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Saskatchewan

Performance Indicators for the Wildfire Prevention Program

Daniel Poirier

Chief Meteorologist
Wildfire Management Branch
Saskatchewan Environment



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OBJECTIVE:

Provide performance indicators to evaluate Saskatchewan Wildfire Prevention Program

Old traditional way:

- *Compare fire season number of human-caused wildfires to decadal or multi-decadal average*
- *Use fire season ratio human versus lightning caused wildfires*

- ❖ *Comment results versus*
 - *Severity fire season*
 - *Wildfire Threat spring/summer/fall months*
 - *Change in Human activity on the landscape*
 - *Seasonal or decadal evolution of fuel on the landscape*



Provide performance indicators to evaluate Saskatchewan Wildfire Prevention Program

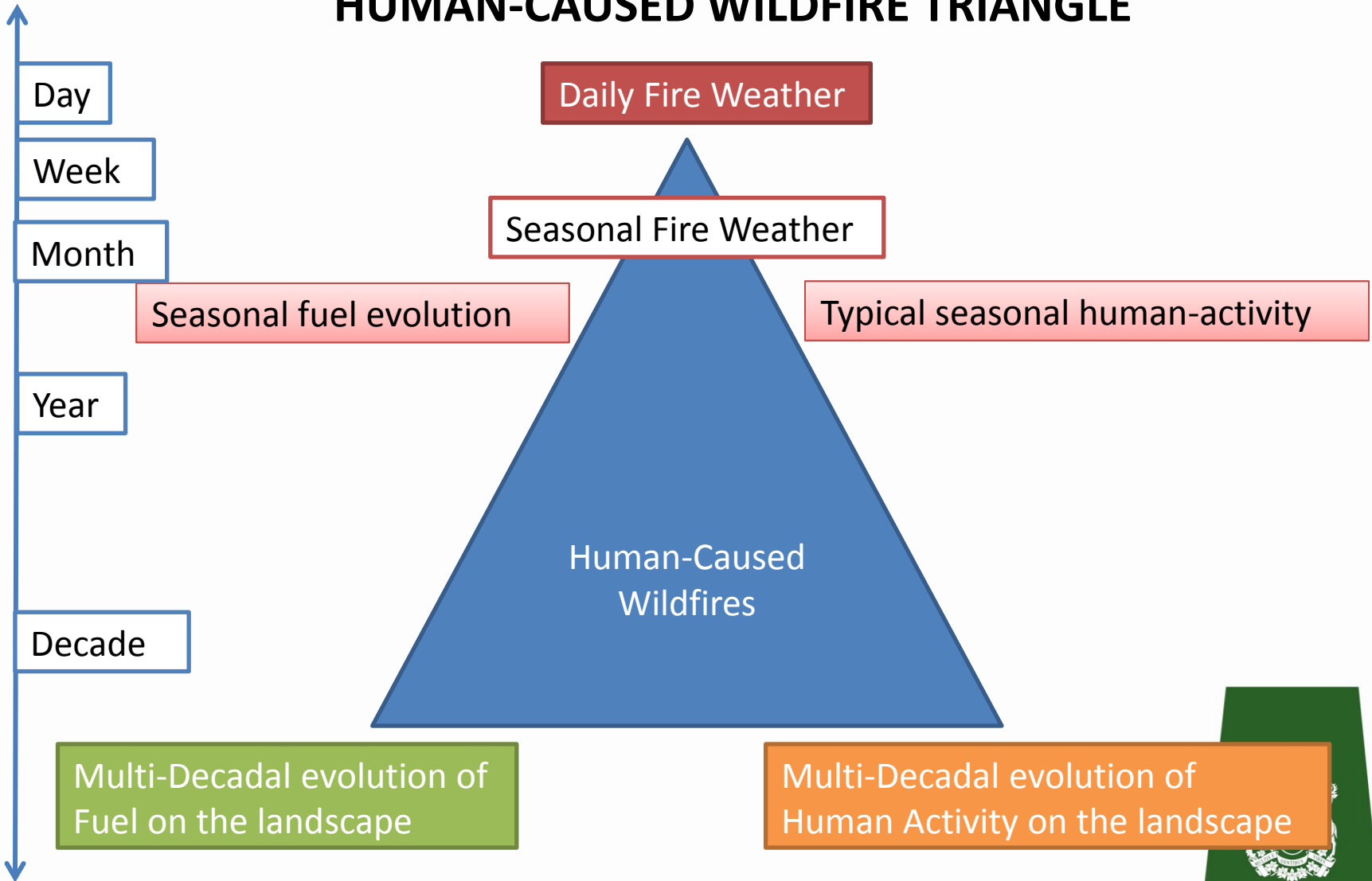
Issues with old traditional way:

- *Fire weather varies greatly from year to year*
- *Human/Lightning Ratio will vary greatly*
 - *from wet spring-dry summer to dry spring-wet summer fire seasons*

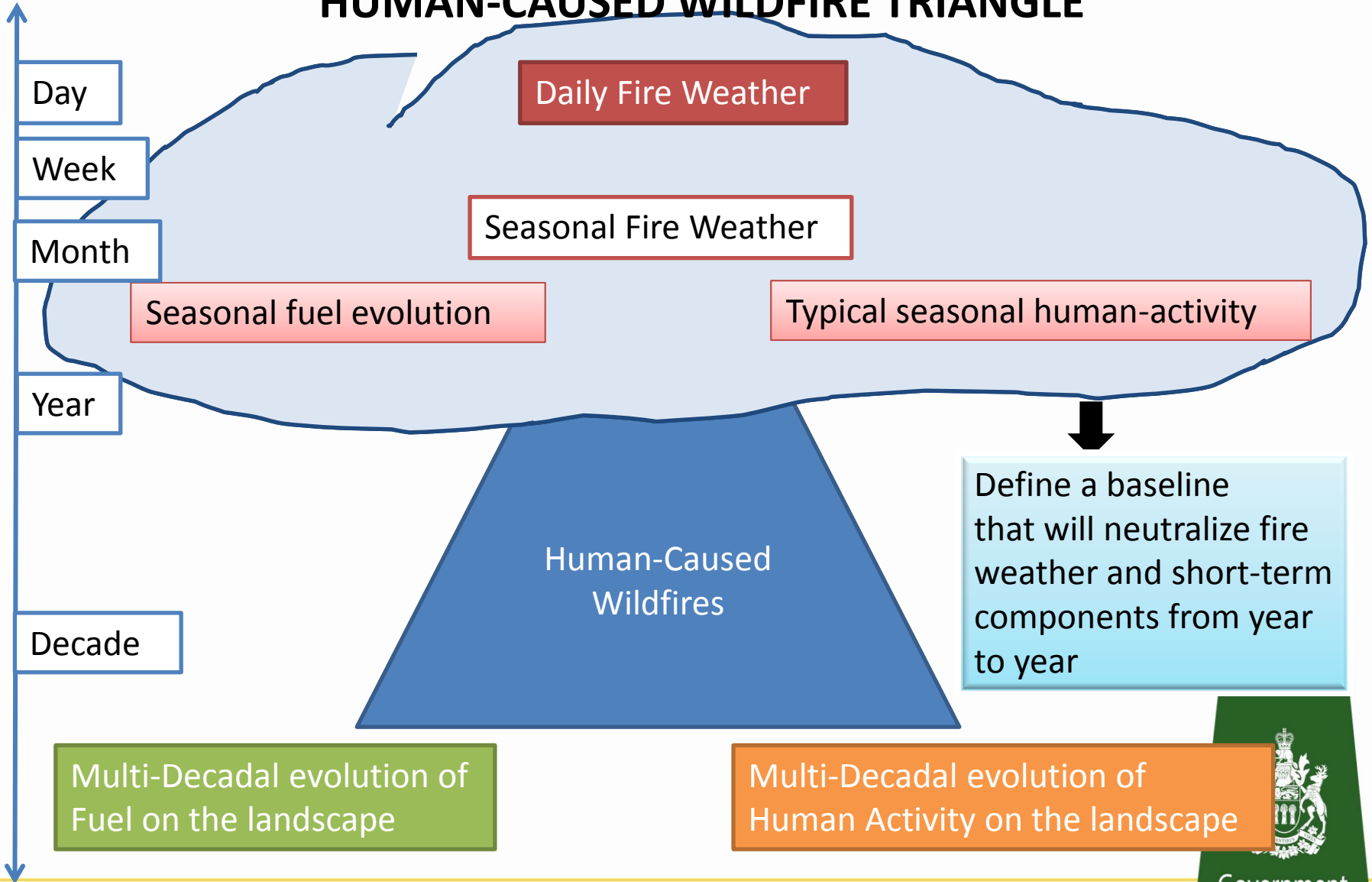
- ❖ *Difficult to effectively evaluate fire prevention program*
 - *Was it the fire weather or prevention campaign ?*
 - *Was campaign seasonally well focused ?*
 - *Was campaign regionally well focused ?*
 - *Was prevention program \$\$ well spent ?*
 - *Is it a change in climate or in Human activity ?*



HUMAN-CAUSED WILDFIRE TRIANGLE



HUMAN-CAUSED WILDFIRE TRIANGLE



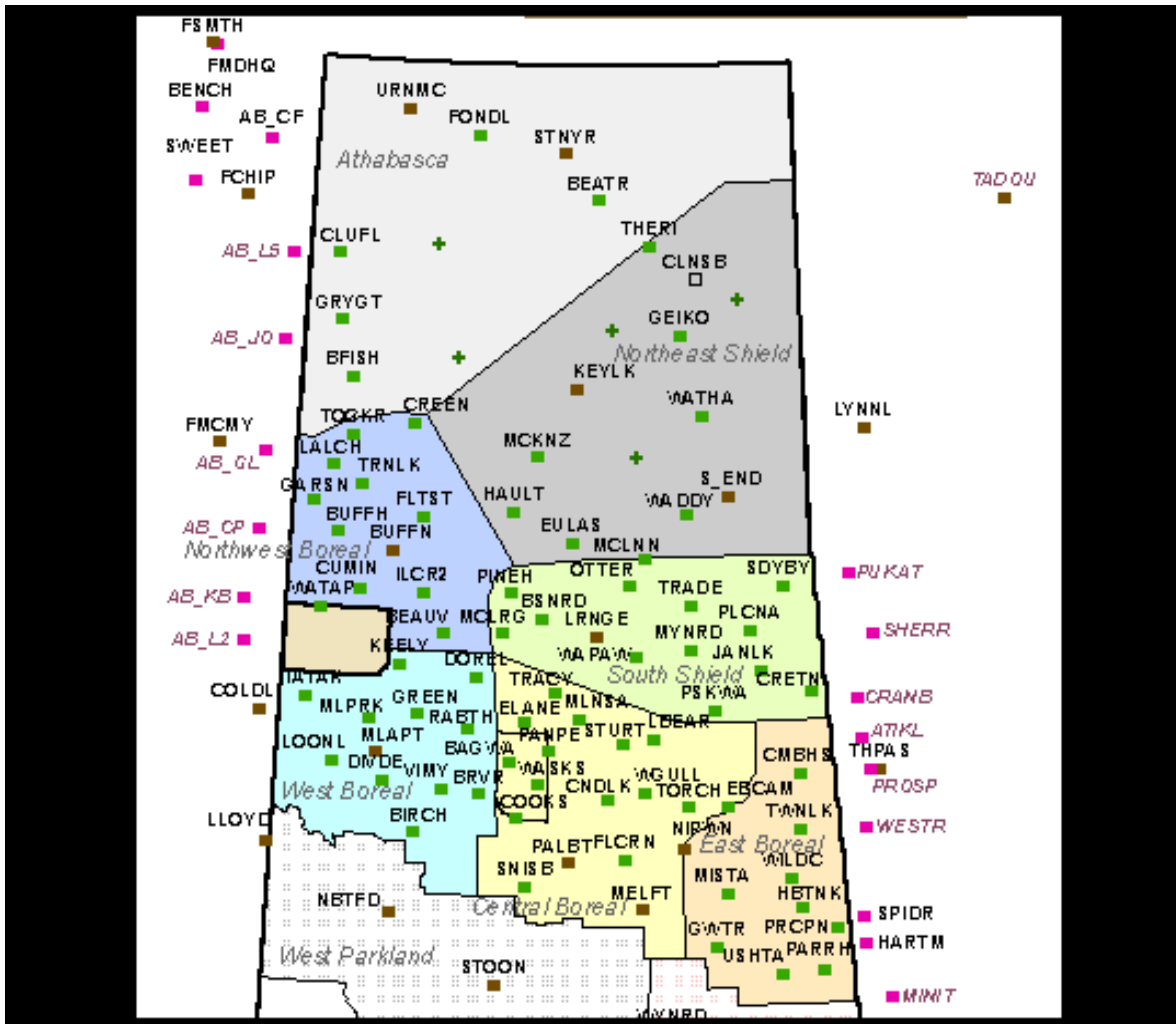
OBJECTIVES:

- *Project human-caused wildfires specific to*
 - ❖ *Regions of Saskatchewan*
 - ❖ *Based on fire weather observed daily*
 - ❖ *Using multi-decadal years of data*

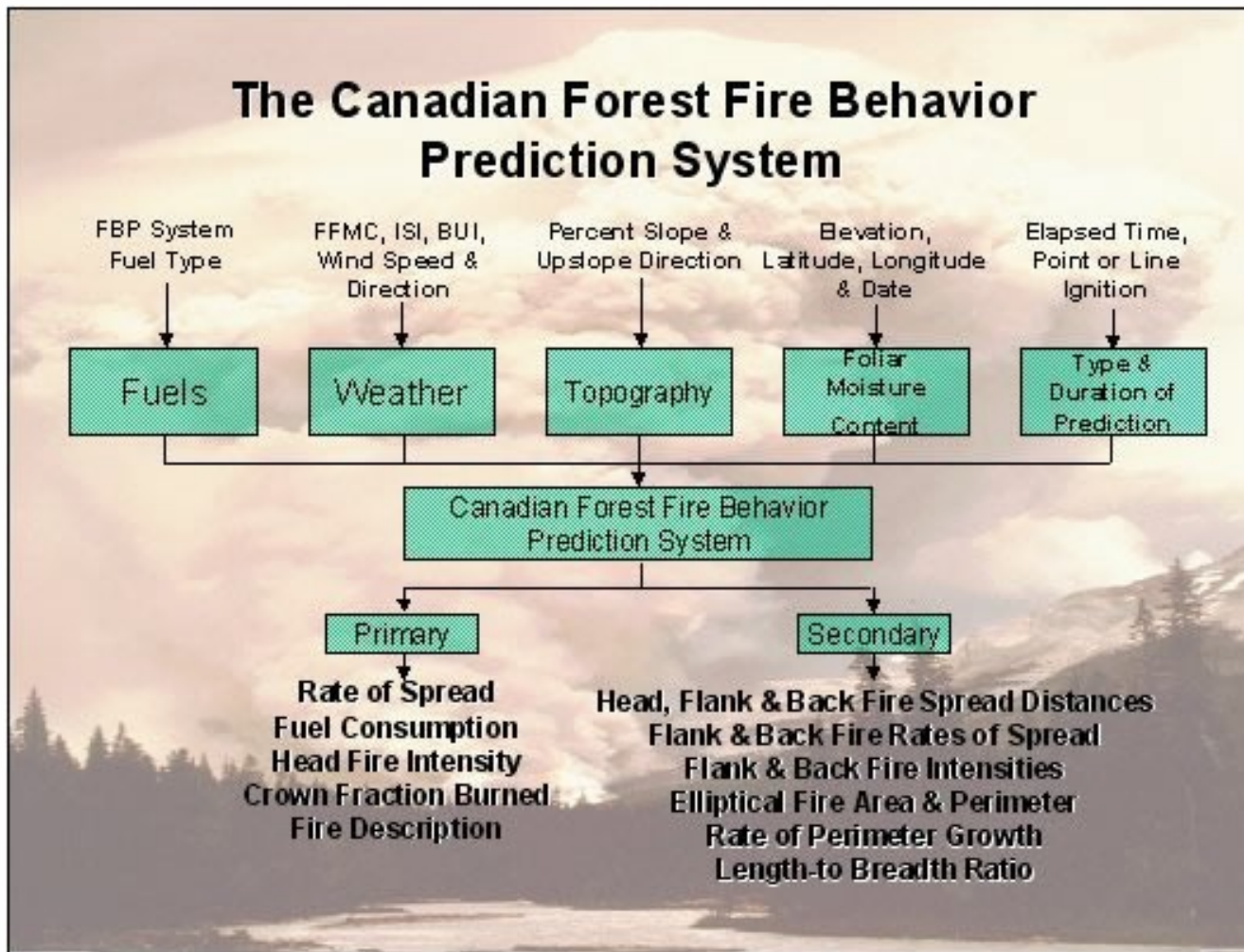
- *The projection is a baseline that*
 - *Reflect expected human-caused wildfires based on historical activity for a region*
 - *Varies from year to year*
 - *Based on observed daily fire weather*
 - *calendar date specific*
 - *using multi observations within the region*



Saskatchewan Weather Regions



Fire Weather: Daily HFI-C2



Fire Weather at locations:

Daily HFI-C2 >> PREP LEVEL

	CRITICAL VALUES:				
Categories	Extreme	Very High	High	Moderate	Low
Prep Level	5	4	3	2	1
Head Fire Intensity	HFI > 10,000	10,000 <= HFI < 4,000	4,000 <= HFI < 2,000	2,000 <= HFI < 500	HFI <= 500

- ❖ PREP levels are calculated at every weather observing locations
- ❖ PREP levels are categories of Head Fire Intensity for C2

Actual Noon for All Regions valid on 2014-09-24 at 12:00

Issued on 2014-09-24

Station	Temp °C	Dew °C	RH %	DDir	CDir	Wspd km/h	Rn_24 mm	FFMC	DMC	DC	ISI	BUI	FWI	PREP
Forest-ATH														
URMMC	12	2	50	70	ENE	5	0.0	88	23	512	4	41	10	3
FONDL	13	2	48	67	ENE	13	0.0	86	28	521	5	49	13	3
STMYR	12	3	55	70	ENE	6	0.0	87	21	494	4	37	9	2
BEATR	15	1	38	72	ENE	8	0.0	89	33	533	6	58	16	4
THERI	17	0	32	132	SE	9	0.0	90	33	496	6	56	17	4
CLUFL	15	6	56	83	E	5	0.0	86	24	523	3	43	9	2
GRYGT	16	2	38	125	SE	14	0.0	89	17	499	8	32	15	4
BFISH	16	0	34	159	SSE	18	0.0	89	21	525	10	38	19	4



Fire Weather at Regions/Zones: PREP LEVEL >> Level-B Rankings

Level B & SCORE valid on 2014-09-24											
ZONE LVLB RATING		LVLB CATEGORIES					% IN		FCST SCORE		
ZONE	LVL B	EXTM	VHI	HIGH	MED	LOW	p_rgn	tavg	eavg	uavg	xavg
OBS SOME											
1-ATH	3	0	50	25	25	0	100	94	92	91	85
2-NES	4	33	44	11	11	0	100	85	83	83	36
9-OES	3	17	47	18	18	0	100	90	88	87	61
FRE SOME											
3-SS	4	8	77	8	8	0	100	87	90	86	31
4-NWB	4	8	58	33	0	0	100	95	96	93	52
5-WB	4	31	69	0	0	0	100	97	97	96	73
6-CB	4	12	75	12	0	0	100	98	97	98	95
7-EB	3	0	46	55	0	0	100	97	98	99	93
9-FRZ	4	12	65	22	1	0	100	95	96	94	69
AGR SOME											
8-WPL	5	67	33	0	0	0	100	97	97	97	82
8-EPL	3	0	0	100	0	0	100	96	92	92	96
8-GL	4	62	12	25	0	0	100	99	98	96	95
8-CYP	4	25	75	0	0	0	100	98	100	98	93
9-AGR	4	38	30	31	0	0	100	98	97	96	92
ALL PROV											
9-PRV	4	13	58	20	7	0	99	92	92	91	66

- ❖ Daily Level-B Rankings are calculated for each region/zone
 - Using algorithm of Daily PREP levels observed within that region
 - Using weighting factor of each regions within zone



Fire Weather at Regions/Zones: PREP LEVEL >> Level-B Rankings

% OF REGION HFI C2 CATEGORY	EXTREME	VERY HIGH	HIGH	MODERATE	LOW
	HFI ≥ 10,000	10,000 > HFI ≥ 4,000	4,000 > HFI ≥ 2,000	2,000 > HFI ≥ 500	HFI < 500
PREPAREDNESS LEVEL-B DECISION TREE	LEVEL 5	> 66.66%			
	LEVEL 4	> 50.0%			
		> 66.66%			
	LEVEL 3	> 33.33%			
		> 50.0%			
	LEVEL 2	> 66.66%			
		> 16.66%			
		> 33.33%			
	LEVEL 1	> 50.0%			
		> 66.66%			
LEVEL 0	REMAINDER INSUFFICIENT OR NO FPB DATA				

	WEATHER REGIONS				
Full Response Zone	SS	NWB	WB	EB	CB
WEIGHTING FACTOR	20%	20%	20%	20%	20%
Modified Response Zone	ATH	NES			
WEIGHTING FACTOR	50%	50%			



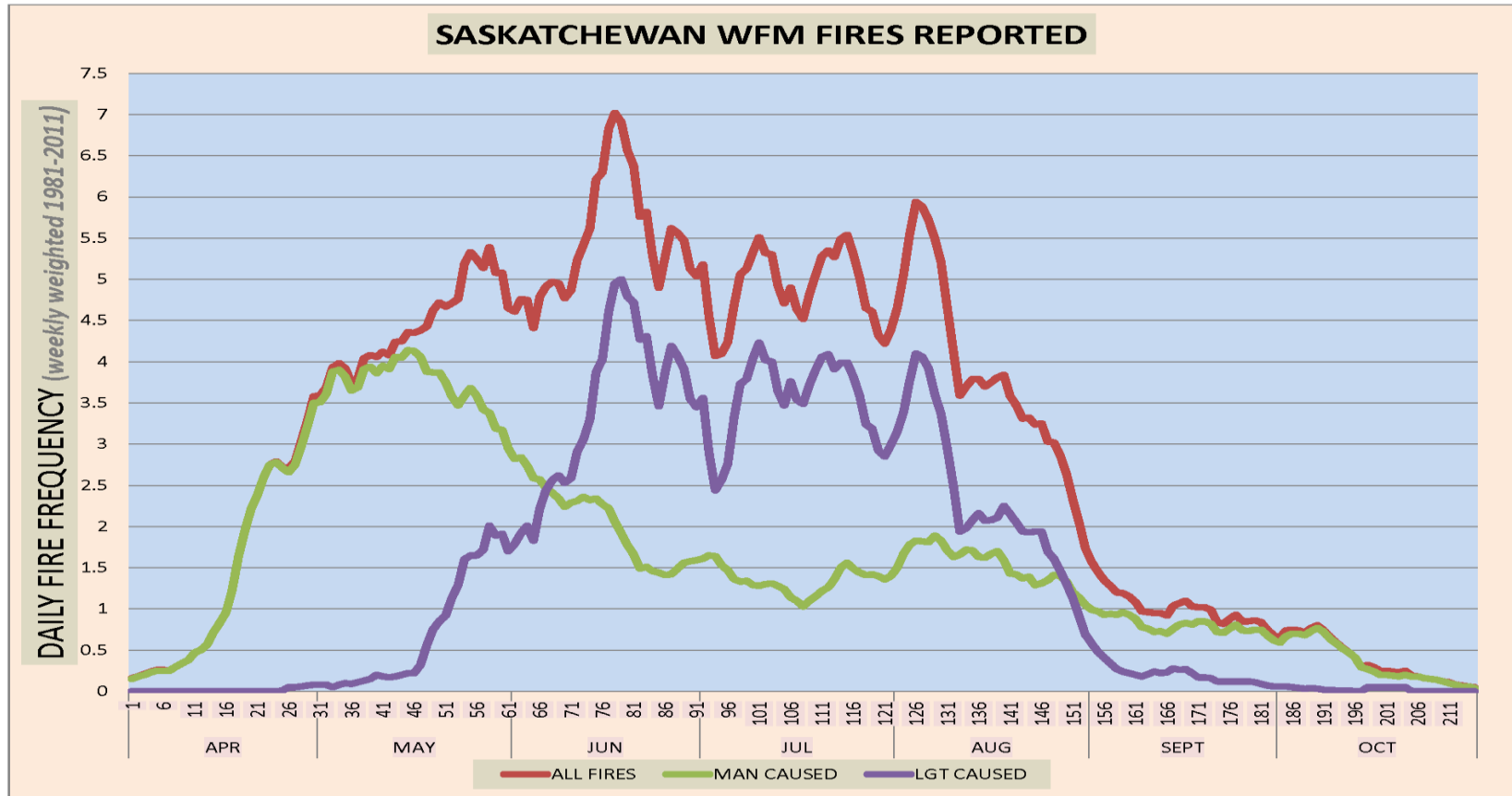
Saskatchewan Wildfire Frequency

Previous studies have shown:

- *Human-caused wildfires are predominant in the spring*
 - *Lightning-caused wildfires are predominant in the summer*
 - *There is a secondary peak of human-caused wildfires in the late summer & fall*
- ❖ *Frequency of human-caused wildfires are strongly correlated with Level-B Rankings, especially in May & June*



Saskatchewan Wildfire Frequency



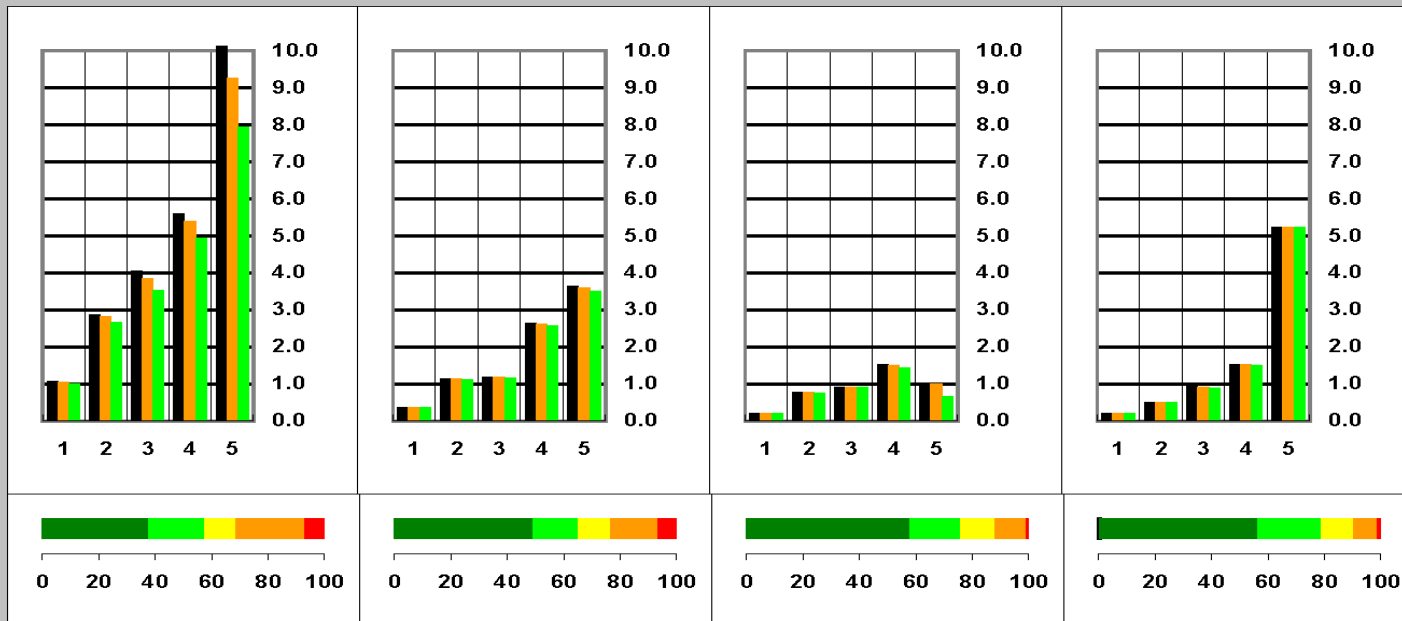
Full Response Zone: Monthly Wildfire Frequency

FULL RESPONSE ZONE

Decade 2000-2009

Daily Frequency of **Man-Caused Fires** based on Level B

NO DATA LOW MODERATE HIGH VERY HIGH EXTREME



MAY

JUNE

JULY

AUGUST

ALL

< 100 Ha

< 10 Ha



Observation Zone: Monthly Wildfire Frequency

OBSERVATION ZONE

Decade 2000-2009

Daily Frequency of **Man-Caused Fires** based on Level B

NO DATA

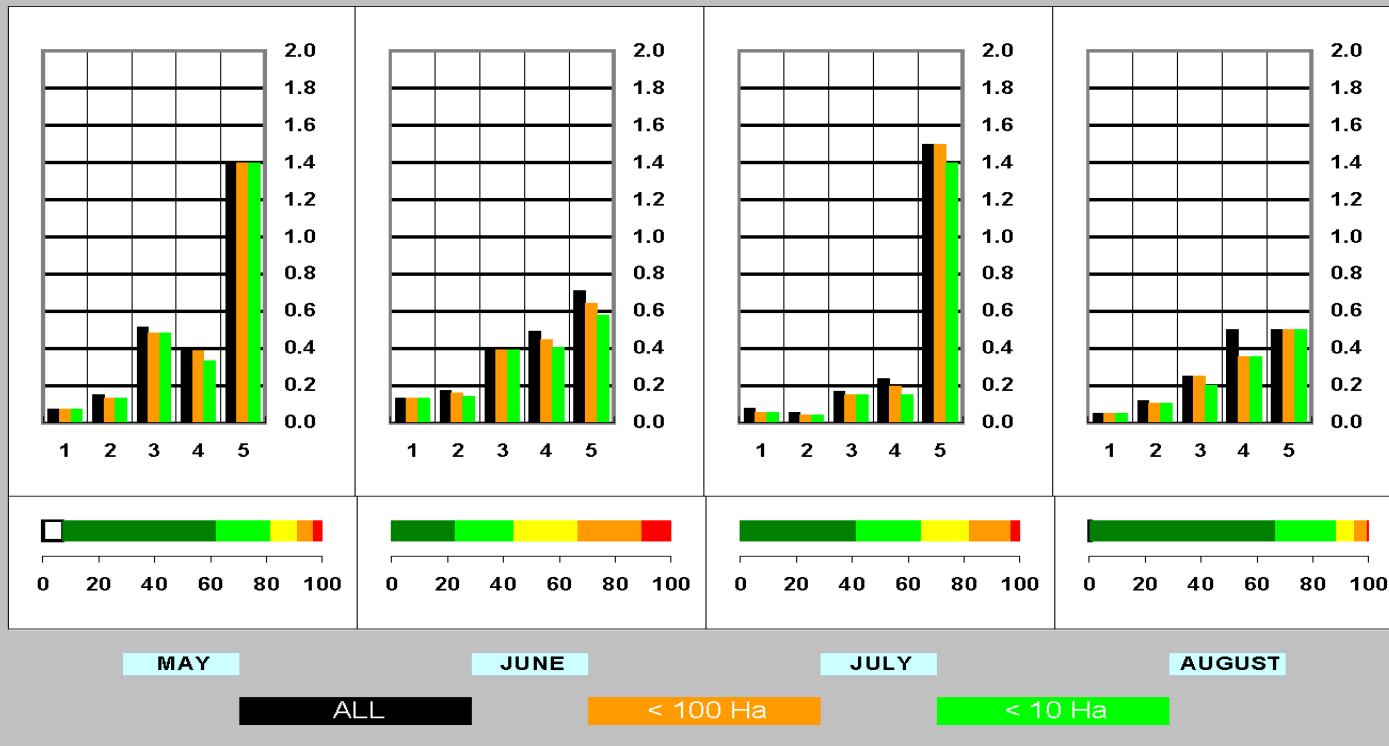
LOW

MODERATE

HIGH

VERY HIGH

EXTREME



DEFINITION OF FIREDAY:

Firedays are integer numbers that represent calendar days of a fire season. This facilitates database and statistical processing of large numbers. Referenced firedays are defined below:

FIREDAY	DATE
1	April 1 st
31	May 1 st
62	June 1 st
92	July 1 st
123	August 1 st
154	September 1 st
184	October 1 st



TO DEFINE THE BASELINE

DATASET YEARS:
1989-2008

- Wildfires and Fire Weather records during the 1989-2008 years
- The dataset, much like a climate 30-years normal, should be redefined every 5 or 10 years
- The dataset should capture a slice in the gradual evolution of human activity on the landscape as well as a slow motion snapshot of the state of the fuel evolution on the landscape

NOTE: The dataset was adjusted to 1995-2008 for the Northwest Boreal weather region due to unusually high incidences of arson wildfires during the 1989-1994 years



WEEKLY AVERAGING of FIREDAY Wildfires numbers:

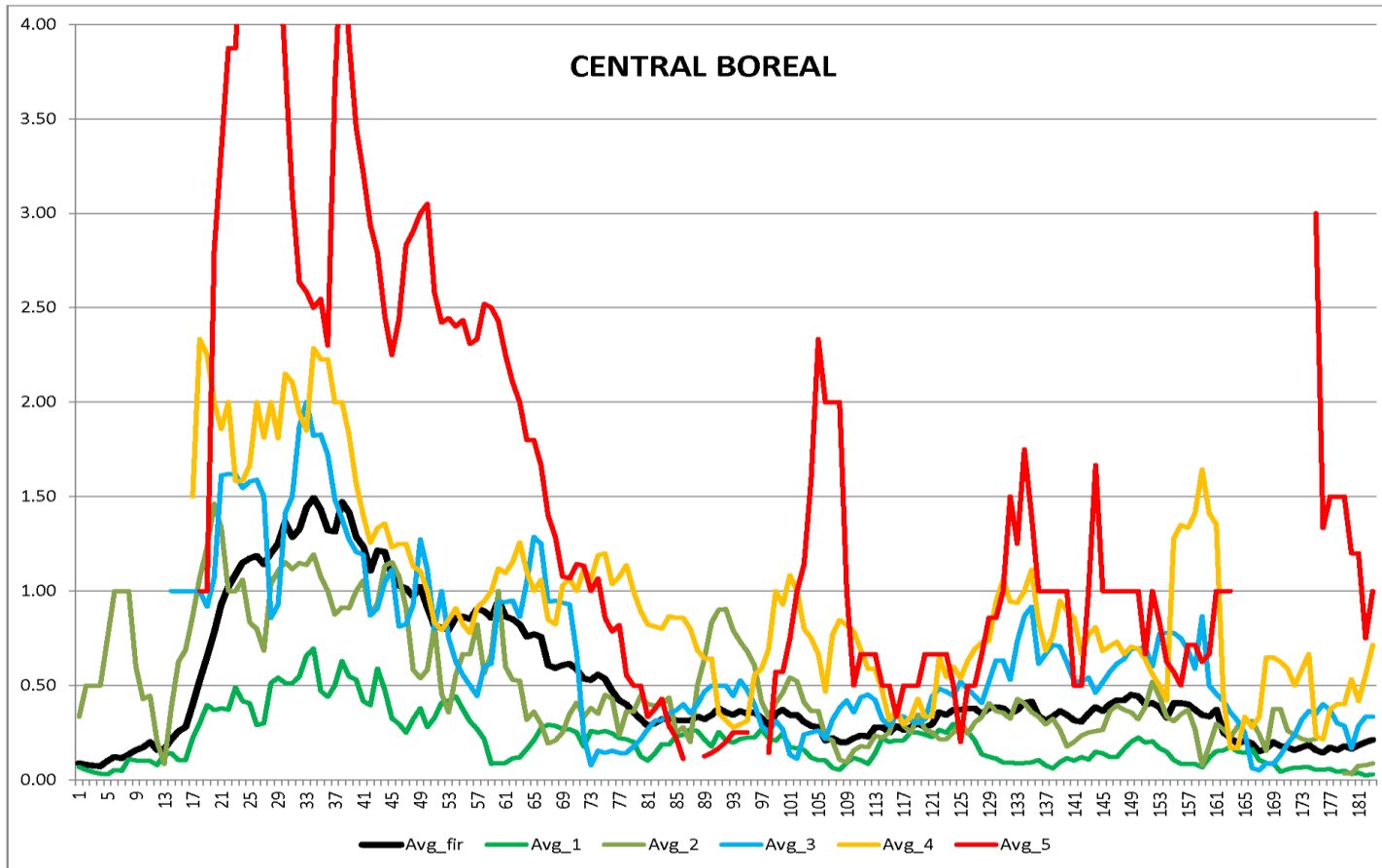
- For each fireday, human-caused wildfires recorded within ± 3 firedays were compiled for the 1989-2008 period
- This result in typically $20 \times 7 = 140$ years of data if the dataset was complete to evaluate weekly averaged human-caused wildfires for each fireday
- The dataset was further mined to evaluate frequency of human-caused wildfires for each Level-B rankings

REGION	fireday	Level-B	# Years	# Fires	Daily fire frequency
6-CB	61	4	42	46	1.1
6-CB	61	5	20	45	2.25
6-CB	62	0	1	1	1
6-CB	62	1	44	5	0.11
6-CB	62	2	17	9	0.53
6-CB	62	3	20	19	0.95
6-CB	62	4	39	45	1.15
6-CB	62	5	19	40	2.11
6-CB	63	0	1	1	1



For each weather region: **BASELINE**

- A table of fireday dependant and Level-B dependant human-caused wildfire frequencies



MODEL: RAW BASELINE

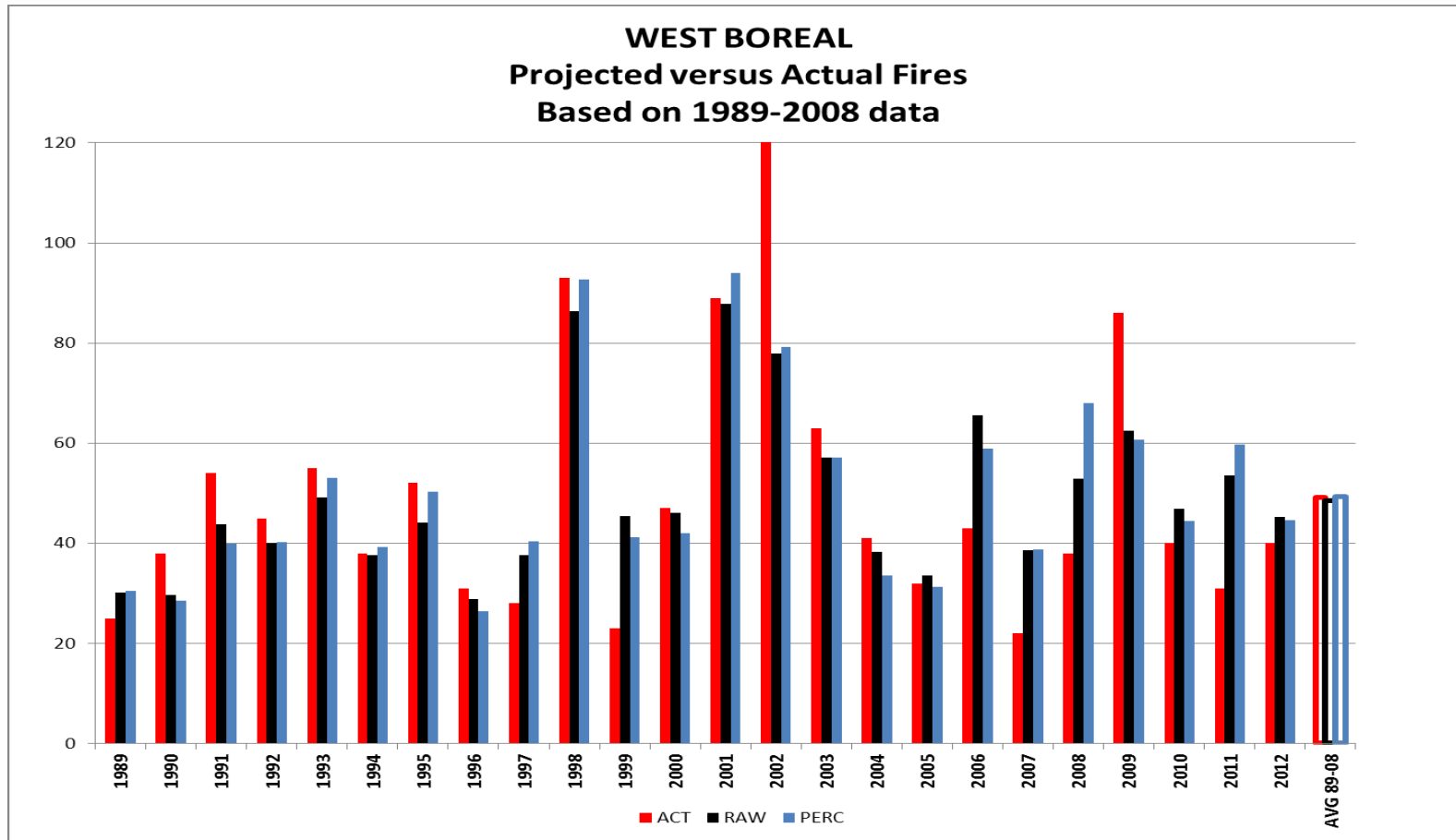
- ➔ Does not have a wildfire frequency for each fireday-Level-B cases
- ➔ Best in compiling yearly projections

	SOUTH SHIELD														
	YEAR			MAY			JUN			JUL			AUG		
	ACT	RAW	PERC	ACT	RAW	PERC	ACT	RAW	PERC	ACT	RAW	PERC	ACT	RAW	PERC
1989	64	52.8	57.6	12	12.9	13.2	17	15.5	22.6	15	10.9	11.2	16	12.5	9.9
1990	90	76.2	77.3	17	23.7	28.1	29	16.7	21.3	6	10.3	9.5	27	17.2	15.1
1991	57	34.8	28.9	9	7.6	6.9	14	6.3	7.5	13	6.9	3.7	12	22.9	6.4
1992	43	50.2	55.3	8	19.6	21.9	14	12.9	18.5	5	7.5	6.4	9	8.5	7.3
1993	67	48.0	45.7	36	22.9	23.1	21	11.2	14.6	3	3.0	2.3	1	3.5	2.6
1994	67	53.9	46.6	9	11.5	11.7	5	12.7	17.2	8	6.0	3.3	17	11.0	9.5
1995	58	72.2	75.3	32	30.1	31.8	19	23.7	31.7	4	8.4	5.3	1	4.6	3.2
1996	43	42.3	38.9	3	10.3	11.4	12	10.3	12.8	19	8.9	6.5	8	8.7	6.3
1997	52	51.6	46.3	22	15.7	13.2	7	12.3	16.2	5	9.1	7.0	17	12.0	8.3
1998	78	83.0	71.9	16	22.2	21.5	13	16.1	20.2	10	12.6	9.2	11	16.0	12.9
1999	33	53.0	50.3	7	12.0	13.9	5	13.2	17.3	8	7.5	5.5	8	9.8	7.9
2000	19	36.7	29.2	4	8.6	6.0	5	8.6	9.4	1	6.5	4.3	3	7.2	5.7
2001	73	75.8	64.6	25	26.3	23.2	12	13.2	16.0	8	8.4	8.2	18	15.9	11.1
2002	35	62.9	79.1	12	25.6	32.8	11	20.5	30.8	4	5.5	7.0	5	6.7	4.7
2003	46	58.4	64.1	14	19.5	25.6	6	10.7	14.2	12	9.4	8.5	12	14.0	12.2
2004	27	47.5	48.0	9	16.6	19.5	6	9.8	12.7	6	9.9	8.2	5	5.5	4.3
2005	36	31.5	31.8	24	13.9	14.0	4	7.0	8.4	7	4.9	4.9	1	3.9	2.8
2006	37	51.9	47.4	12	12.6	13.9	7	12.7	14.5	6	7.5	6.9	2	5.9	4.5
2007	74	58.4	63.3	13	12.6	18.1	21	20.6	26.8	21	12.2	10.2	13	7.4	5.4
2008	118	70.9	84.6	56	22.8	29.6	52	30.6	39.4	7	7.0	7.0	2	7.6	6.2
2009	59	35.7	30.4	29	6.5	6.2	9	10.2	12.4	1	3.9	2.4	4	8.3	5.2
2010	61	51.0	51.1	22	17.7	17.8	27	16.0	20.5	5	8.1	6.0	5	6.3	4.6
2011	57	61.9	69.5	31	23.3	34.4	9	14.5	20.1	2	5.0	5.0	2	6.4	3.8
2012	31	55.0	61.5	4	24.5	31.0	5	10.3	12.2	8	10.1	11.1	12	5.9	4.9
AVG 89-08	55.9	55.6	55.3	17.0	17.4	19.0	14.0	14.2	18.6	8.4	8.1	6.7	9.4	10.0	7.3



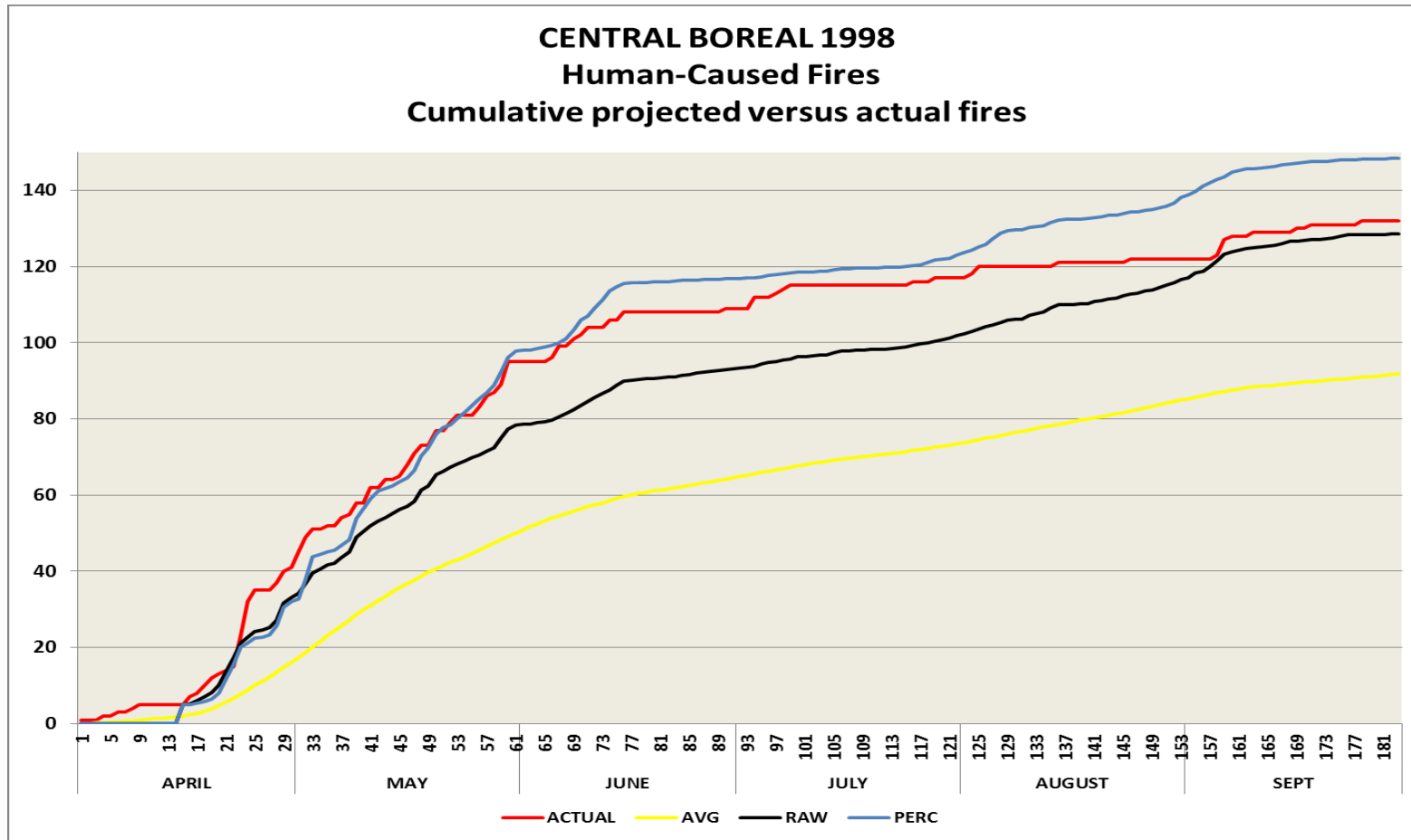
MODEL: RAW BASELINE

- Good in differentiating active versus slow years
- Underestimate short extreme spring events (2002, 2009)



Yearly Projection: CB 1998

➤ The table is used to project human-caused wildfires on any given year



MODEL: PERCENT-AVERAGED BASELINE

- ❖ Evaluate the average fireday wildfire frequency independently of the Level-B
- ❖ Associate a percentage of a fireday average frequency to each Level-B Rankings

LVL-B	% of AVERAGE
1	25%
2	50%
3	100%
4	200%
5	400%

- ➔ Will associate a wildfire frequency for all fireday & Level-B cases
- ➔ Simple methodology to implement
- ➔ Better Representation of years outside dataset years
- ➔ For some weather regions slightly overestimate yearly human-caused wildfires

YEARLY AVERAGE		ATH	NES	SS	NWB	WB	CB	EB
1989-2008	ACTUAL	11.6	14.8	55.9	29.4	49.1	92.4	21.5
	RAW	11.0	13.7	55.6	29.0	48.5	91.8	21.1
	PERC	14.0	13.7	55.3	27.0	49.3	93.7	19.0
2009-2012	ACTUAL	10.3	18.3	52.0	22.5	49.3	75.0	11.5
	RAW	13.8	13.9	50.9	33.8	52.0	84.3	17.3
	PERC	18.3	15.6	53.1	32.3	52.4	78.8	15.6



Comparing MODELS: RAW versus Percent-Average Models

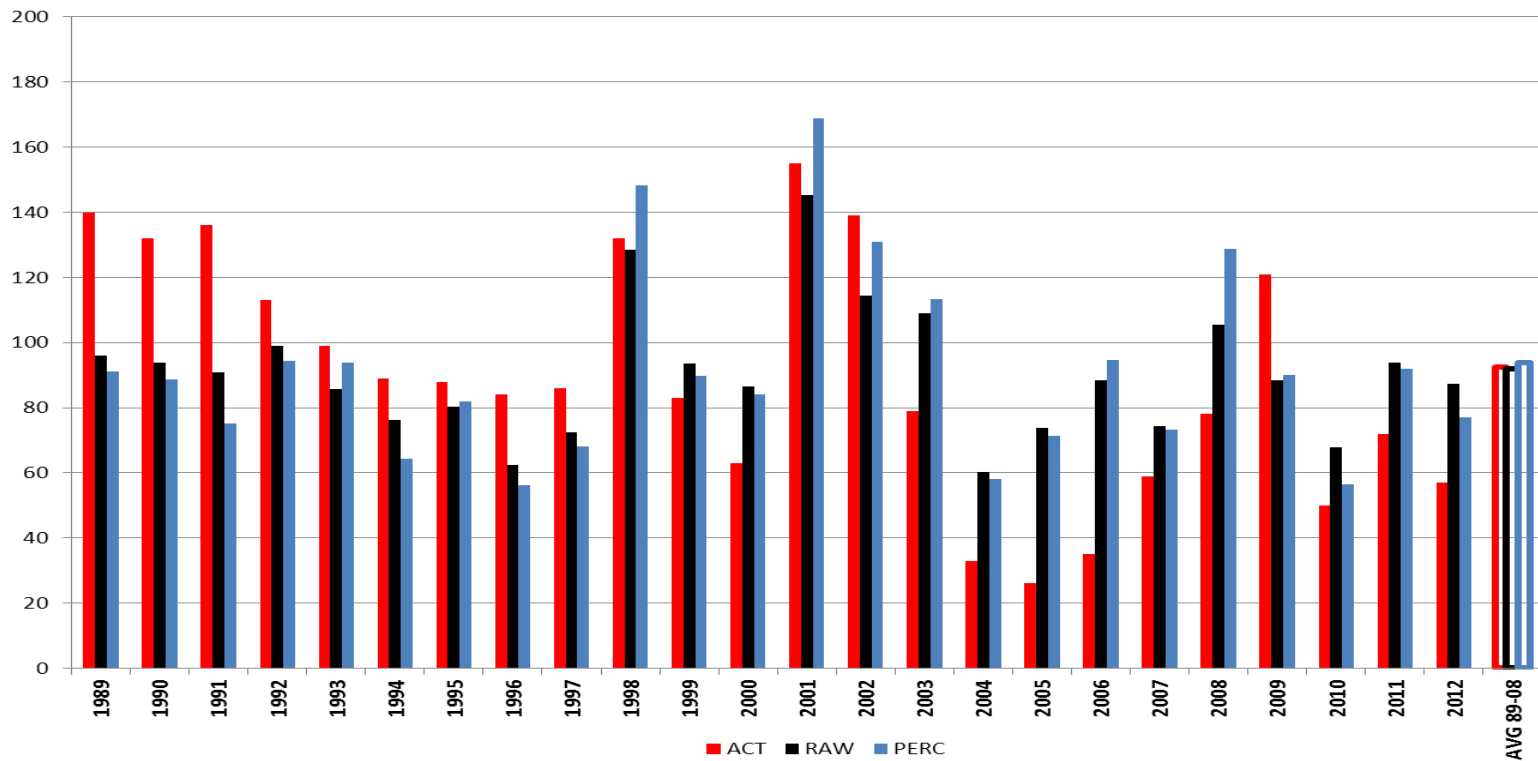
MAY-JUNE AVERAGE		ATH	NES	SS	NWB	WB	CB	EB
1989-2008	ACTUAL	6.6	7.9	31.0	17.6	28.8	49.2	12.6
	RAW	6.2	7.5	31.6	17.4	29.4	51.3	13.2
	PERC	8.7	8.6	37.6	18.9	35.3	61.6	13.6
2009-2012	ACTUAL	5.8	10.5	34.0	16.3	34.8	47.8	7.8
	RAW	10.2	7.9	30.8	23.6	34.6	44.7	10.1
	PERC	13.7	10.3	38.6	26.4	40.8	54.1	11.4
JULY AVERAGE		ATH	NES	SS	NWB	WB	CB	EB
1989-2008	ACTUAL	2.5	2.9	8.4	3.1	3.0	9.1	1.1
	RAW	2.2	2.8	8.1	3.0	2.9	8.9	1.0
	PERC	3.3	2.9	6.7	2.3	1.9	6.3	0.6
2009-2012	ACTUAL	3.0	3.0	4.0	1.3	0.0	2.8	0.0
	RAW	2.1	2.3	6.8	2.6	2.6	8.5	1.1
	PERC	3.3	2.9	6.2	1.8	1.2	4.4	0.6
AUG-SEP AVERAGE		ATH	NES	SS	NWB	WB	CB	EB
1989-2008	ACTUAL	2.4	3.9	13.5	4.5	6.5	18.5	3.3
	RAW	2.5	3.4	13.4	4.4	6.2	18.2	3.1
	PERC	1.9	2.1	9.3	2.5	3.9	14.4	2.2
2009-2012	ACTUAL	1.5	4.3	13.0	2.0	1.5	6.5	0.5
	RAW	1.5	3.7	12.1	5.8	5.6	17.5	2.5
	PERC	1.3	2.4	7.4	2.5	3.4	11.4	1.7



MODELS: RAW Versus Percent-Averaged BASELINE

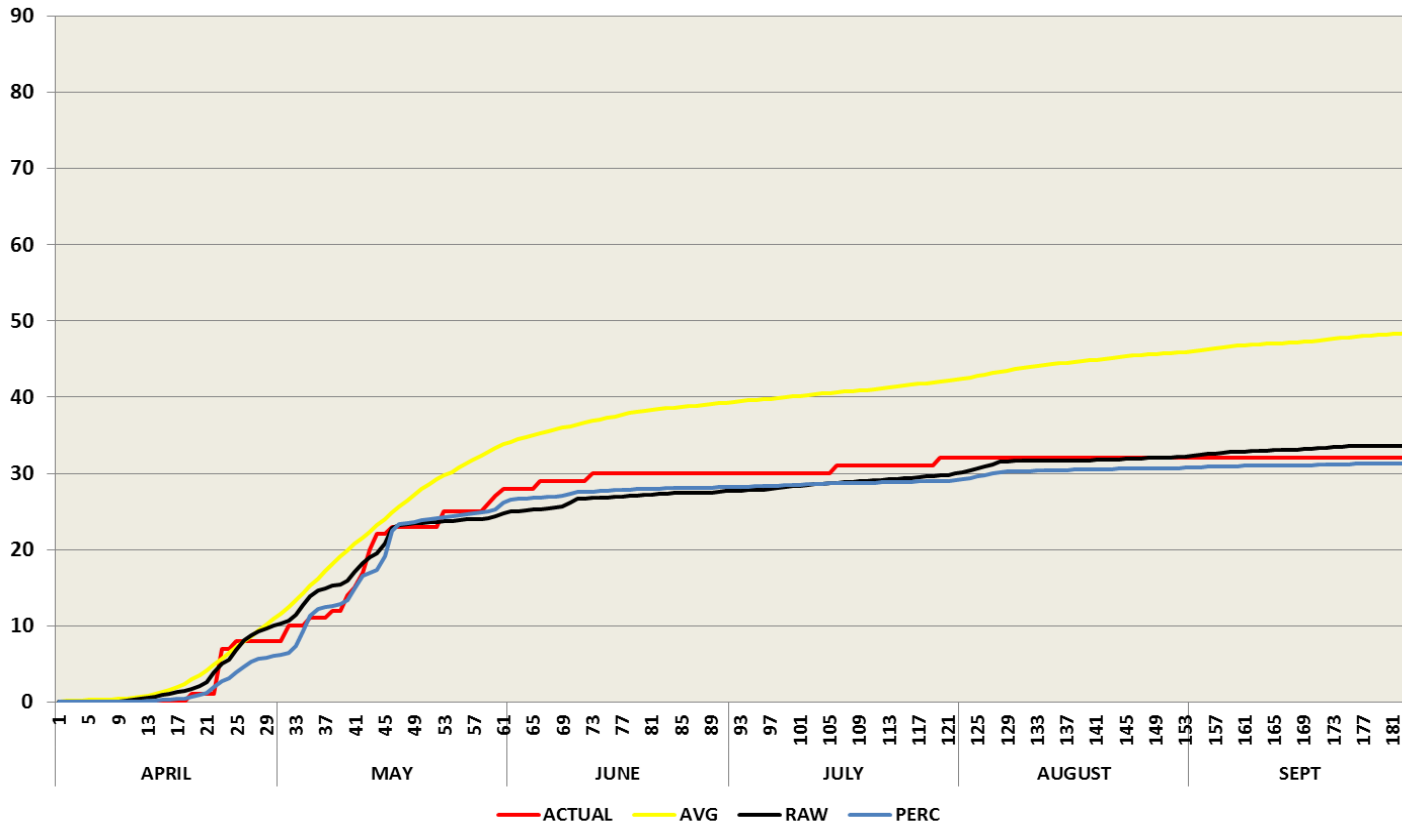
- Good in differentiating active versus slow years
- Both Underestimate short extreme spring events (2002, 2009)

CENTRAL BOREAL
Projected versus Actual Fires
Based on 1989-2008 data



YEARLY PROJECTION: WB 2005

**WEST BOREAL 2005
Human-Caused Fires
Cumulative projected versus actual fires**

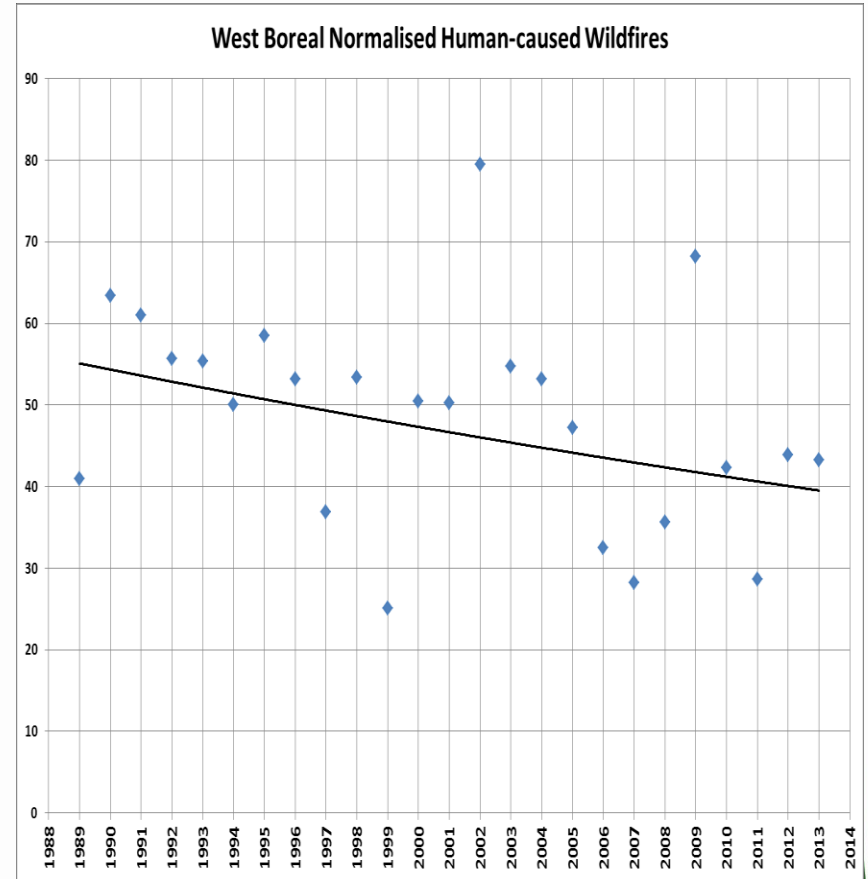
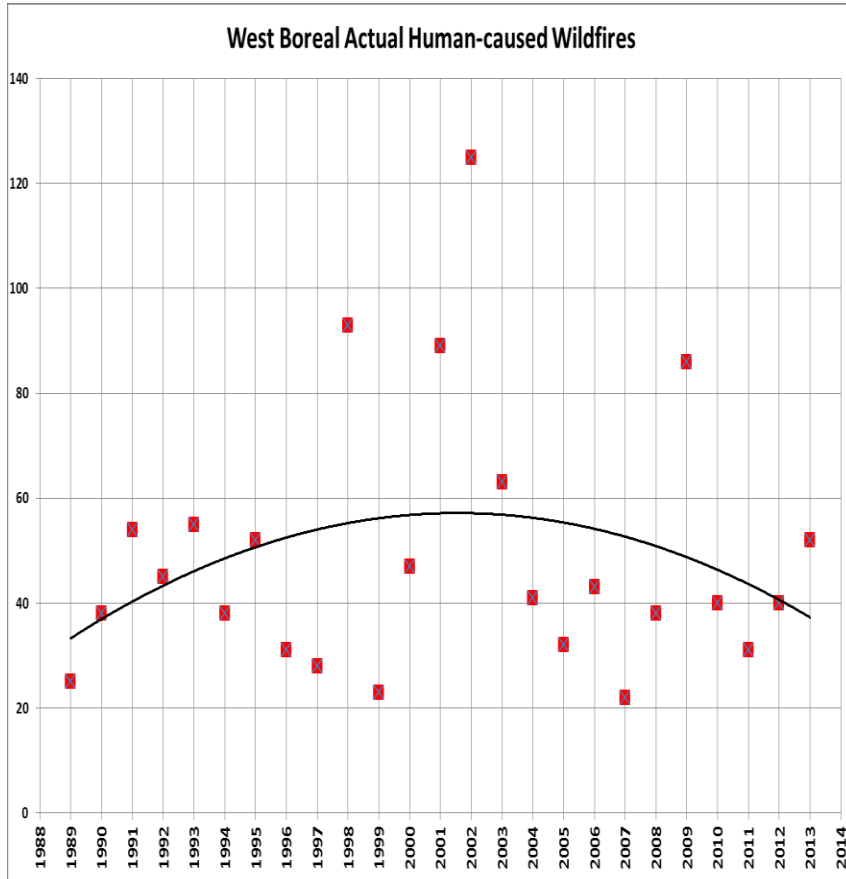


Model Applications

- Provide better in-context facts to evaluate prevention program performance objectives after individual fire season
 - Provide better historical background information to identify prevention program targets and performance objectives
 - Provide methodology to evaluate contribution and trends of different human-caused wildfires sources in relation to the evolution of human activities on the landscape
-
- In combination with fire weather observations and forecast, provide Wildfire Operations with real-time estimate of potential human-caused wildfires



Model Applications: Trends



Model Applications : Web-based Operational Projections

HUMAN CAUSED WILDFIRES PROJECTION BASED ON FORECAST WEATHER

HUMAN CAUSED WILDFIRES PROJECTIONS BASED ON WEATHER FORECAST ON 2014-09-24			
WEATHER REGION	FORECAST DATE	AVERAGE	PROJECTED
FIREDAY177			
1-ATH	2014-09-24	0.0	0.0
2-NES	2014-09-24	0.0	0.0
3-SS	2014-09-24	0.2	0.1
4-NWB	2014-09-24	0.1	0.1
5-WB	2014-09-24	0.1	0.1
6-CB	2014-09-24	0.2	0.3
7-EB	2014-09-24	0.0	0.0



Model Applications : Web-based Cumulative Projections

HUMAN CAUSED WILDFIRES PROJECTION BASED ON ACTUAL WEATHER

HUMAN CAUSED WILDFIRES PROJECTIONS by 2014-09-24			
WEATHER REGION	ACTUAL TO DATE	AVERAGE TO DATE	PROJECTED TO DATE
APR			
1-ATH	---	0	---
2-NES	---	0	0
3-SS	---	3	1
4-NWB	---	4	1
5-WB	---	11	2
6-CB	---	16	3
7-EB	---	4	1
WEATHER REGION	ACTUAL TO DATE	AVERAGE TO DATE	PROJECTED TO DATE
MAY			
1-ATH	---	3	2
2-NES	---	4	4
3-SS	---	17	18
4-NWB	---	12	11
5-WB	---	23	9
6-CB	---	34	26
7-EB	---	10	9
WEATHER REGION	ACTUAL TO DATE	AVERAGE TO DATE	PROJECTED TO DATE
JUN			
1-ATH	---	5	8
2-NES	---	5	4
3-SS	---	14	7
4-NWB	---	5	2
5-WB	---	5	2
6-CB	---	15	6
7-EB	---	3	1
WEATHER REGION	ACTUAL TO DATE	AVERAGE TO DATE	PROJECTED TO DATE
JUL			
1-ATH	---	3	3
2-NES	---	3	5
3-SS	---	8	7
4-NWB	---	3	3
5-WB	---	3	1
6-CB	---	9	4
7-EB	---	1	0
WEATHER REGION	ACTUAL TO DATE	AVERAGE TO DATE	PROJECTED TO DATE
AUG			
1-ATH	---	2	3
2-NES	---	3	2
3-SS	---	9	6
4-NWB	---	3	3
5-WB	---	4	1
6-CB	---	12	7
7-EB	---	2	1



Potential Improvements:

Provide performance indicators to evaluate
Saskatchewan Prevention Program

- *Create a PREP Level 6 and LVL-B ranking 6 to take into consideration extreme windy spring days where RH < 20%*

*Percent-Averaged Model
(Increase complexity)*

- *Could use different Percent-Average values for different weather regions*
- *Could use fireday variable Percent-average values*

THE END




Government
of
Saskatchewan

DANIEL POIRIER
CHIEF METEOROLOGIST
WILDFIRE MANAGEMENT
SASKATCHEWAN ENVIRONMENT



Government
— of —
Saskatchewan



Ministry of Environment
Wildfire Management Branch
Box 3003, Hwy#2 North
Prince Albert, Canada S6V 6G1

www.gov.sk.ca