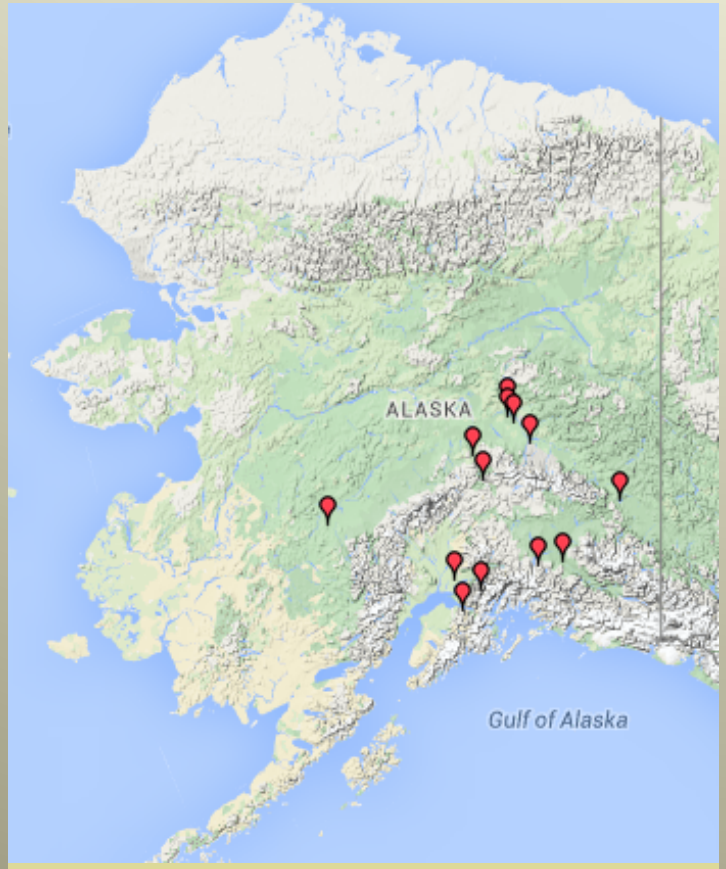
# 2012-2014
# Duff Fuel Moisture and FWI Codes




**Seasonal sampling 2012-2014**


**Jennifer Barnes - NPS AKR Fire Ecologist**

**Eric Miller - BLM-AFS Fire Ecologist**

**Lisa Saperstein – FWS Fire Ecologist**

**Oct 2014 – CFFDRS Summit**

# Why Duff Sample?

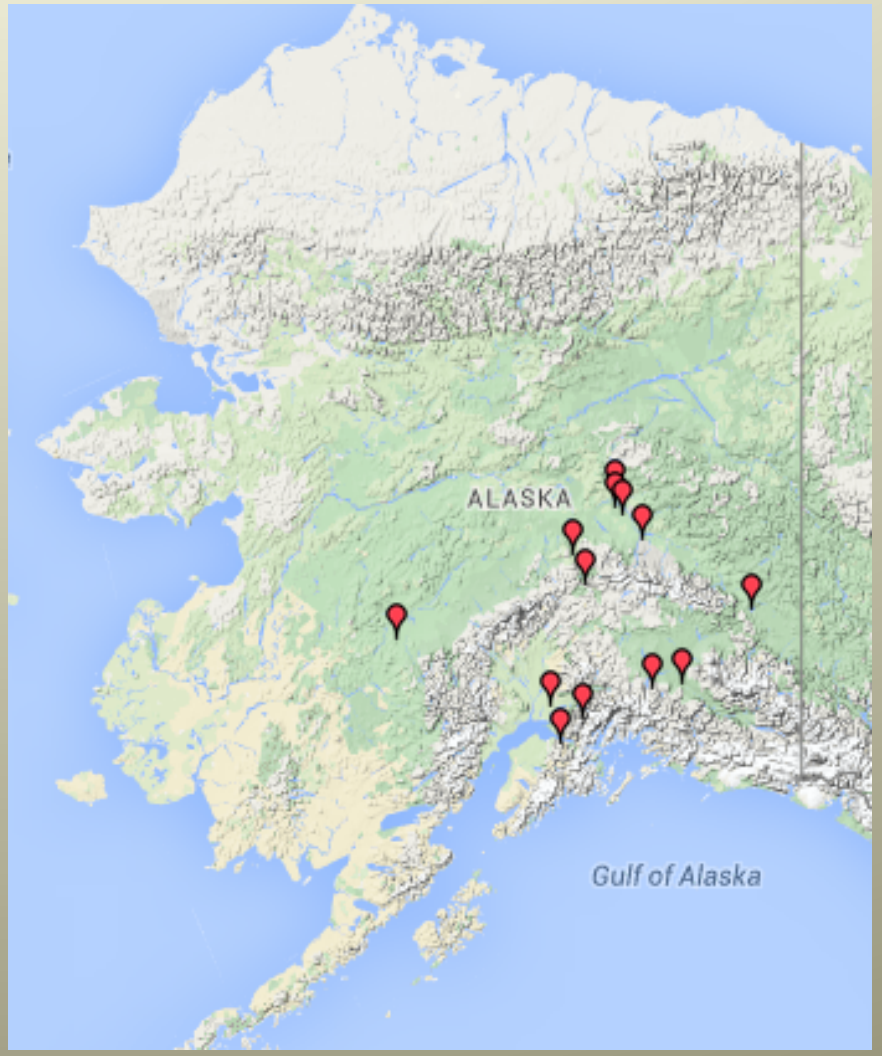
- Do the FWI codes reflect actual moisture content of the duff layers?
- To calibrate a weather station for CFFDRS. For example station start up values may be “Default” or “Overwintered” or “Fuel Moisture Calculated” values.
- For prescribed fire
  - To determine within prescription
  - To start a new portable RAWS or if no nearby RAWS
- Weather station has been down for a while (to re-start codes)
- Convert a code to a moisture content – relate to probability of ignition

# Background on FWI and Duff Sampling

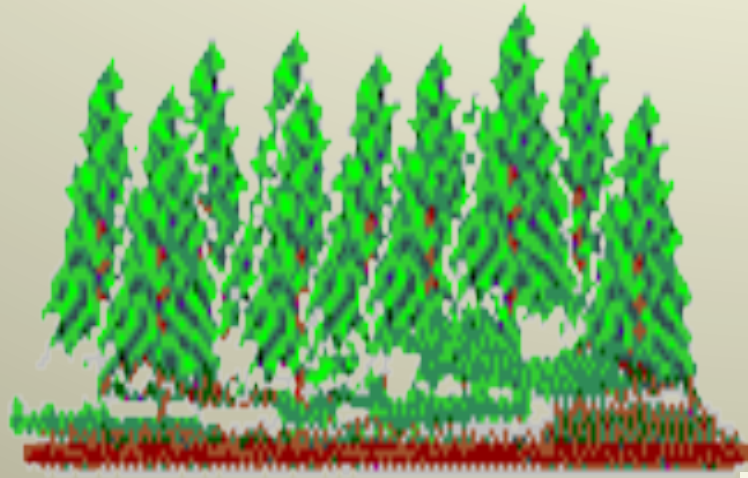
- History of duff sampling in Alaska
  - 1990s – Tetlin, L. Vanderlinden – duff moisture and probability of ignition
  - Brenda Wilmore's Thesis 2001 – develop Alaska specific curves and assess question of overwintering
  - 2002-2004 field sampling using Wilmore recommendations (Report: Jandt, Allen and Horschel 2005)
  - 2012 – 2014…

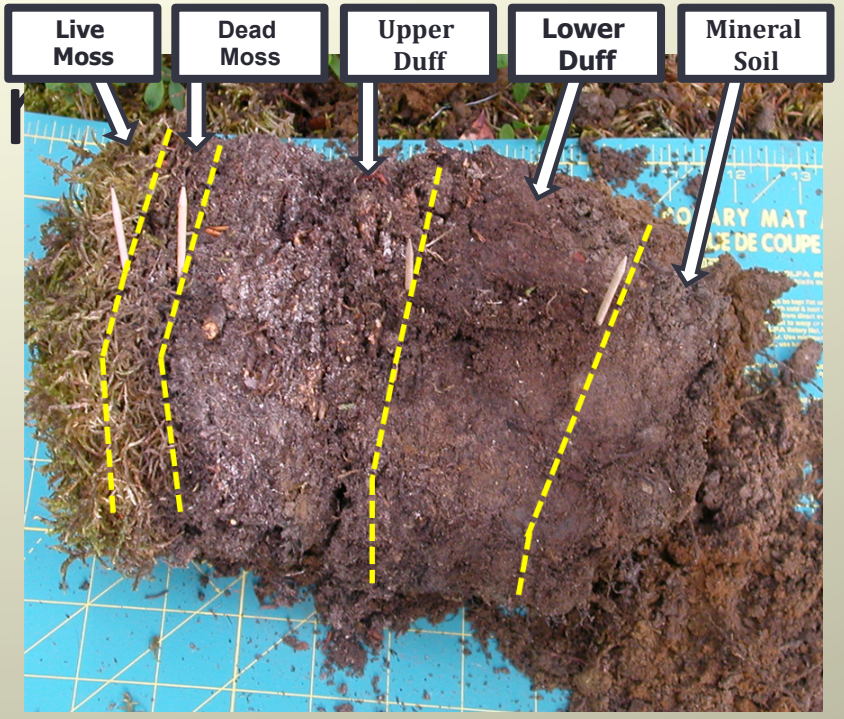
# 2012-2014
# Seasonal Fuel Moisture Sampling

- Verify FWI codes in Alaska
- Three seasons
  - 10 Sites
  - 108 Sample events
  - ~ 324 Duff samples
- Sampled ~ every 2 weeks



# Fuel Moistur







FFMC Surface layer 1-2 cm deep

DMC Duff layer 5-10 cm deep

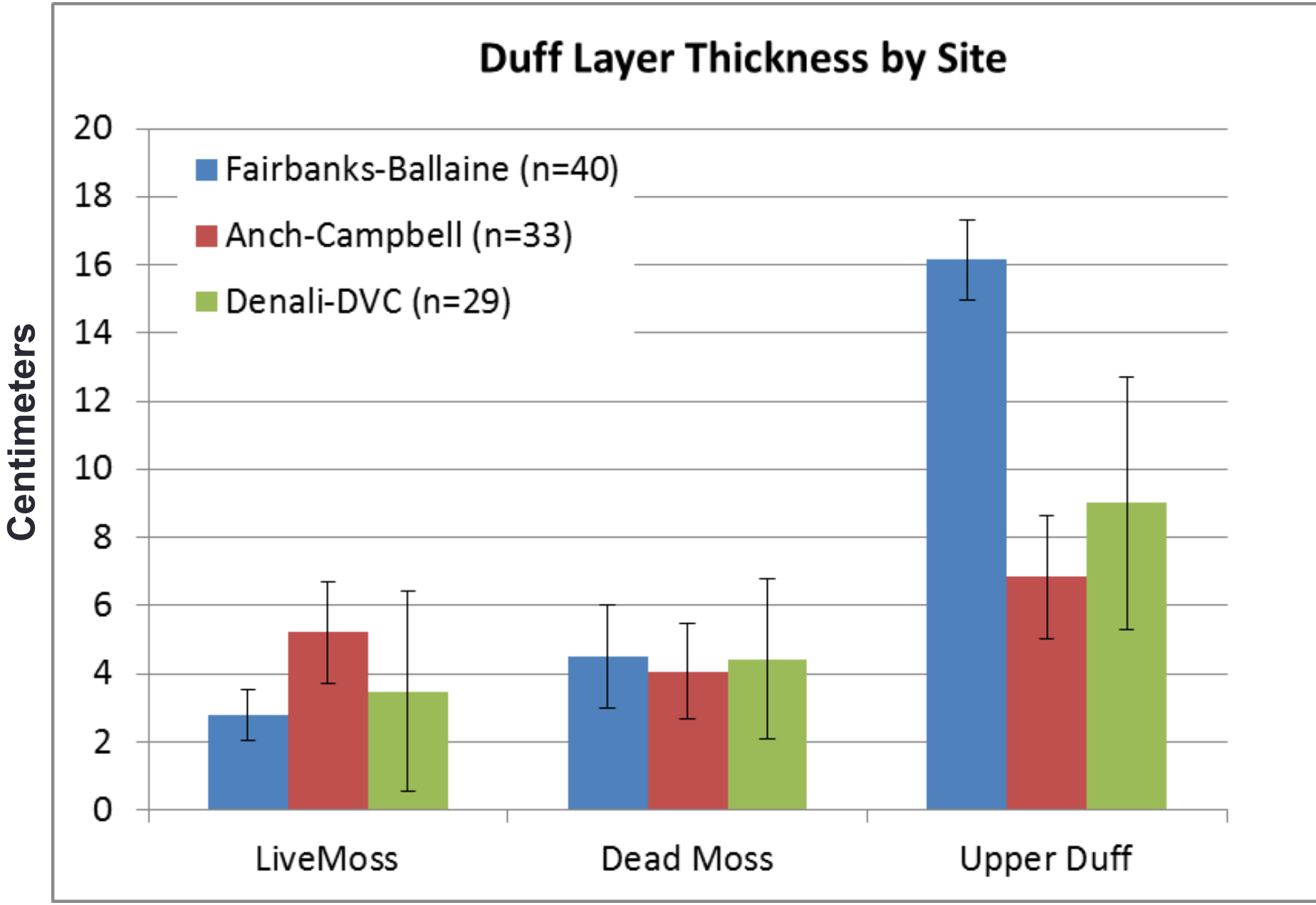
DC Deep duff layers 10-20 cm deep

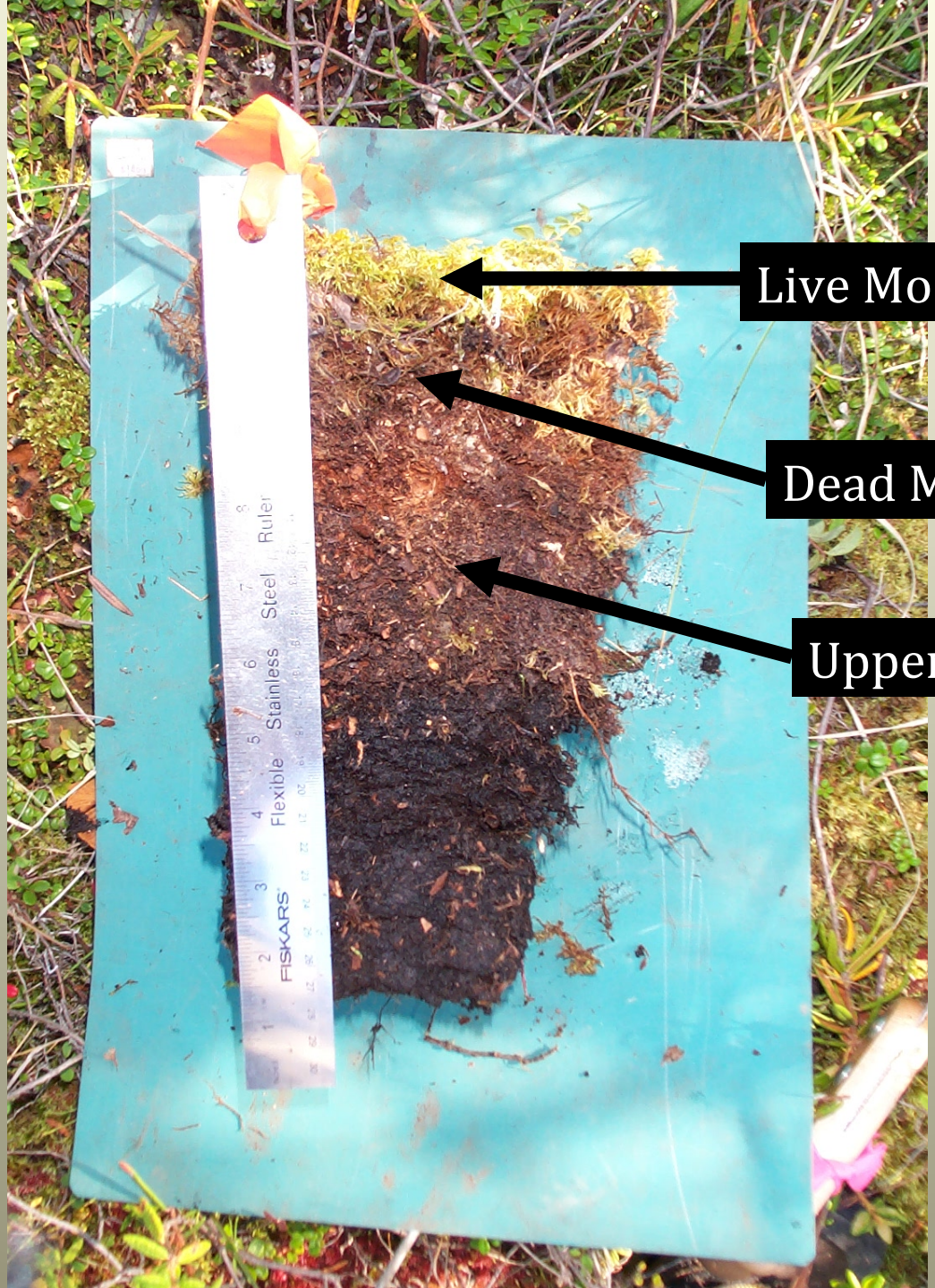
# Alaska Duff Sampling


Sampling based on organic soil strata type (versus sampling by depth) –Wilmore 2001 recommendations

- "Live moss" ~ FFMC
- "Dead moss" ~ DMC
- "Upper duff" ~ DC

# Duff Layers


Duff Layer Thickness by Site
Centimeters
20
18
16
14
12
10
8
6
4
2
0
Fairbanks-Ballaine (n=40)
Anch-Campbell (n=33)
Denali-DVC (n=29)
LiveMoss
Dead Moss
Upper Duff


Live Moss ~ FFMC
Dead Moss ~ DMC
Upper Duff ~ DC
FISKARS
Flexible Stainless Steel Ruler

# Published equations from Canada and Alaska

- Compare Alaska data to published equations
  - DMC to Moisture Content (Lawson et. al. 1997 Whitehorse FM Eq)
  - DC to Moisture Content (Lawson & Dalrymple 1996; Wilmore 2001)

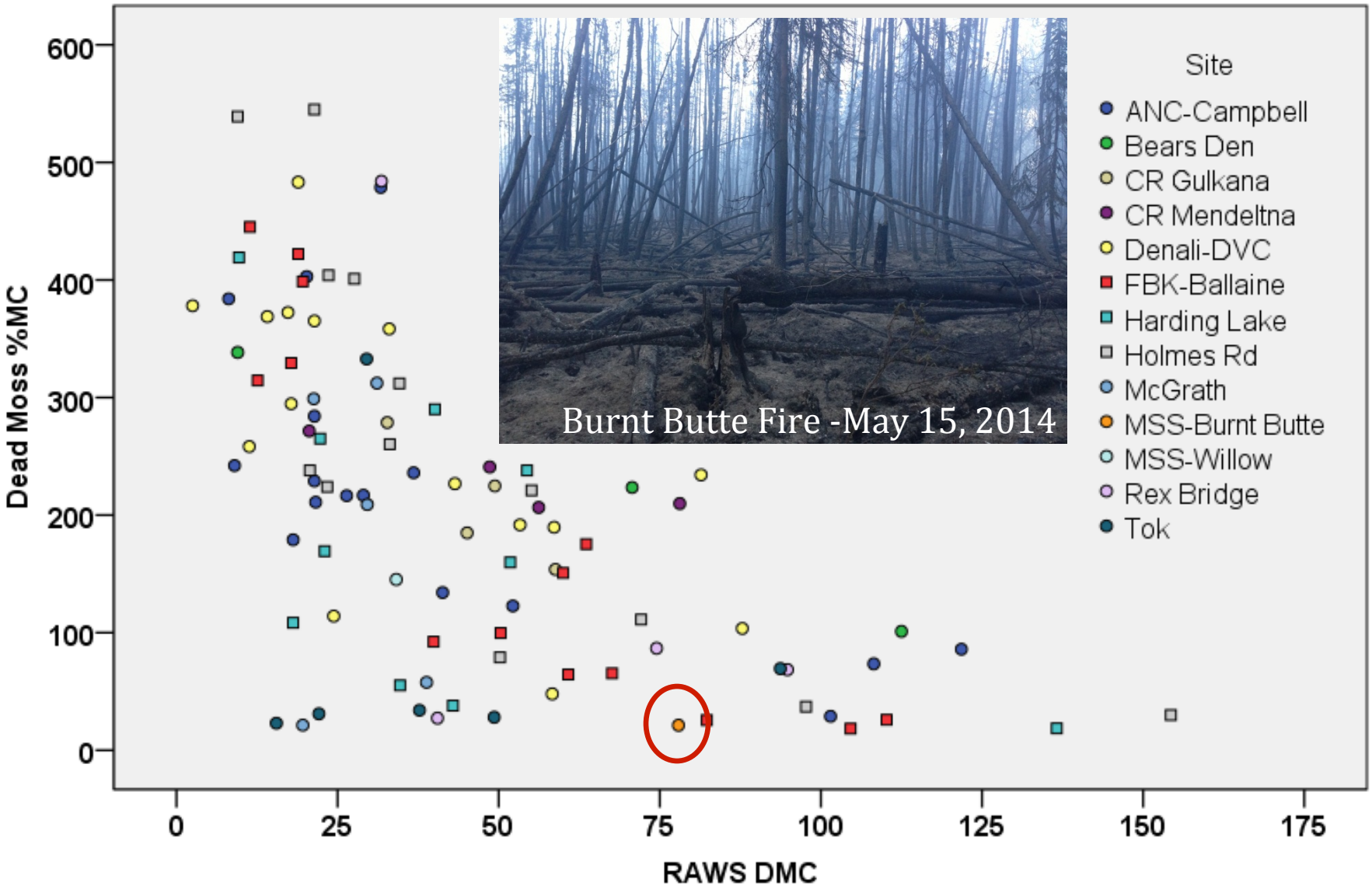
- Utilized standard published equations to convert duff moisture to CFFDRS codes (DMC & DC)
  - $MC = -108.09 \ln(DC) + 833.15$ (published format)
  - $DC = 1 / \exp[(MC - 833.15) / 108.09]$

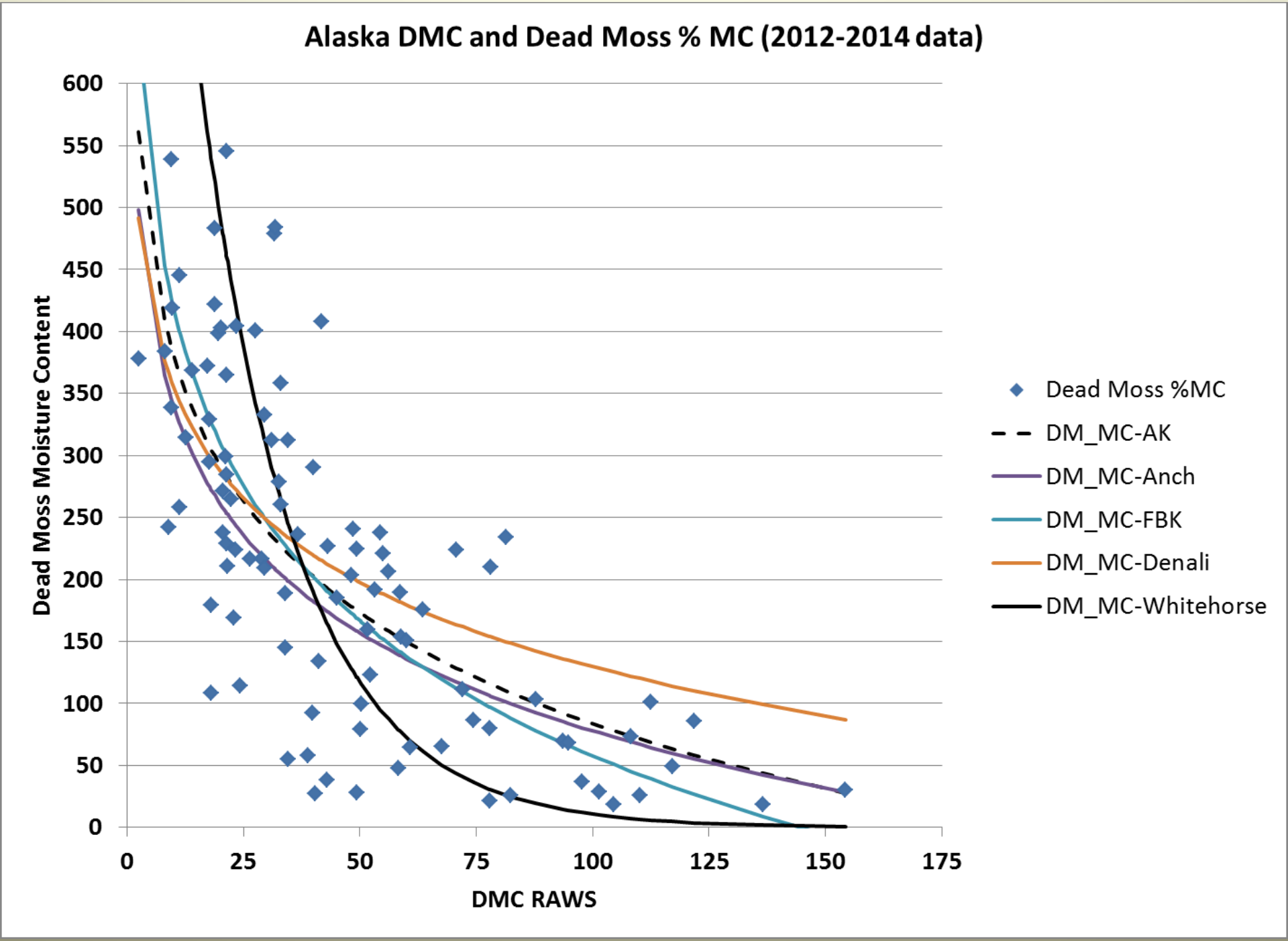
# Moisture content and codes

- Do the codes reflect moisture content?
- Are there regional or geographic patterns?
- Are there seasonal patterns?

# DMC and Fuel Moisture in AK

# DMC vs Dead Moss Moisture




Alaska DMC and Dead Moss % MC (2012-2014 data)
Dead Moss Moisture Content
600
550
500
450
400
350
300
250
200
150
100
50
0
0
25
50
75
100
125
150
175
DMC RAWS
Dead Moss %MC
DM_MC-AK
DM_MC-Anch
DM_MC-FBK
DM_MC-Denali
DM_MC-Whitehorse

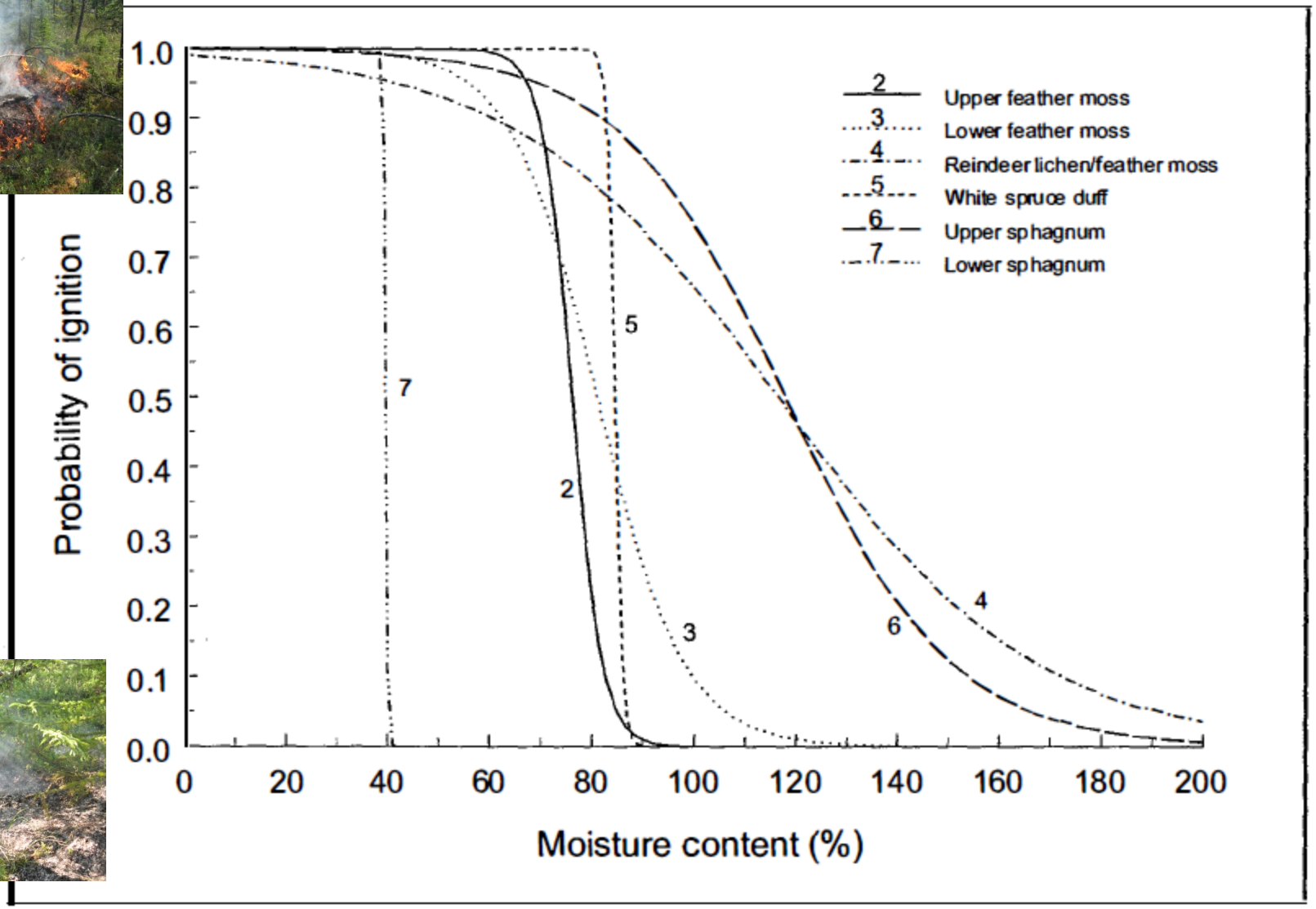
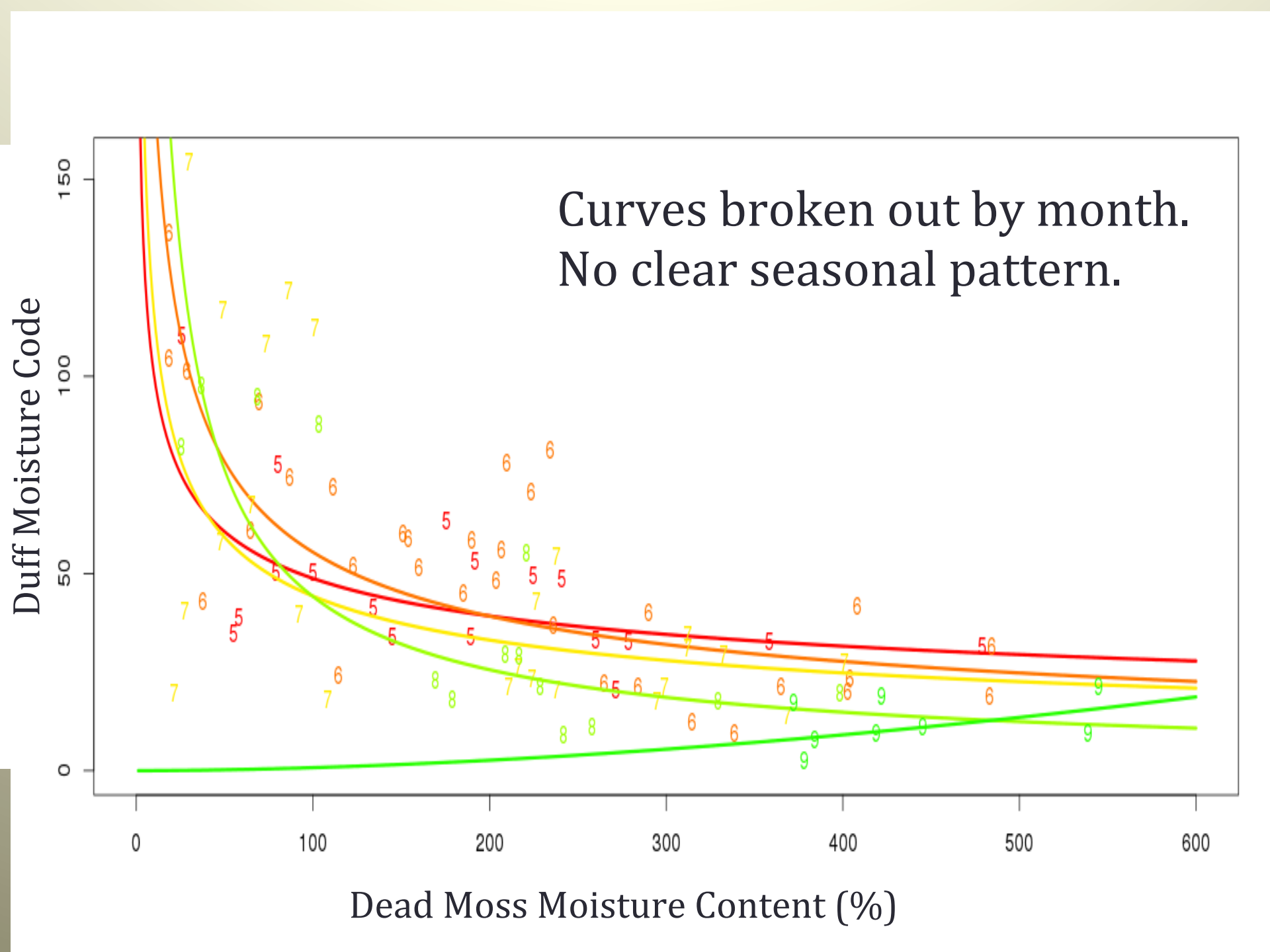



**Figure 2. Probability of sustained smoldering ignition as a function of duff moisture content for several boreal forest duff types.**

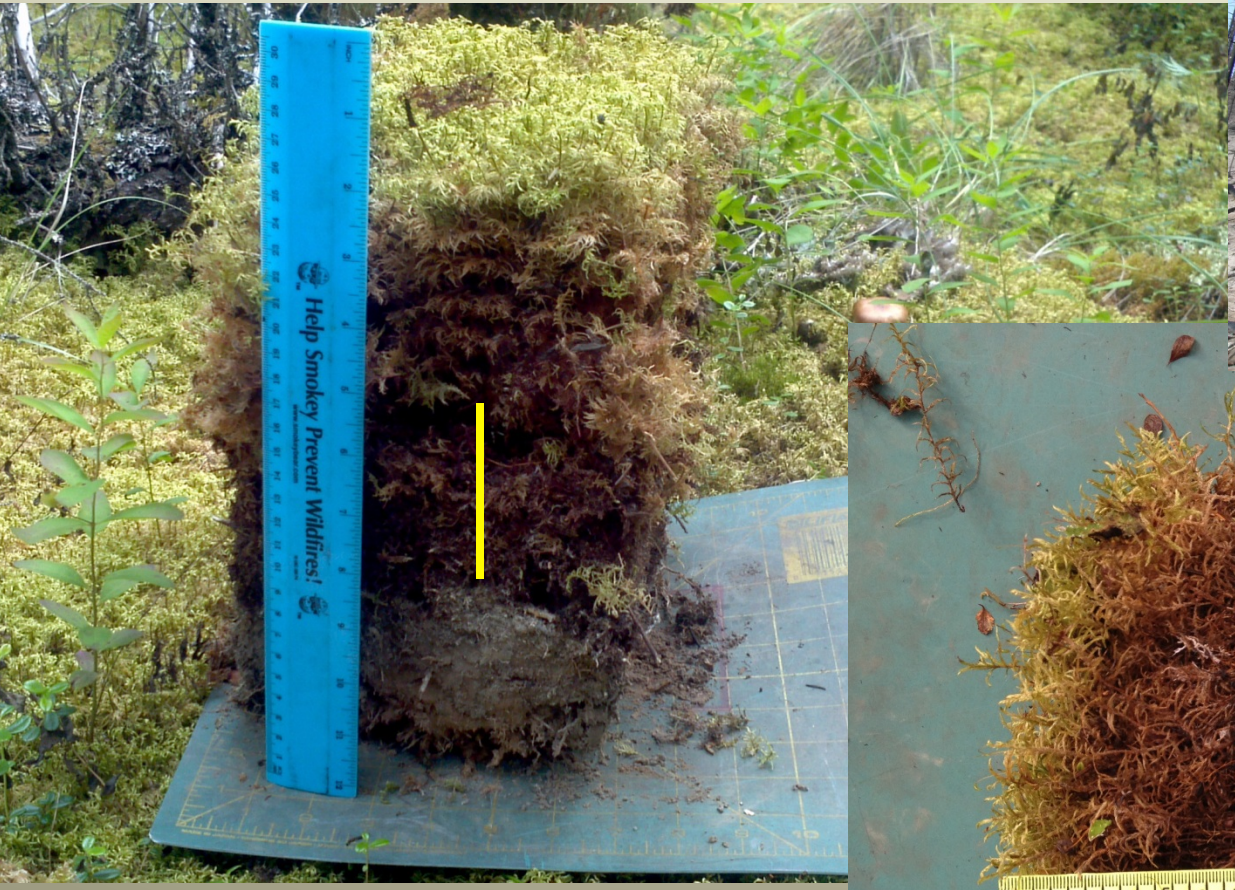
Lawson, B.D.; Frandsen, W.H.; Hawkes, B.C.; Dalrymple, G.N. 1997. Probability of sustained smoldering ignition for some boreal forest duff types. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, Alberta. For. Manage. Note 63.

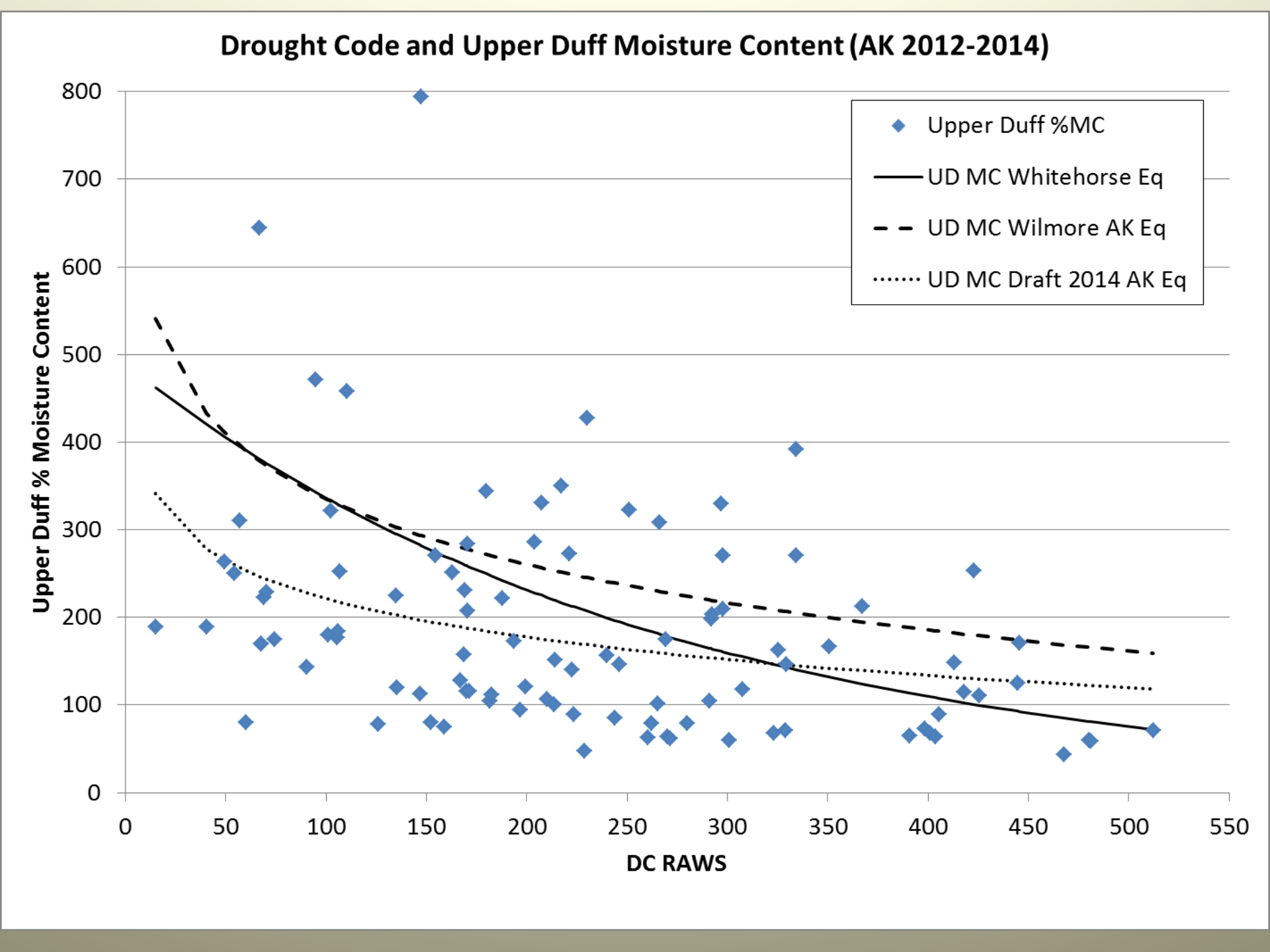

Curves broken out by month.
No clear seasonal pattern.
Duff Moisture Code
0
50
100
150
0
100
200
300
400
500
600
Dead Moss Moisture Content (%)

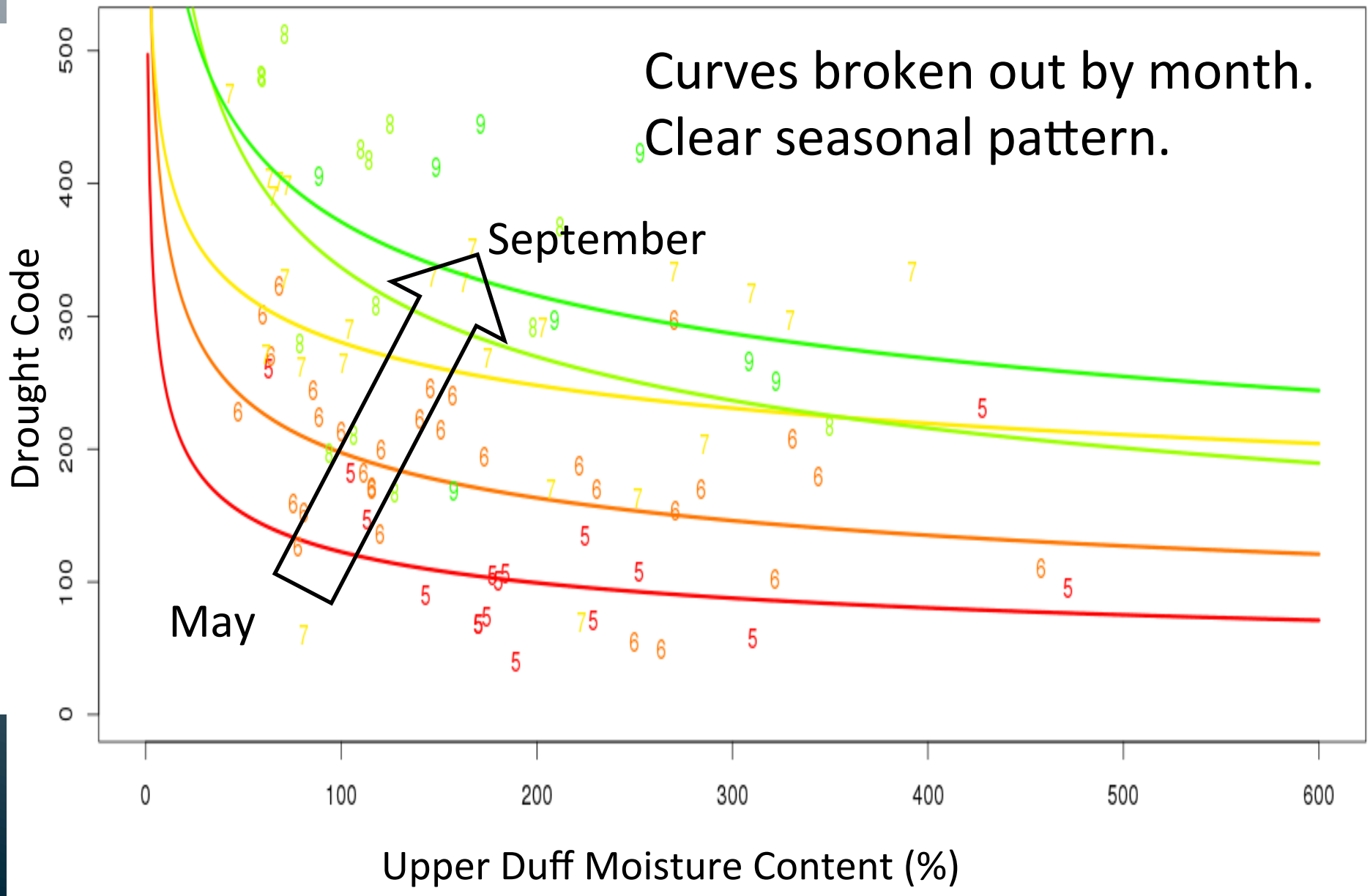
# Duff Moisture Code Conclusions

- DMC appears to represent moisture content of ‘dead moss’ layers
- Curve different from Whitehorse or National Standard
- Weak regional differences detected within Alaska
- No seasonal effect detected (works throughout most months)

# DC and Upper Duff Moisture





Drought Code and Upper Duff Moisture Content (AK 2012-2014)
Upper Duff %MC
UD MC Whitehorse Eq
UD MC Wilmore AK Eq
UD MC Draft 2014 AK Eq
Upper Duff % Moisture Content
DC RAWS
0
100
200
300
400
500
600
700
800
0
50
100
150
200
250
300
350
400
450
500
550

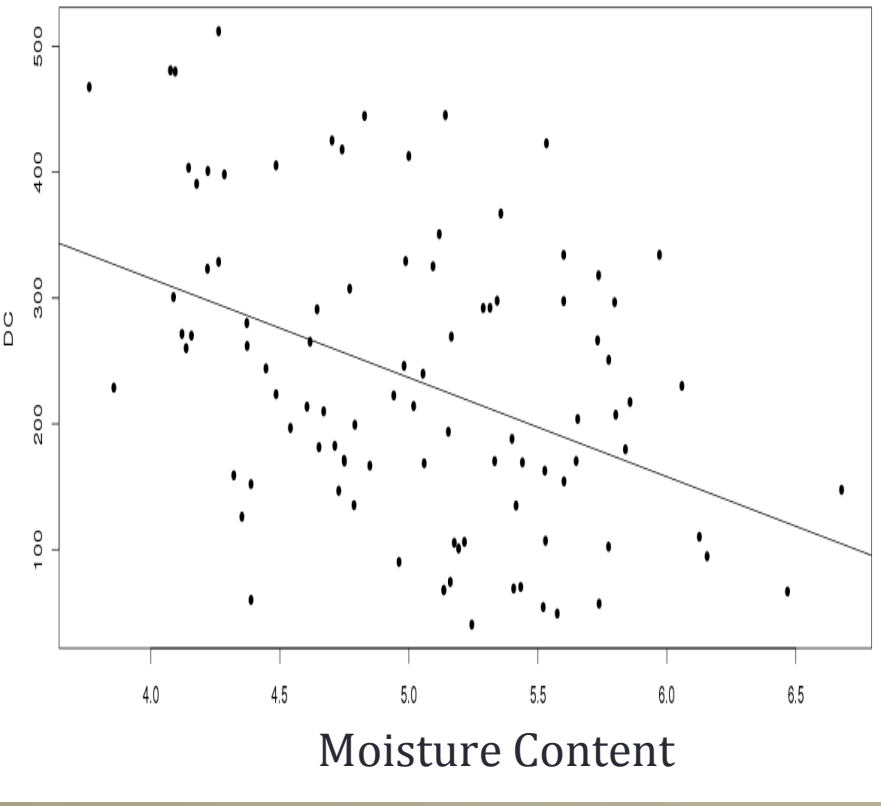

Curves broken out by month.
Clear seasonal pattern.
September
May
Drought Code
Upper Duff Moisture Content (%)
0
100
200
300
400
500
600

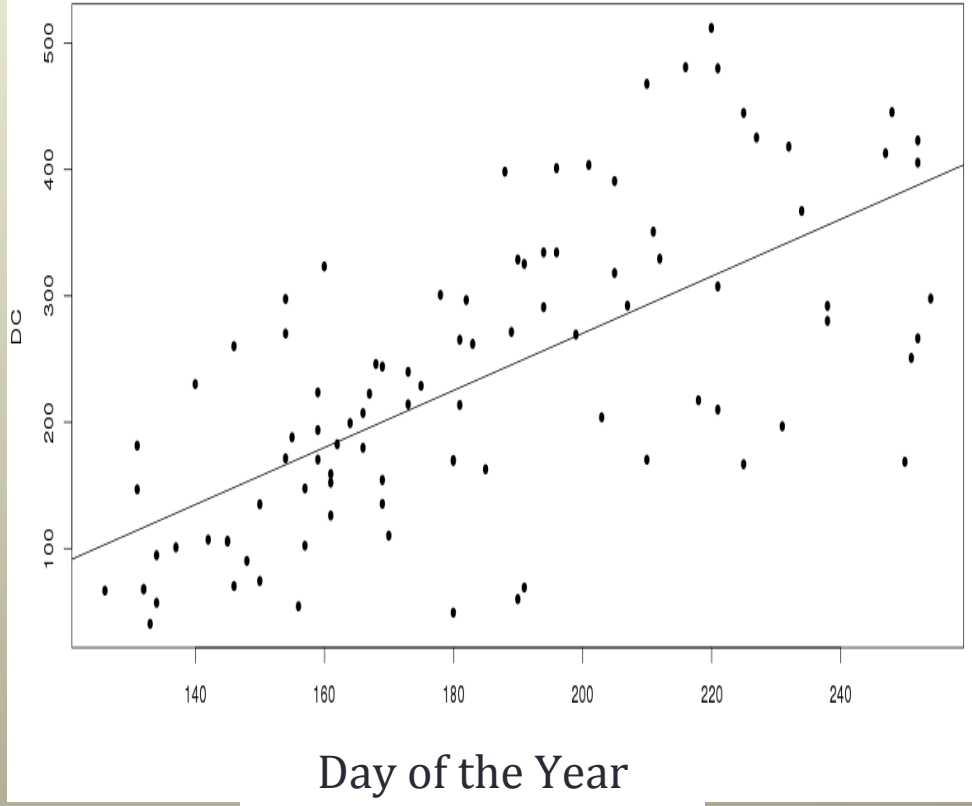
# Drought Code

- We think we have a moisture effect
- But we also have a seasonal effect
- Which is more important?

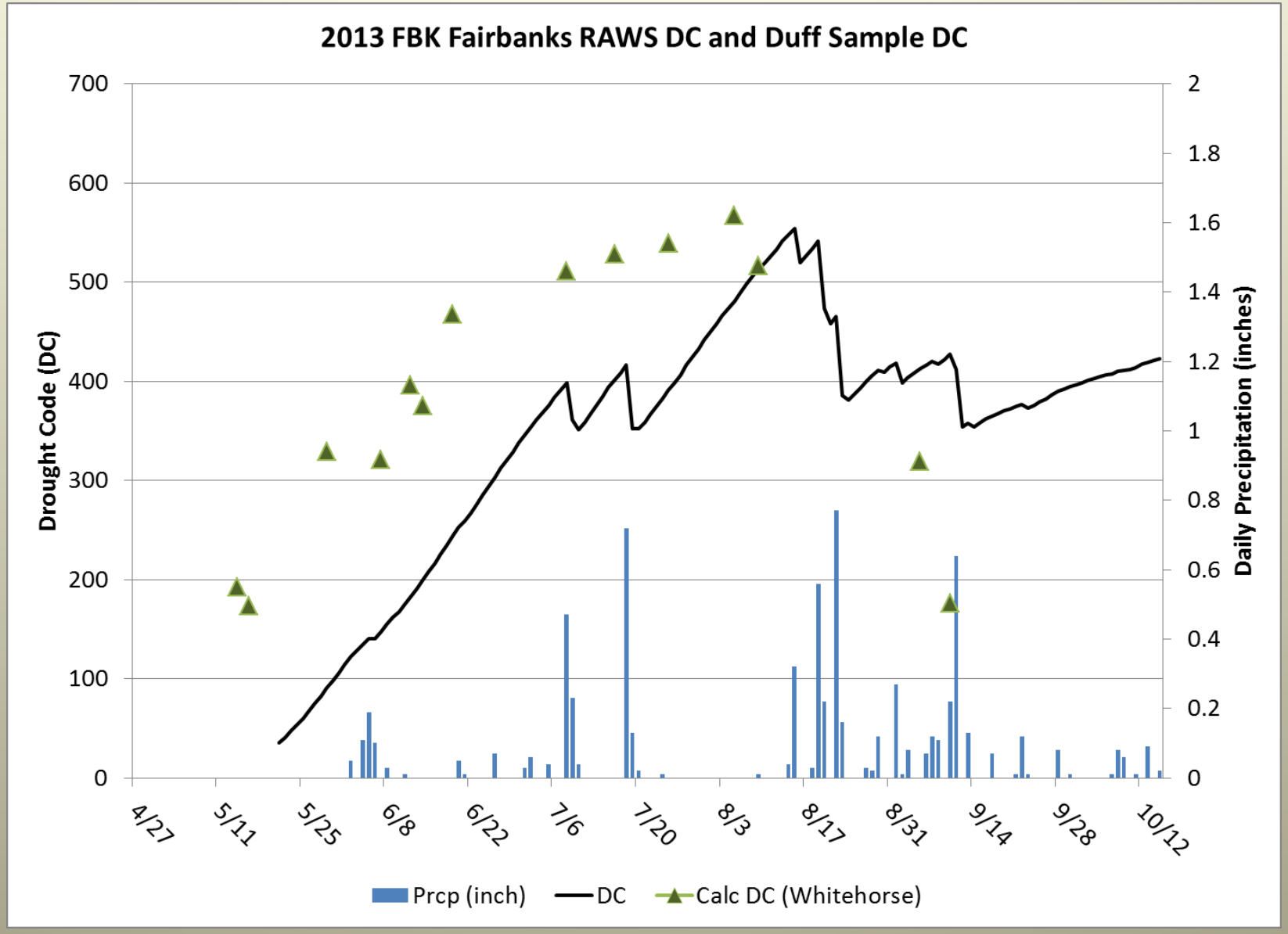
Upper Duff MC explains 16% of the error in DC

Day of Year explains 54%.

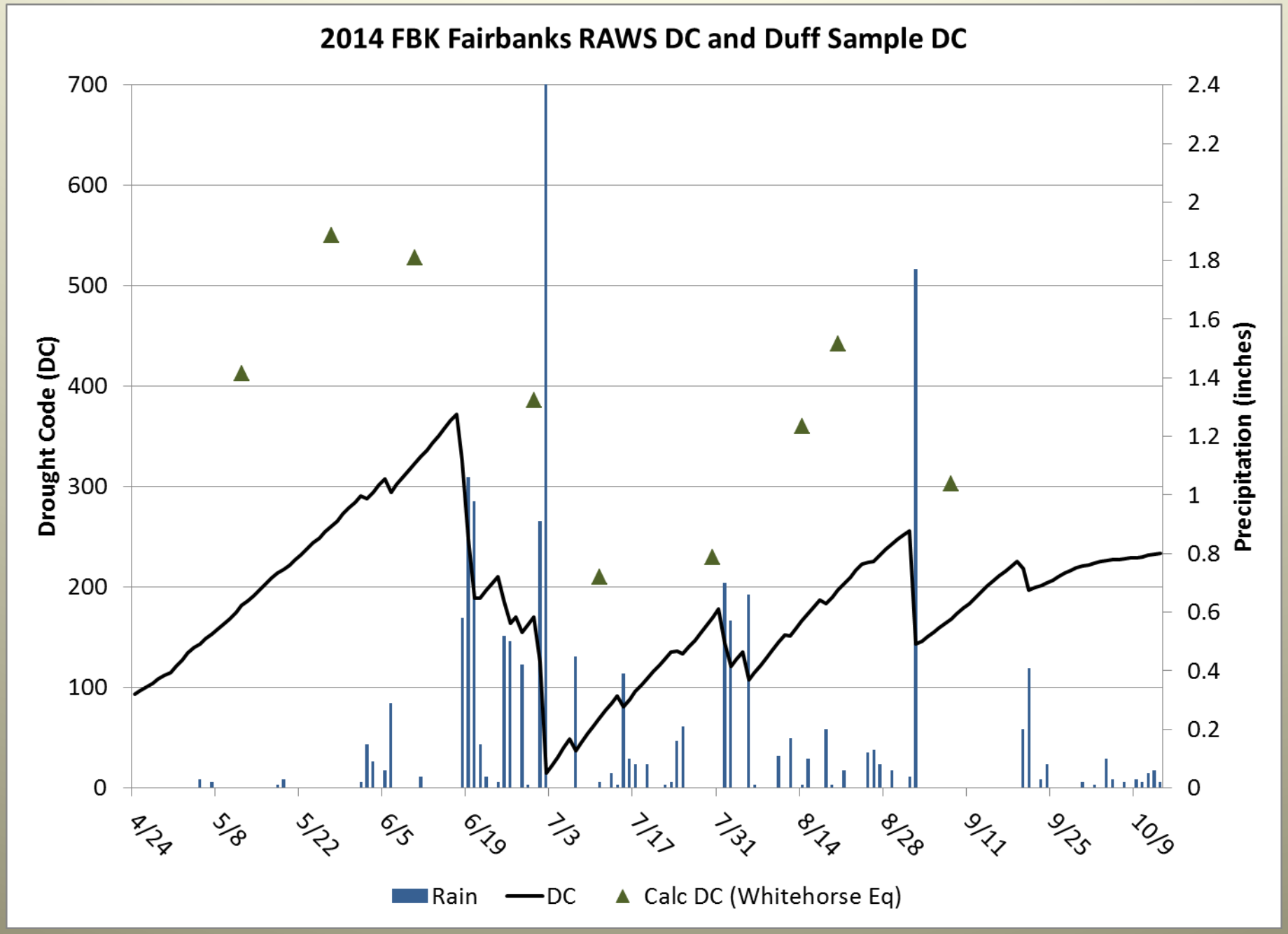



- Suggests we have a DC problem




- DC tends to continue rising over the season


2014 FBK Fairbanks RAWS DC and Duff Sample DC
Drought Code (DC)
Precipitation (inches)
700
600
500
400
300
200
100
0
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
4/24
5/8
5/22
6/5
6/19
7/3
7/17
7/31
8/14
8/28
9/11
9/25
10/9
Rain
DC
Calc DC (Whitehorse Eq)

# Drought Code Conclusion

- Factors
  - MC not relevant
  - Possible regional differences
  - Duff property differences across sites (next slide)
  - Season (correlated but not causative)
- Moisture sampling suggests
  - Drier in spring than DC suggests
  - Wetter in fall than DC suggests
- DC does not appear to represent Upper Duff moisture content

# Conclusions / Next Steps

- DMC conversion is reasonable
- DC is probably not telling us as much as we think about moisture content in the upper duff layer

- Is it meaningful to provide a DC:MC equation?
- Mine old duff sampling data
- Decide on an equation form

***FWI Codes are atmospheric weather driven – not a hydrologic system***

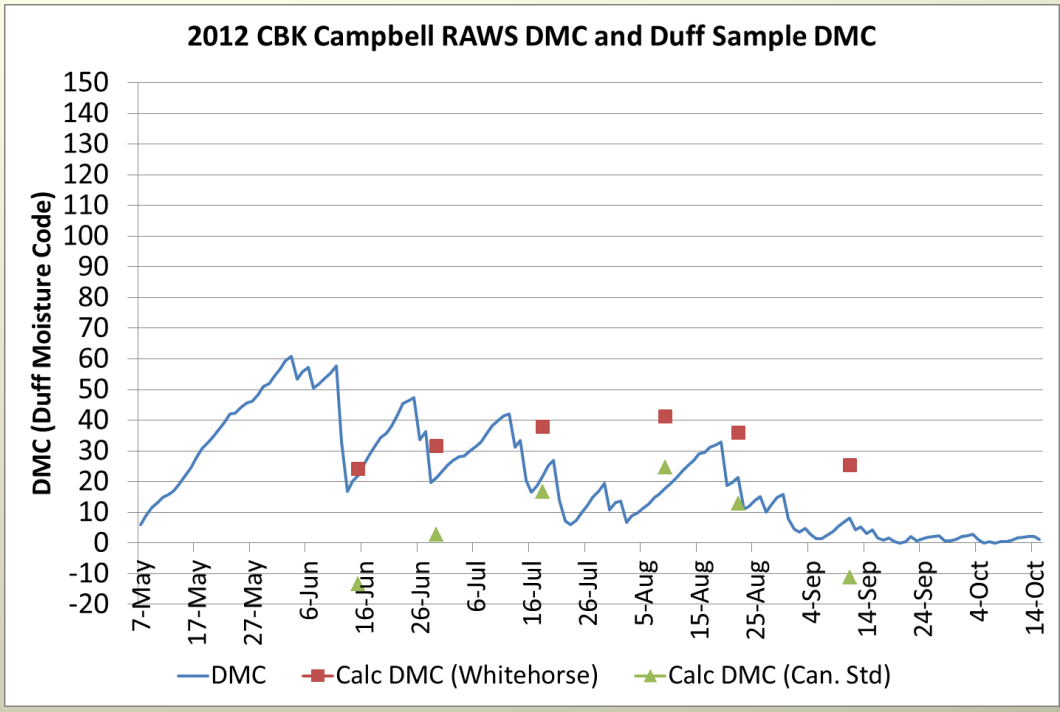
# Discussion

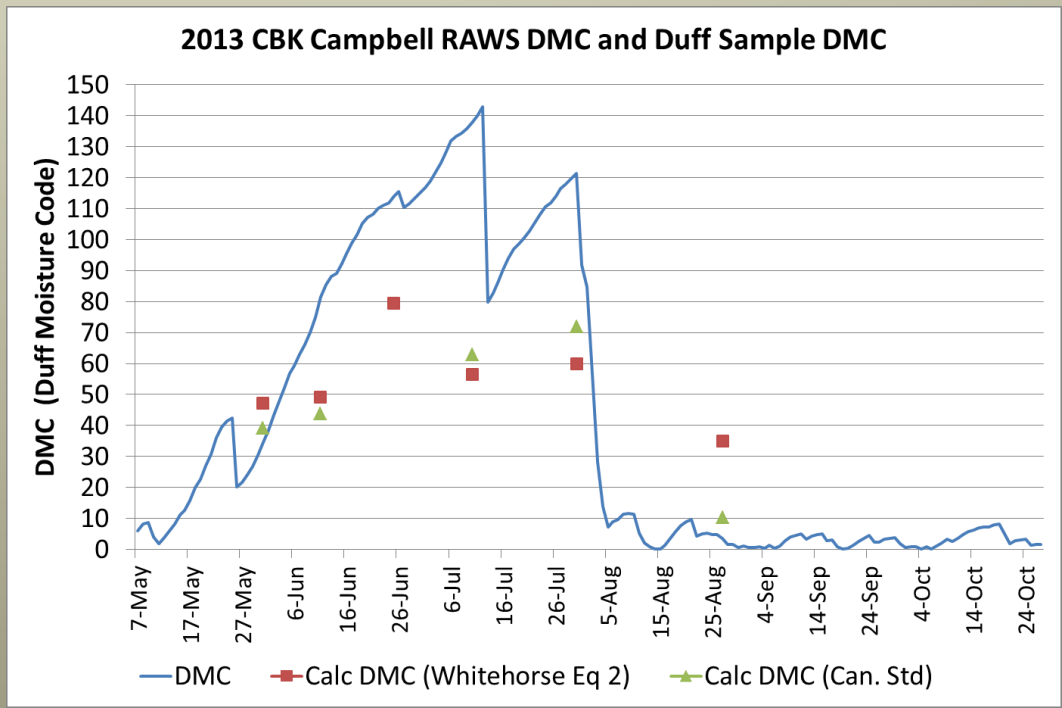
- How are people using this data?
- Should we keep sampling?
- Should the data be used for setting or re-setting FWI codes for RAWS?
- How do we improve on the DC?

- Does the equation format matter?  Do we want to calculate a code from moisture content?

# DMC - Duff Sampling Anchorage

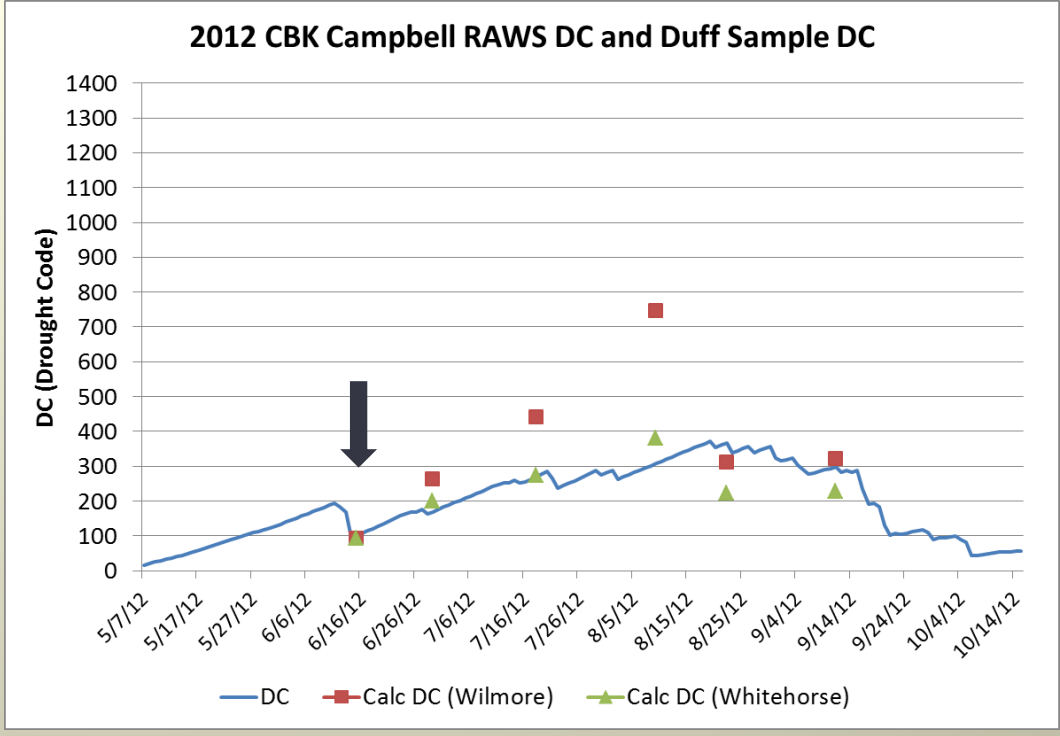
- DMC RAWS shows seasonal weather patterns
- Campbell - Duff samples do not follow DMC RAWS well
- Which equation works or none?

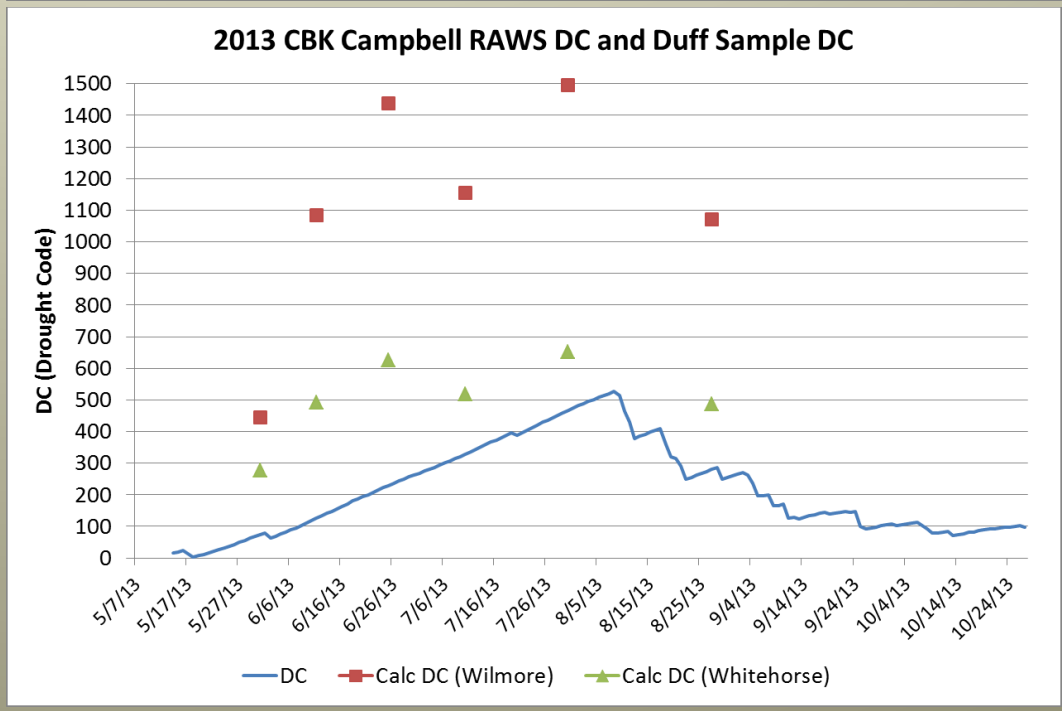


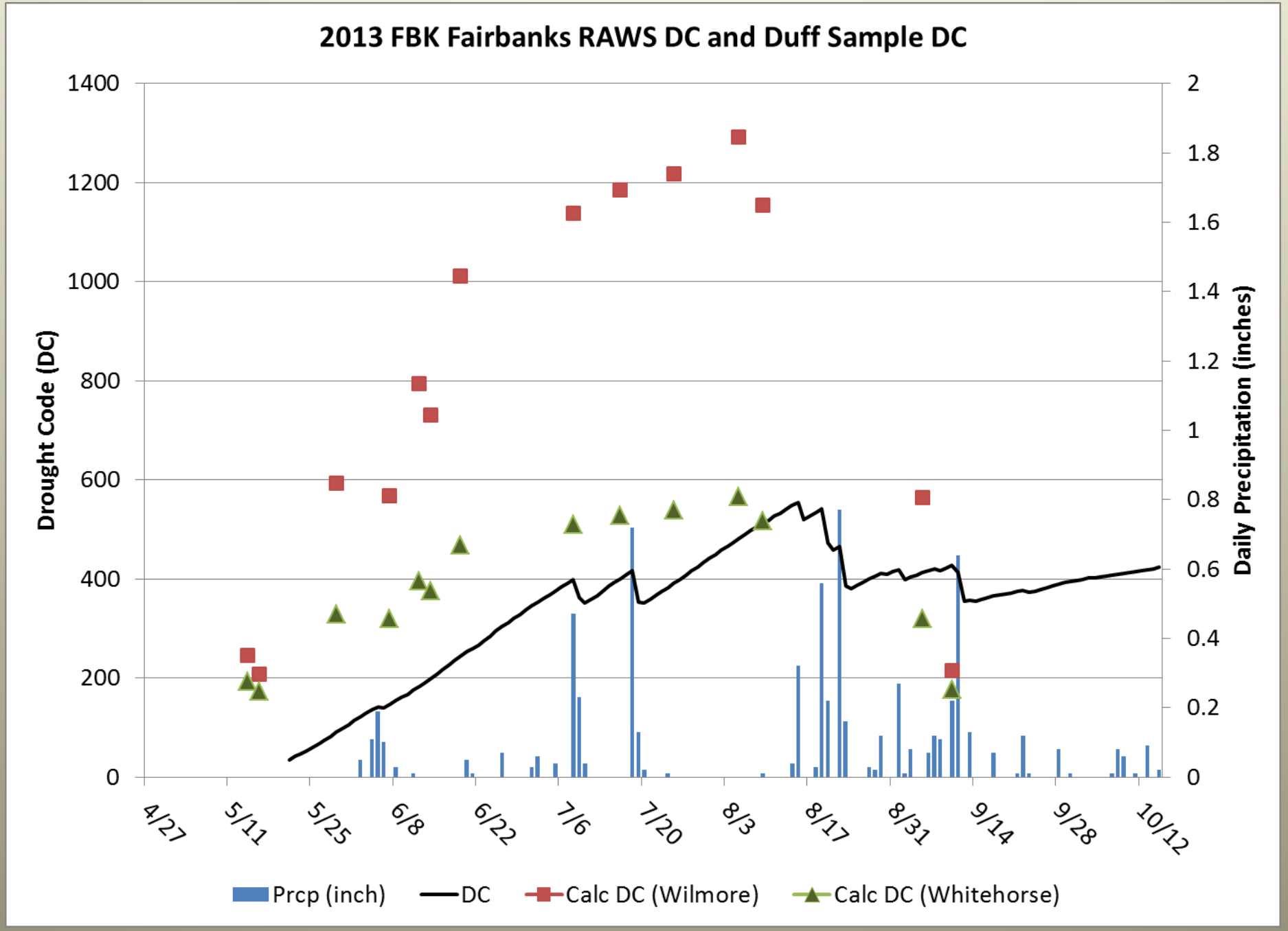



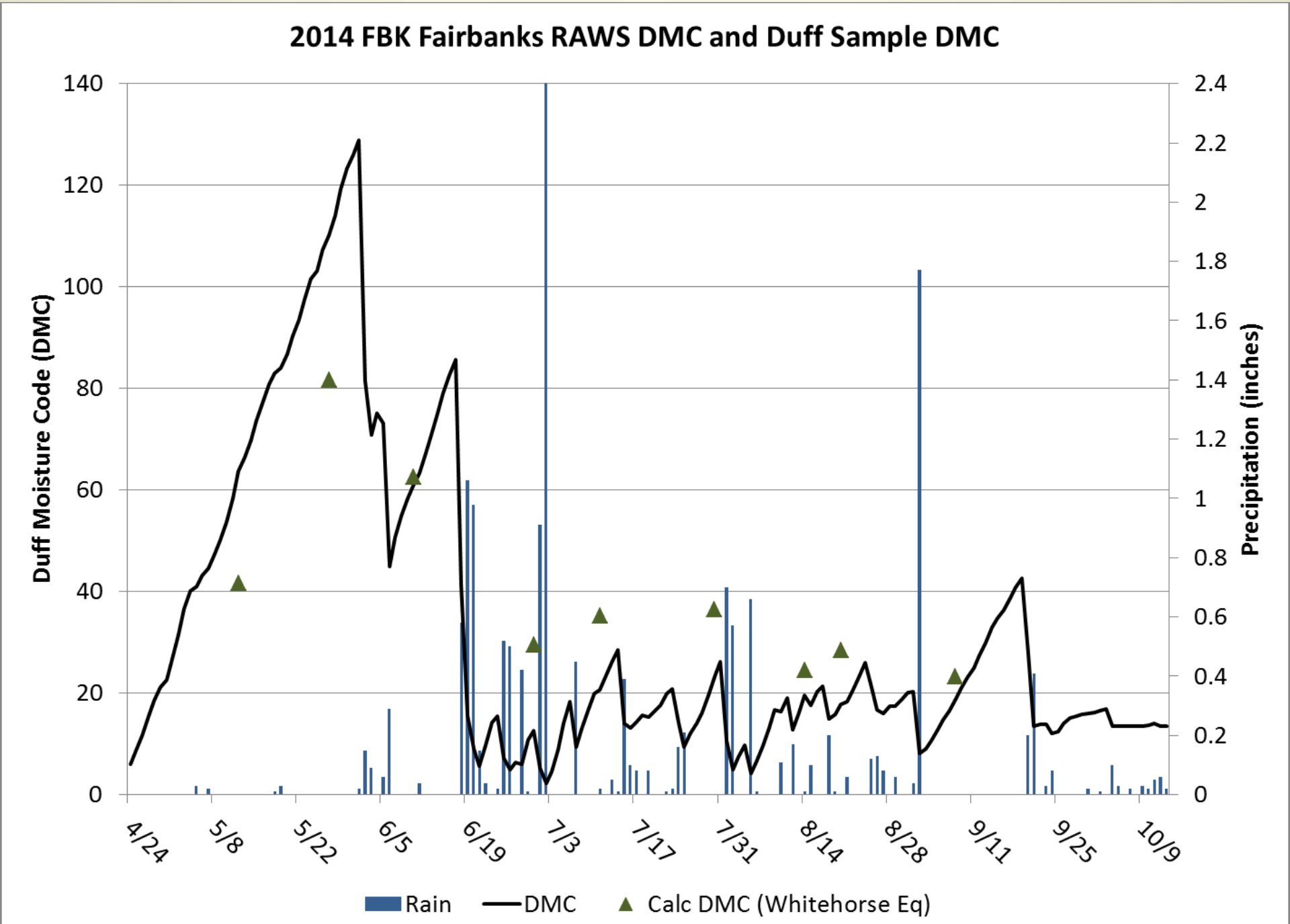
# DC Duff Field Sampling - ANC

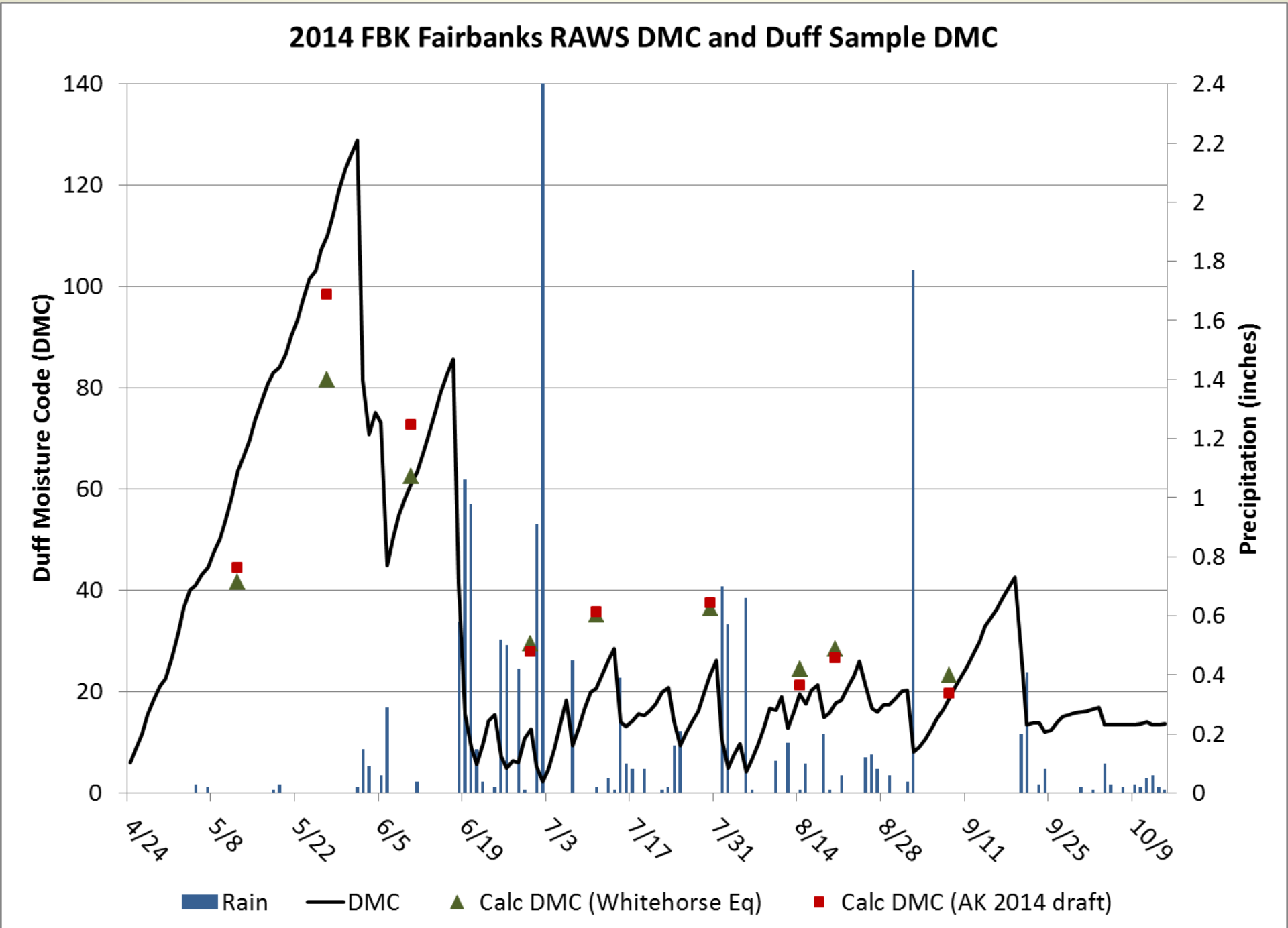
- CBK reset in 2012 but not 2013
- Yukon Eqn better than Wilmore's

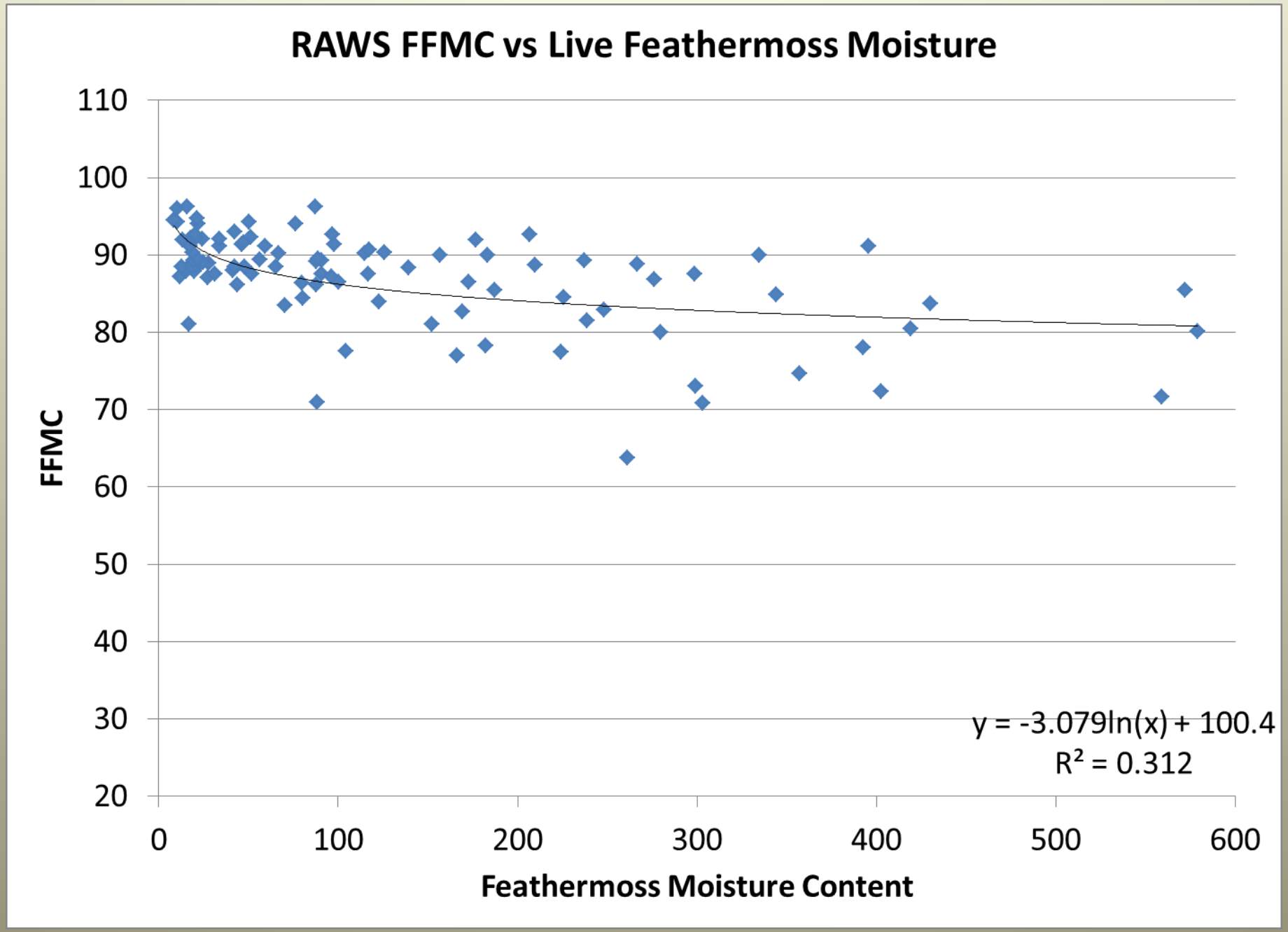



2013 FBK Fairbanks RAWS DC and Duff Sample DC
Drought Code (DC)
Daily Precipitation (inches)
1400
1200
1000
800
600
400
200
0
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
4/27
5/11
5/25
6/8
6/22
7/6
7/20
8/3
8/17
8/31
9/14
9/28
10/12
Prcp (inch)
DC
Calc DC (Wilmore)
Calc DC (Whitehorse)


2014 FBK Fairbanks RAWS DMC and Duff Sample DMC
Duff Moisture Code (DMC)
Precipitation (inches)
140
120
100
80
60
40
20
0
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
4/24
5/8
5/22
6/5
6/19
7/3
7/17
7/31
8/14
8/28
9/11
9/25
10/9
Rain
DMC
Calc DMC (Whitehorse Eq)


2014 FBK Fairbanks RAWS DMC and Duff Sample DMC
Duff Moisture Code (DMC)
Precipitation (inches)
140
120
100
80
60
40
20
0
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
4/24
5/8
5/22
6/5
6/19
7/3
7/17
7/31
8/14
8/28
9/11
9/25
10/9
Rain
DMC
Calc DMC (Whitehorse Eq)
Calc DMC (AK 2014 draft)


RAWS FFMC vs Live Feathermoss Moisture
FFMC
110
100
90
80
70
60
50
40
30
20
0
100
200
300
400
500
600
Feathermoss Moisture Content
y = -3.079ln(x) + 100.4
R² = 0.312