Spot Prob	Delay
96	33	6.7	7.9	14.0	166.	178.	360	0.15	0
89	30	7.6	9.1	15.2	174.	184.	300	0.10	0
76	26	8.2	10.1	15.9	170.	180.	240	0.05	0
67	24	8.9	11.0	16.7	171.	182.	180	0.01	0
58	22	9.7	12.2	17.3	170.	181.	120	0.00	0

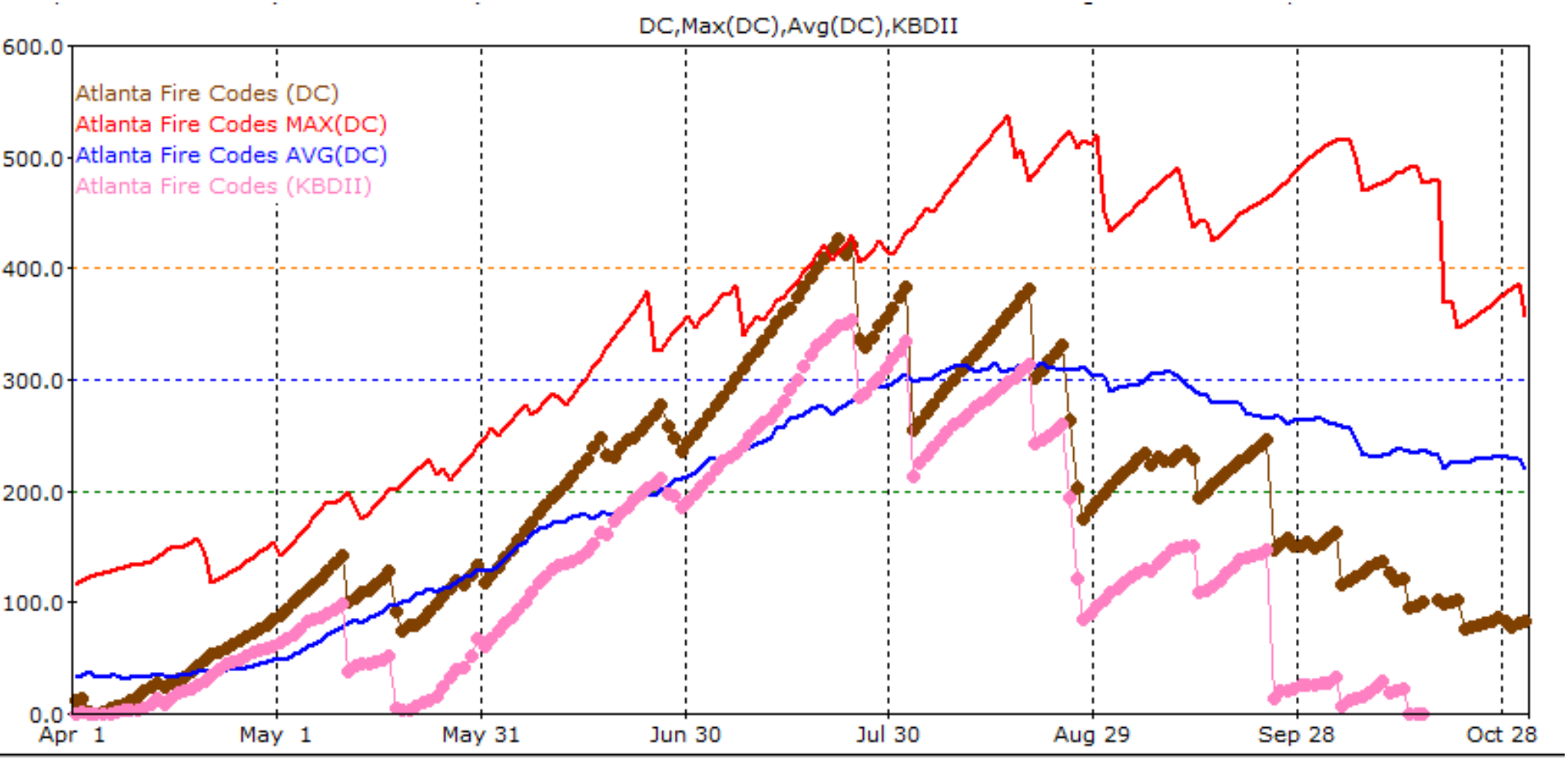

Comparing Buildup Index and Energy Release Component
2015 Hogatza (AK) RAWS
Energy Release Component & Fuel Model G
Buildup Index (BUI)
80
70
60
50
40
30
20
10
0
160
140
120
100
80
60
40
20
0
BUI 90+
BUI 60+
5/11/15
5/18/15
5/25/15
6/1/15
6/8/15
6/15/15
6/22/15
6/29/15
7/6/15
7/13/15
7/20/15
7/27/15
8/3/15
8/10/15
8/17/15
8/24/15
8/31/15
9/7/15
9/14/15
9/21/15
9/28/15
ERC
ERC-Ne
BUI


2011 Fernberg Season Severity
Energy Release Component & Buildup Index
Energy Release Component (ERCg)
Buildup Index (BUI)
70
60
50
40
30
20
10
0
140
120
100
80
60
40
20
0
97th
90th
4/25/11
5/9/11
5/23/11
6/6/11
6/20/11
7/4/11
7/18/11
8/1/11
8/15/11
8/29/11
9/12/11
9/26/11
ERCg
ERCg-Ne
BUI
Growth Periods


Spincich Lake (MI) RAWS
BUI 2002-2015 Climatology with Avg ERCg
Buildup Index (BUI)
140
120
100
80
60
40
20
0
70
60
50
40
30
20
10
0
1-Apr
15-Apr
29-Apr
13-May
27-May
10-Jun
24-Jun
8-Jul
22-Jul
5-Aug
19-Aug
2-Sep
16-Sep
30-Sep
14-Oct
28-Oct
Max BUI
Avg BUI
Avg ERCg

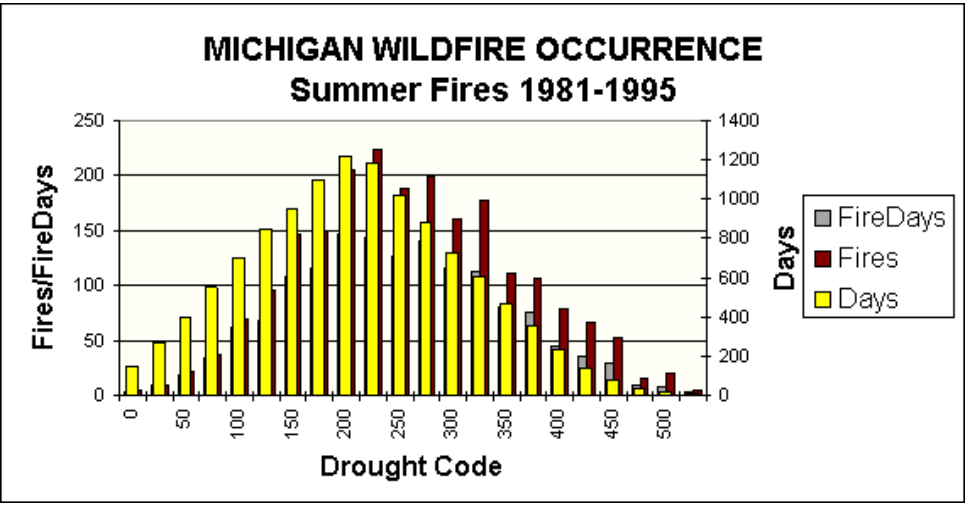

Salcha Seasonal Severity
Average ERC-G, DMC, and BUI Trends
80
70
60
50
40
30
20
10
0
1-May
8-May
15-May
22-May
29-May
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
ERC-G
BUI
DMC
Area Burned, Weekly Incident Management Situation Report (background)
Above Normal
Normal
Below Normal
Average

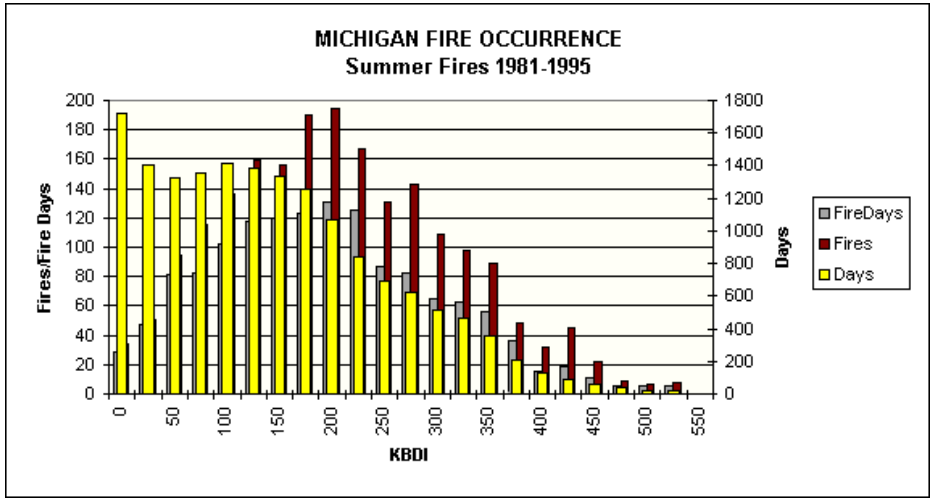
KBDI and DC at Atlanta, MI from 2006



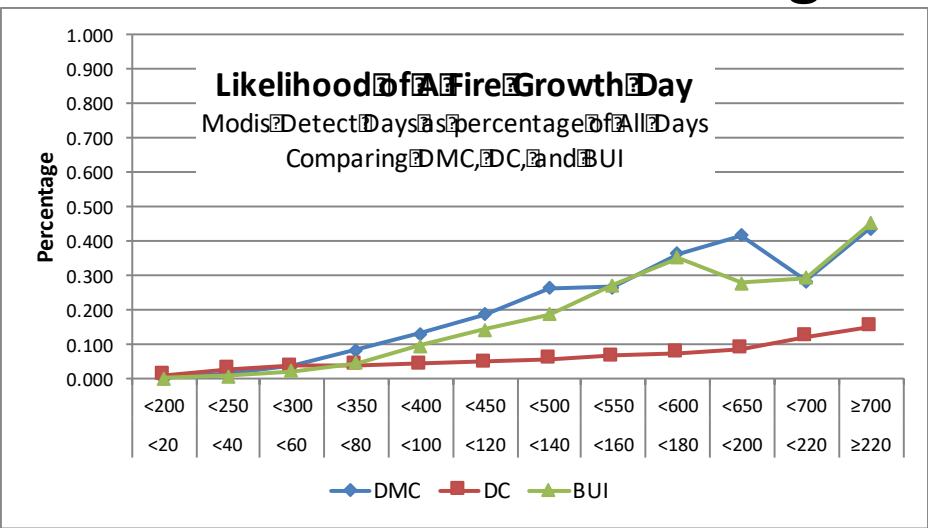
Trends for DC and KBDI are very similar,
though DC produces higher values overall

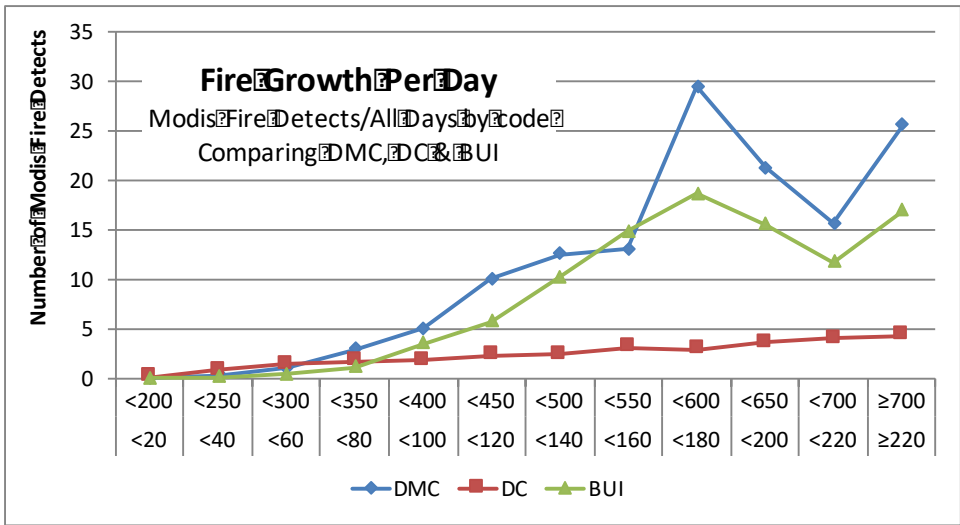
Drought Code and KBDI





Keetch-Byram Drought Index (KBDI) and Drought Code (DC) have only a slightly positive correlation with fire occurrence in Michigan and MODIS detection in Alaska

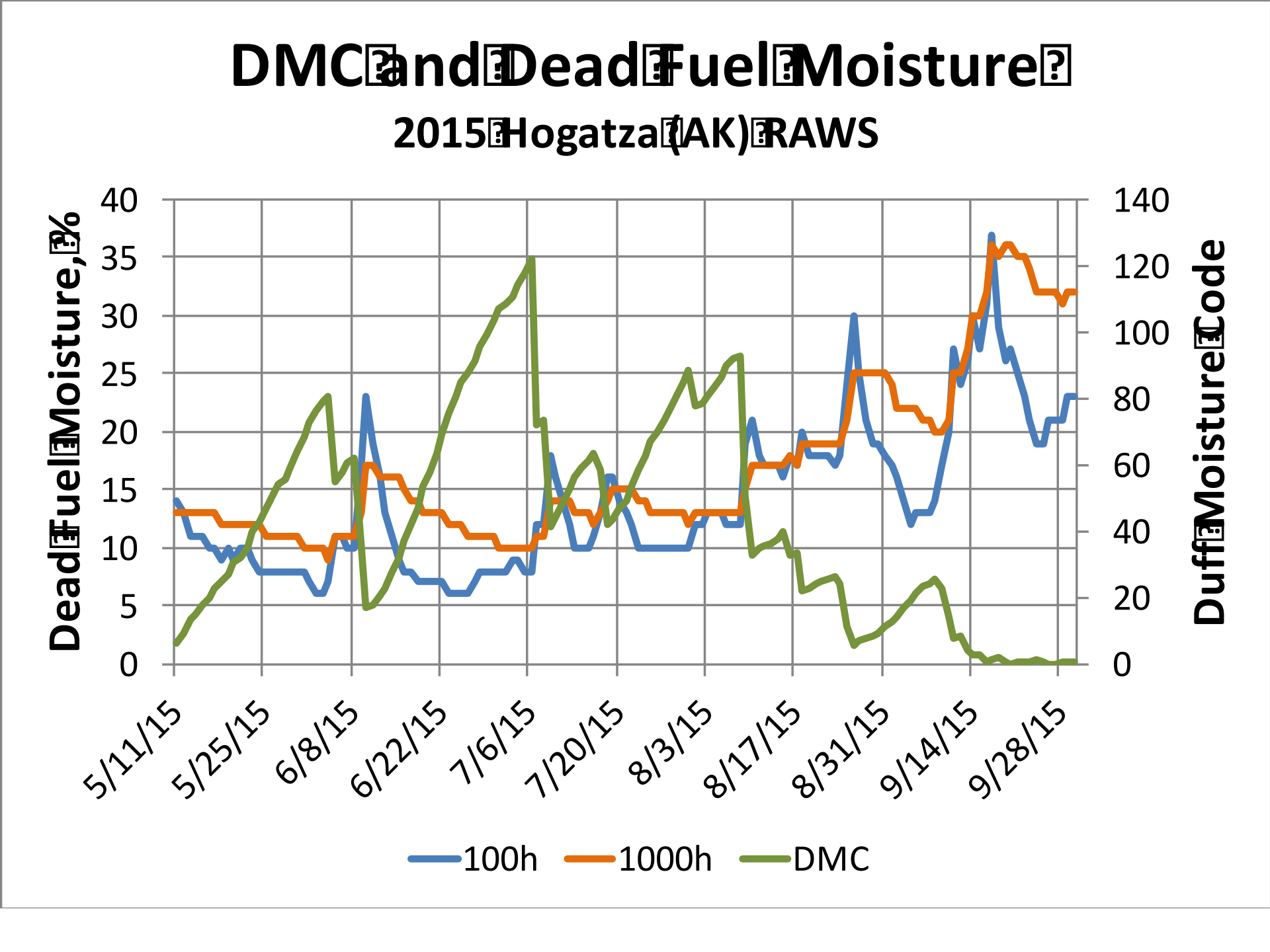


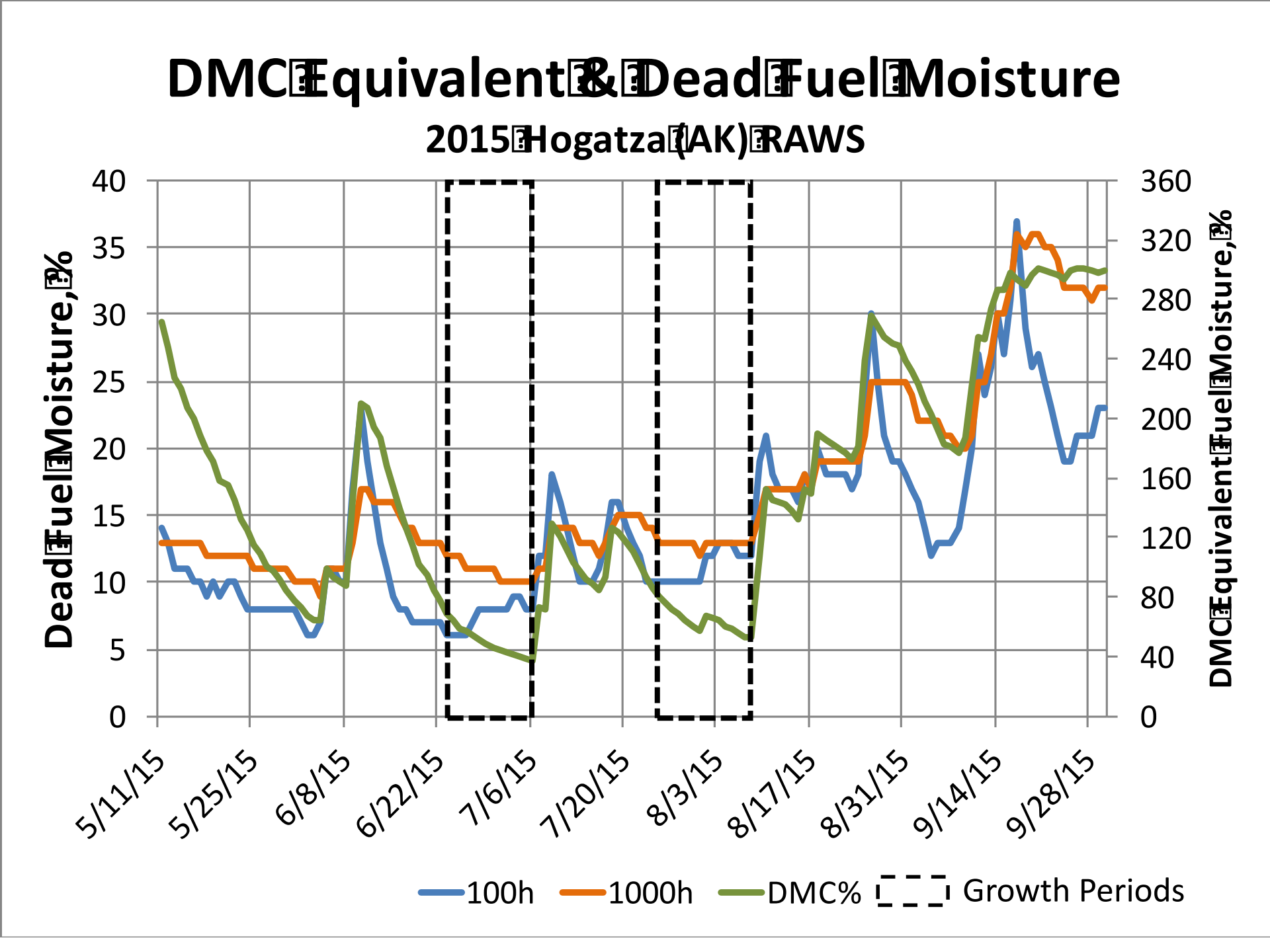


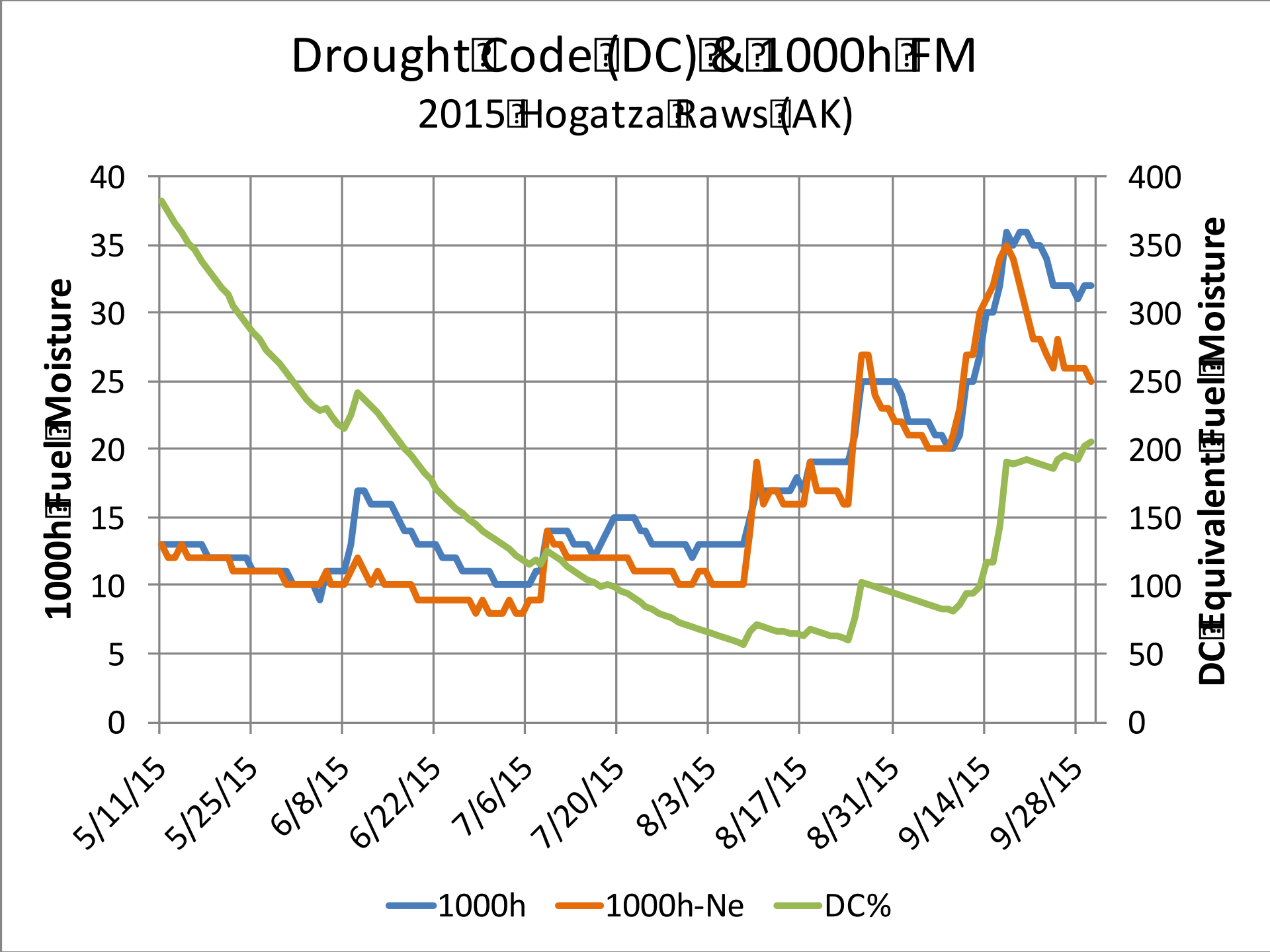
My Assumptions and Conclusions

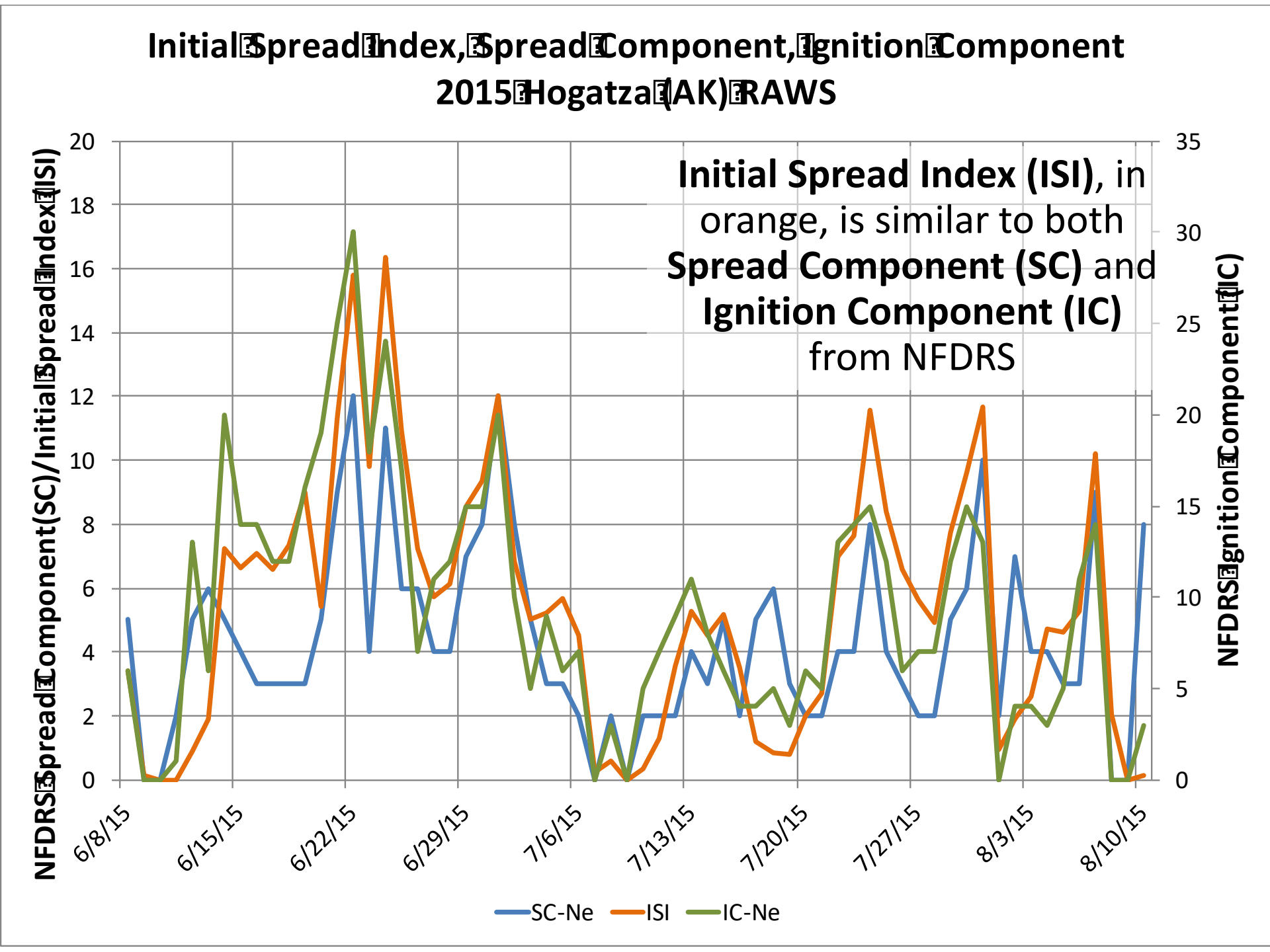
- These comparisons represent only weather conditions and fuel moisture estimates from Alaska and the Lake States.
- NFDRS ’16 makes some very important advances for simplicity of operation over older versions
- There are concerns that the Nelson Fuel Moisture model is raising Fine Fuel Moisture estimates to a level that impacts fire behavior analysis in our regions.
- New live Fuel Moisture estimates are significantly higher in our regions. “Current” estimates probably can’t be directly applied as inputs to fire behavior analysis in the growing season
- It is likely that FFMC and DMC can help inform these fuel moisture inputs for fire behavior analysis providing objective “current” source information.

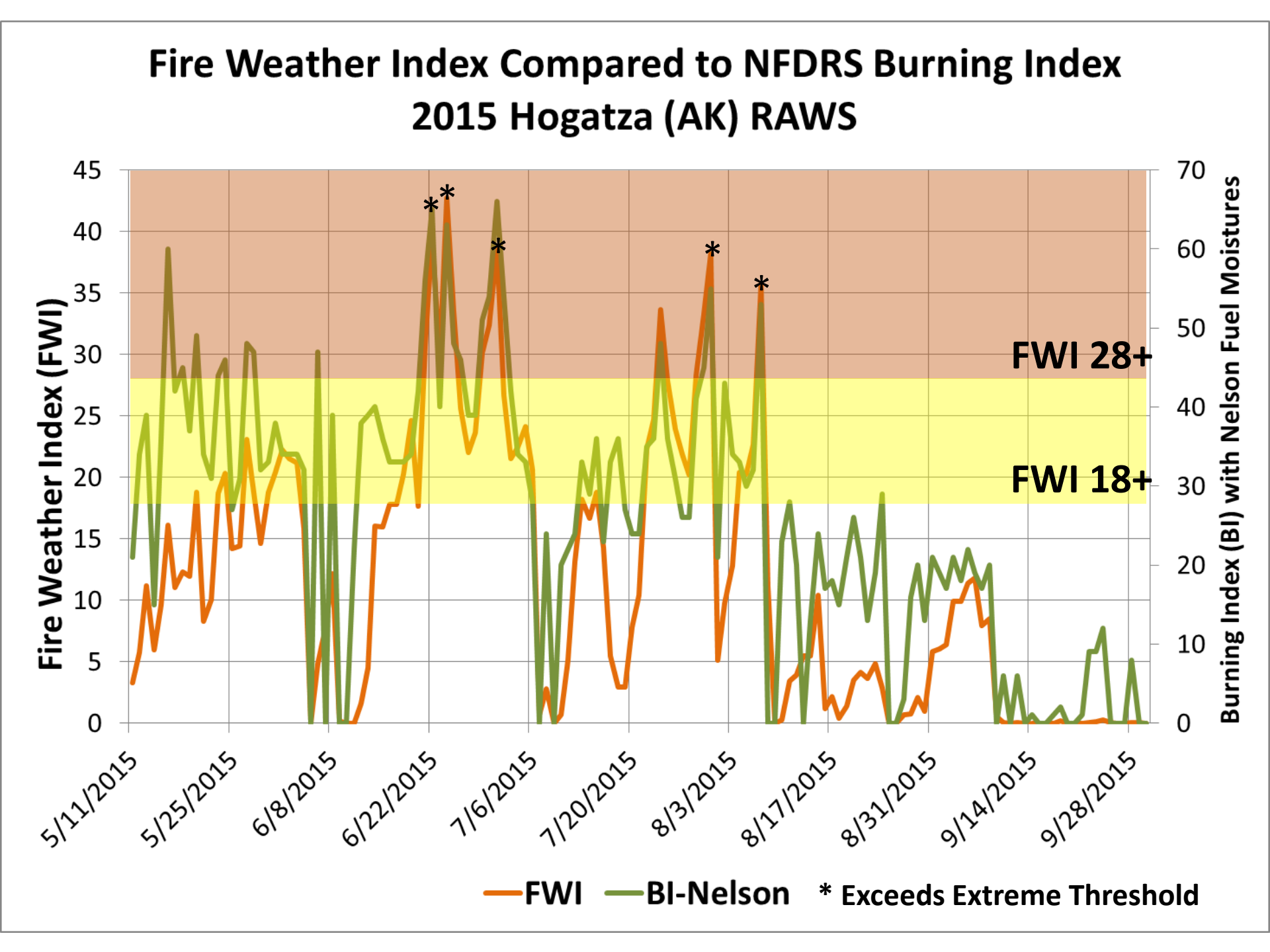
Mack Lake (MI), May 5, 1980


DMC and Dead Fuel Moisture
2015 Hogatza (AK) RAWS
Dead Fuel Moisture, %
Duff Moisture Code
40
35
30
25
20
15
10
5
0
140
120
100
80
60
40
20
0
5/11/15
5/25/15
6/8/15
6/22/15
7/6/15
7/20/15
8/3/15
8/17/15
8/31/15
9/14/15
9/28/15
100h
1000h
DMC


DMC & Equivalent & Dead Fuel Moisture
2015 Hogatza (AK) RAWS
Dead Fuel Moisture, %
DMC Equivalent Fuel Moisture, %
40
35
30
25
20
15
10
5
0
360
320
280
240
200
160
120
80
40
0
5/11/15
5/25/15
6/8/15
6/22/15
7/6/15
7/20/15
8/3/15
8/17/15
8/31/15
9/14/15
9/28/15
100h
1000h
DMC%
Growth Periods


Drought Code (DC) & 1000h FM
2015 Hogatza Raws (AK)
1000h Fuel Moisture
DC Equivalent Fuel Moisture
40
35
30
25
20
15
10
5
0
400
350
300
250
200
150
100
50
0
5/11/15
5/25/15
6/8/15
6/22/15
7/6/15
7/20/15
8/3/15
8/17/15
8/31/15
9/14/15
9/28/15
1000h
1000h-Ne
DC%


Initial Spread Index, Spread Component, Ignition Component
2015 Hogatza (AK) RAWS
Initial Spread Index (ISI), in orange, is similar to both Spread Component (SC) and Ignition Component (IC) from NFDRS
NFDRS Spread Component(SC)/Initial Spread Index(ISI)
NFDRS Ignition Component(IC)
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30
35
6/8/15
6/15/15
6/22/15
6/29/15
7/6/15
7/13/15
7/20/15
7/27/15
8/3/15
8/10/15
SC-Ne
ISI
IC-Ne


Fire Weather Index Compared to NFDRS Burning Index
2015 Hogatza (AK) RAWS
Fire Weather Index (FWI)
Burning Index (BI) with Nelson Fuel Moistures
45
40
35
30
25
20
15
10
5
0
70
60
50
40
30
20
10
0
FWI 28+
FWI 18+
*
*
*
*
*
5/11/2015
5/25/2015
6/8/2015
6/22/2015
7/6/2015
7/20/2015
8/3/2015
8/17/2015
8/31/2015
9/14/2015
9/28/2015
FWI
BI-Nelson
* Exceeds Extreme Threshold

WFDSS Analysis Fuel Moisture Inputs

STFB (1 conditioning day) and FSPro (8/1-10/15) analyses for Pagami Creek Fire, 9/11/11.

Default FWI fuel moistures suggest much drier fuelbeds

Model	1 Hour FM	10 Hour FM	100 Hour FM	Herb FM	Woody FM
default	5	7	16	16	18

FFMC 94, FFMC% (10hr) 6-7%, DMC 85 (100th)

Wildland Fire Decision Support System — Help

Incident	Analysis	Analysis Date	Time
Pagami Creek	09-11 Review 8h S/R v2 1 conditioning day	09/11/2011	16:00

Wind Speed	Direction	RAWS Station
8 mph	328° azimuth	210509 - ELY MN

1 Hr Fuel Moisture Legend

Resolution: 60 meters Units: percent

Value	Freq
Non-burnable	49,923
6.00 - 7.00	50
7.00 - 8.00	19,791
8.00 - 9.00	165,792
9.00 - 10.00	282,585
10.00 - 11.00	277
No Data	2,466

Wildland Fire Decision Support System — Help

Incident	Analysis	Analysis Date	Time
Pagami Creek	09-11 Review 8h S/R v2 1 conditioning day	09/11/2011	16:00

Wind Speed	Direction	RAWS Station
8 mph	328° azimuth	210509 - ELY MN

10 Hr Fuel Moisture Legend

Resolution: 60 meters Units: percent

Value	Freq
Non-burnable	49,923
11.00 - 12.00	10,310
12.00 - 13.00	26,676
13.00 - 14.00	312,387
14.00 - 15.00	119,121
15.00 - 16.00	1
No Data	2,466

Generate ERC Classes

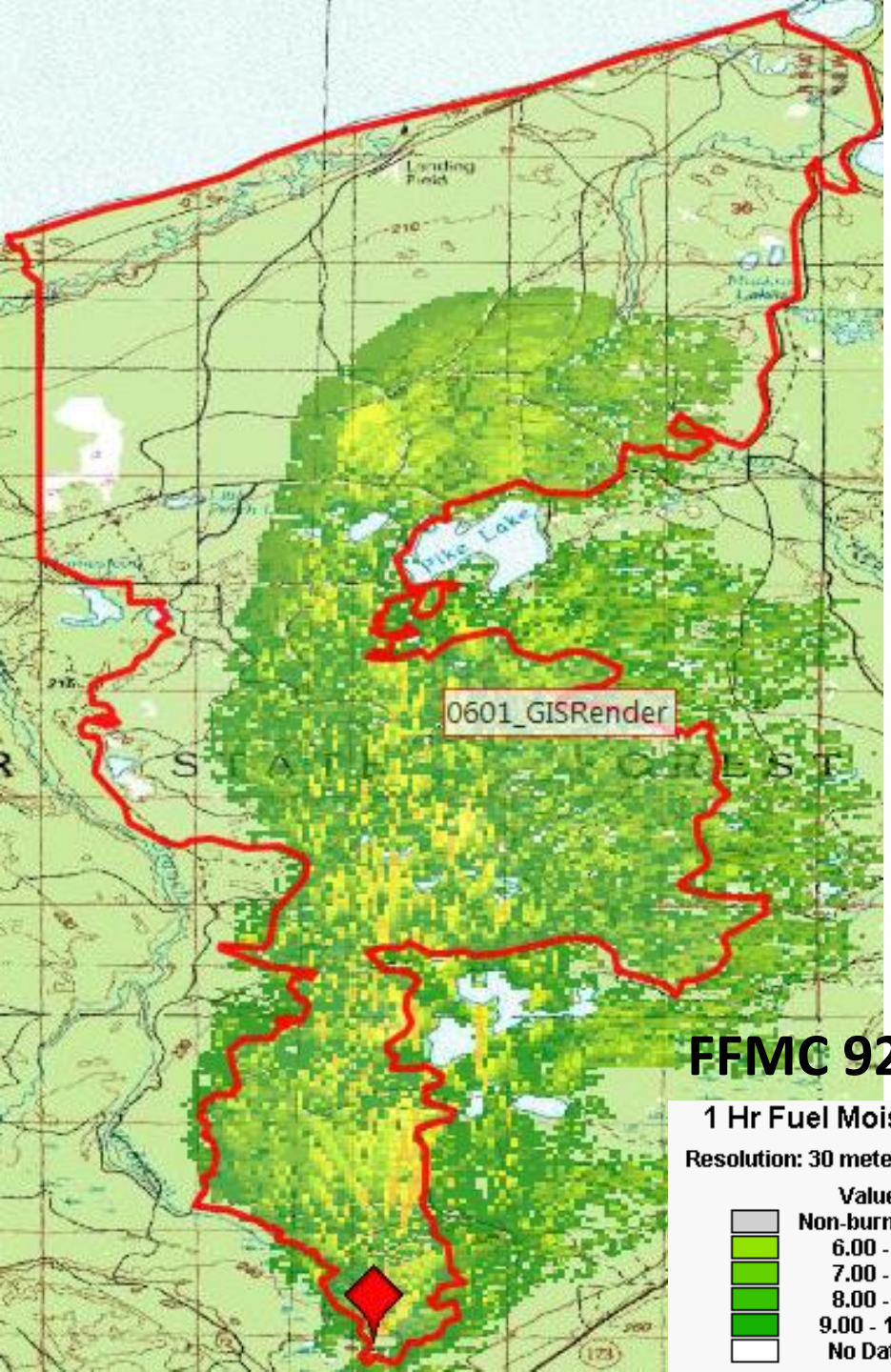
%ile	Min ERC	1 Hour FM	10 Hour FM	100 Hour FM	Herb FM	Woody FM	Burn Period	Spot Prob	Delay
96	33	6.7	7.9	14.0	166.	178.	360	0.15	0
89	30	7.6	9.1	15.2	174.	184.	300	0.10	0
76	26	8.2	10.1	15.9	170.	180.	240	0.05	0
67	24	8.9	11.0	16.7	171.	182.	180	0.01	0
58	22	9.7	12.2	17.3	170.	181.	120	0.00	0

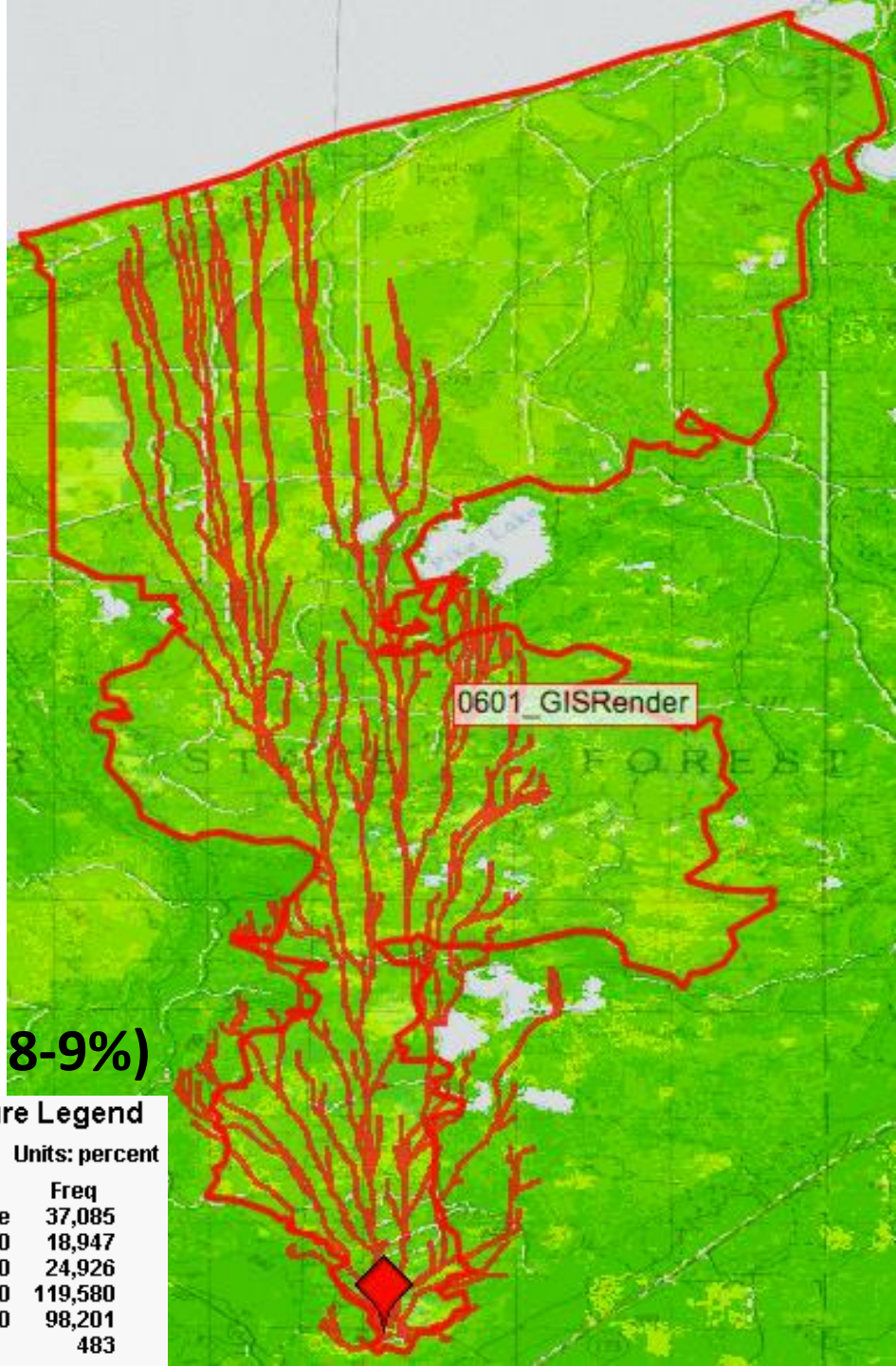
AK Calibrations color maps for spatial views

Class	LOW	MOD	HIGH	VHIGH	EXT
Max Temp	<50°	50° to 59.9°	60° to 69.9°	70° to 79.9°	80°+
Min RH	51% to 100%	41% to 50%	31% to 40%	21% to 30%	<20%
FFMC	0 to 79.9	80 to 85.9	86 to 88.9	89 to 91.9	92+
DMC	0 to 39.9	40 to 59.9	60 to 79.9	80 to 99.9	100+
DC	0 to 149.9	150 to 349.9	350 to 399.9	400 to 449.9	450+
ISI	0 to 1.9	2 to 4.9	5 to 7.9	8 to 10.9	11+
BUI	0 to 39.9	40 to 59.9	60 to 89.9	90 to 109.9	110+
FWI	0 to 8.9	9 to 17.9	18 to 27.9	28 to 34.9	35+

Think of what each item speaks to:

- FFMC to ignition
- DMC to lightning ignition, fuel availability in duff layer
- DC to holdover fire, mop-up difficulty
- ISI to spread potential
- BUI to overall fuel consumption
- FWI to fire intensity & control difficulty





FFMC 92(8-9%)

1 Hr Fuel Moisture Legend

Resolution: 30 meters Units: percent

Value	Freq
Non-burnable	37,085
6.00 - 7.00	18,947
7.00 - 8.00	24,926
8.00 - 9.00	119,580
9.00 - 10.00	98,201
No Data	483

7-Day Significant Fire Growth Potential