Incorporating a spread event model defined by MODIS hot spots into fire growth modeling

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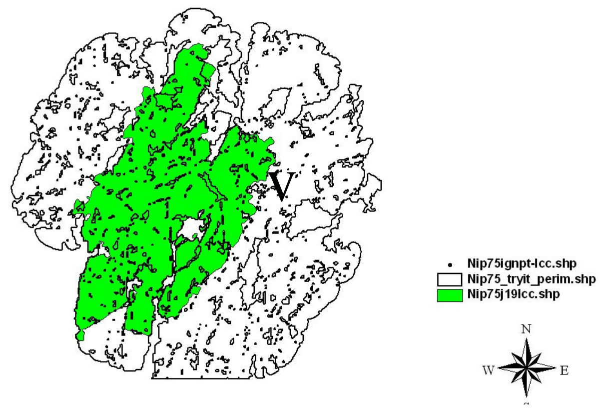
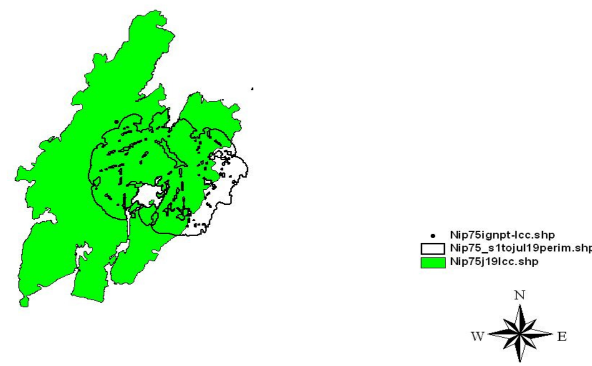
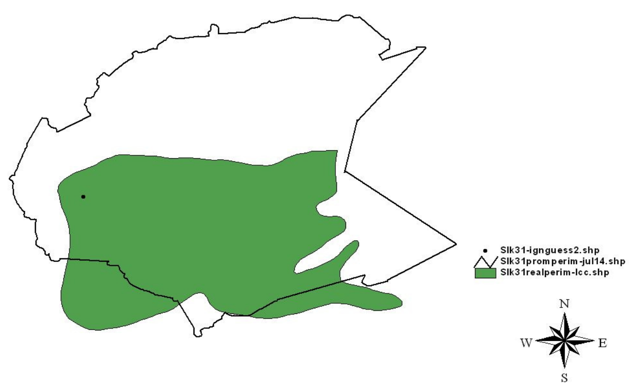
NIP075-2002 simulated and actual to July 19



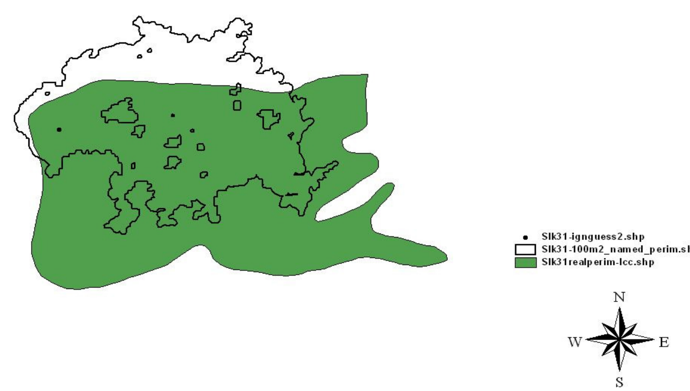
NIP075-2002 simulated and actual to July 19 - 3 burning days



SLK-031-2002: Simulated and Actual perimeter



SLK031-2002: Simulated and actual perimeters (with spread events)



Introduction	**Calibrating fire growth models**
Data	**MODIS Satellite Hotspots**
Model	**A logistic regression model for fire spread events based on ISI; extinguishment based on rain**
Conclusions	**Predicting fire sizes and fire growth days**

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Fire managers report: fires either “run” or don't

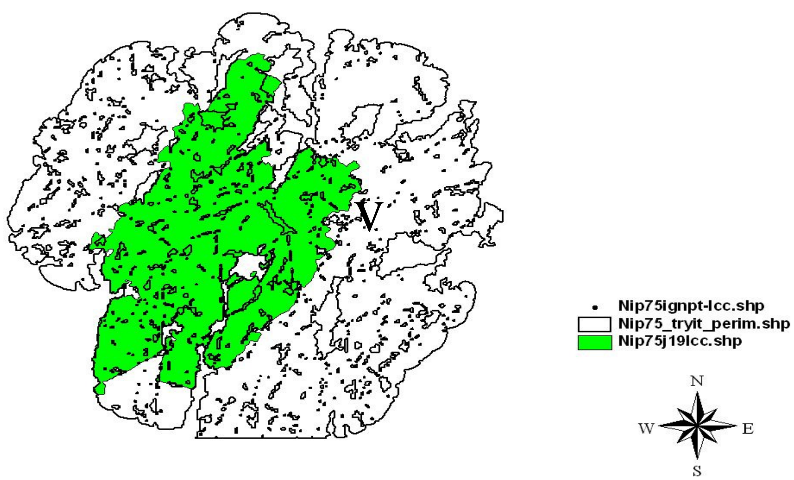
During fire “runs” (which we will call spread events), it is very difficult to do fire suppression.

During non-spread events, it is possible.

http://www.nofc.forestry.ca/fire/research/management/fgm/prometheus_e.htm

Using FBP or PROMETHEUS requires calibration

NIP075-2002 simulated and actual to July 19



To use PROMETHEUS for multi-day large fire simulations and landscape fire research, it is necessary to identify a sub set of burning days from the start date to the end date.

http://www.nofc.forestry.ca/fire/research/management/fgm/prometheus_e.htm

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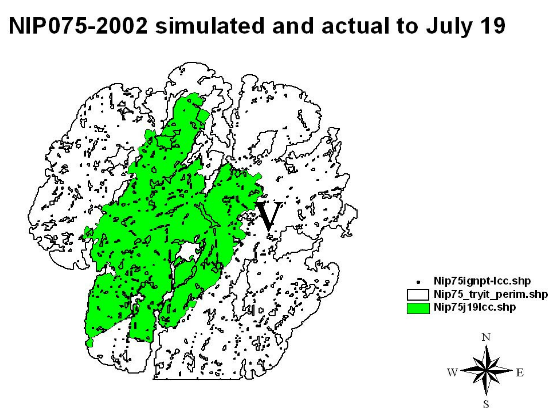
Using FBP or PROMETHEUS requires calibration



Anderson (2009) suggests several reasons:

The assumption that the whole perimeter is active

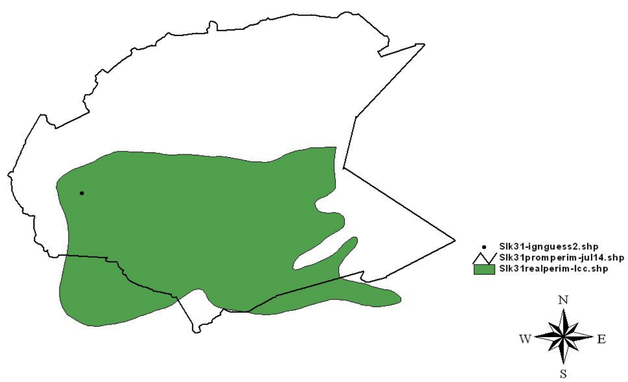
The need for diurnal adjustment in litter moisture

We argue for an additional possibility: that the FBP System predicts better at the higher end of fire spread potential, because of the burning conditions during the experimental burns the system is based on.

http://www.nofc.forestry.ca/fire/research/management/fgm/prometheus_e.htm

There are several options for calibration

SLK-031-2002: Simulated and Actual perimeter



Anderson (2009) collects several options:

Turn FFMC off at night

Use hourly FFMC (Van Wagner 1977)

Use the diurnal adjustment (Lawson and Armitage 1996)

Use the EMC

We offer another option: the use of the 'spread event' concept.

http://www.nofc.forestry.ca/fire/research/management/fgm/prometheus_e.htm

MODIS active fire mapping can find spread events

Assume that when the fires are running, they will be detected by MODIS Aqua or Terra satellite passes.

http://activefiremaps.fs.fed.us/gisdata.php

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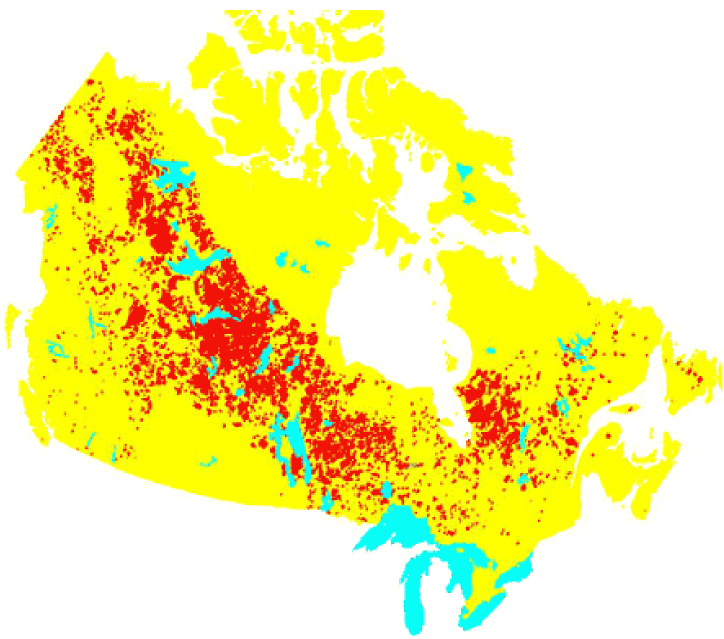
Both fire growth days and 'non-growth' days are required

Forest fire records are available from the OMNR, including perimeters – in a few cases, multiple perimeters.



http://www.nofc.forestry.ca/fire/research/climate_change/lfdb/lfdb_map_e.htm

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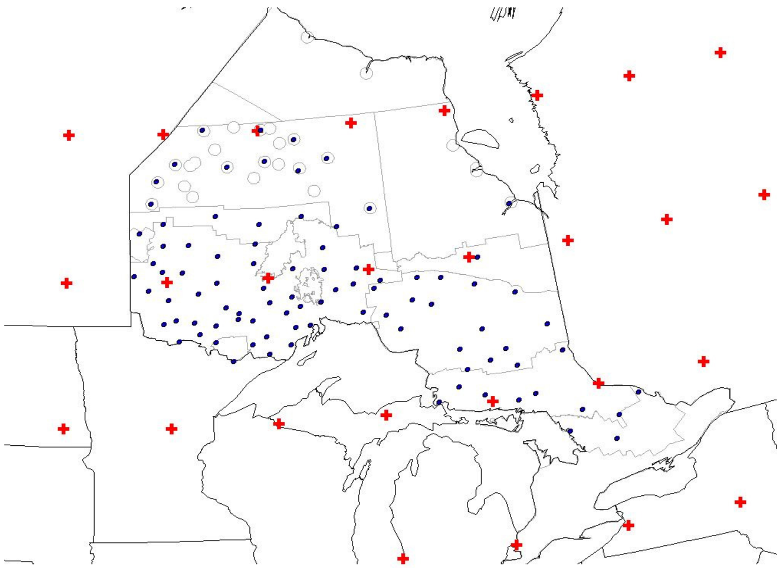
Fire weather indices are the independent variables

The OMNR weather stations provide the weather data and indices needed



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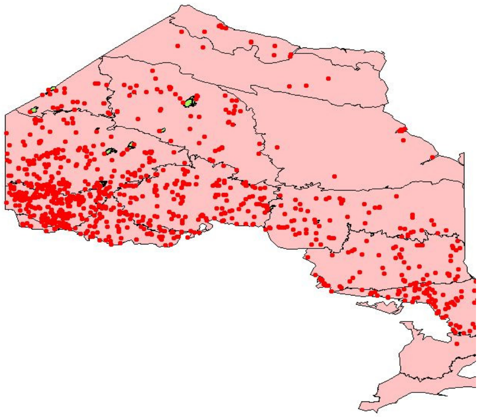
Non-growth days come from satellite data

Start and end dates of fires are recorded, but not 'spread events'. Active fire growth is available through MODIS satellite data.



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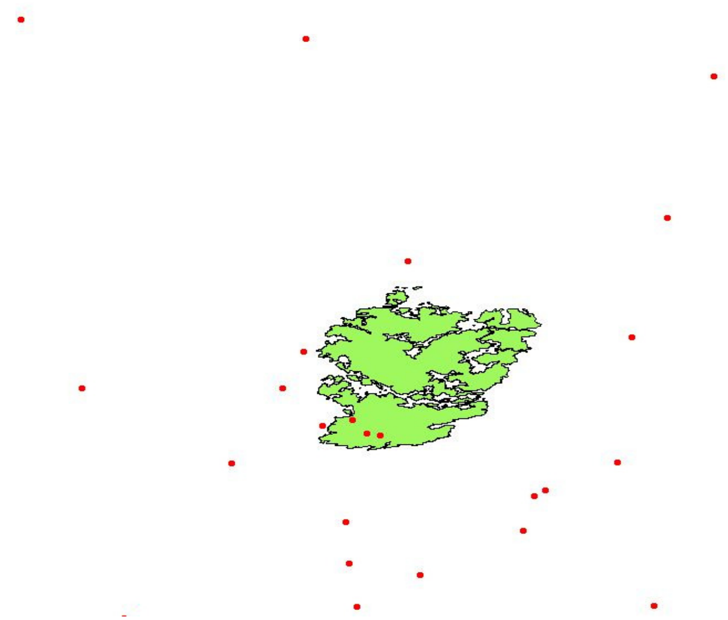
We combine MODIS active fire points with fire perimeter polygons

This includes spatial and temporal merging of data. We also compared it with DFOSS's data on active burning fires.



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The resulting dataset has growth day/non growth day vs. FWI component

This includes spatial and temporal merging of data. We also compared it with DFOSS's data on active burning fires.

year	mon	day	NUMHOTSPOTS	orgunit	firenum	Final_size	Longitude	Latitude	temp
2001	8	11	0	NIP	72	381.7	-88.3132	53.7968	15
2001	7	23	0	SLK	50	430	-92.3227	52.9571	19.4
2001	7	24	0	SLK	50	430	-92.3227	52.9571	12.3
2001	7	28	0	SLK	50	430	-92.3227	52.9571	20.3
2002	9	1	0	COC	10	600	-89.7726	55.6419	16.5

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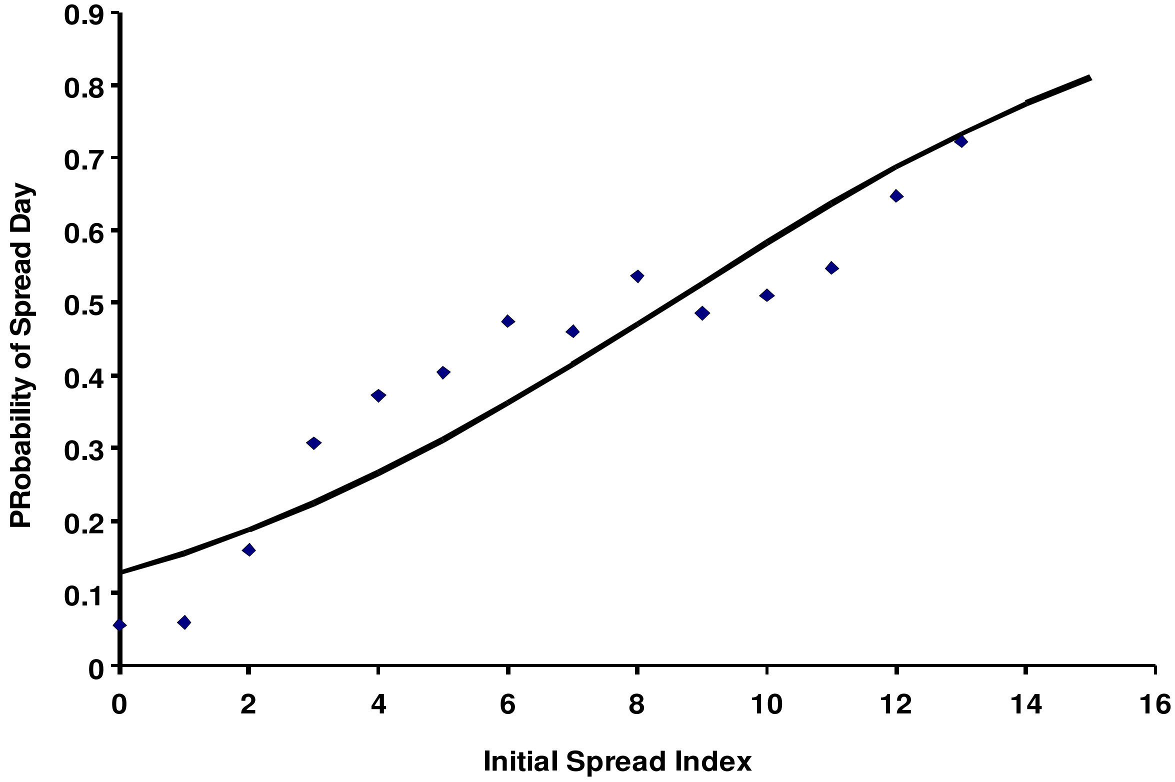
Probability of a growth day depends on ISI



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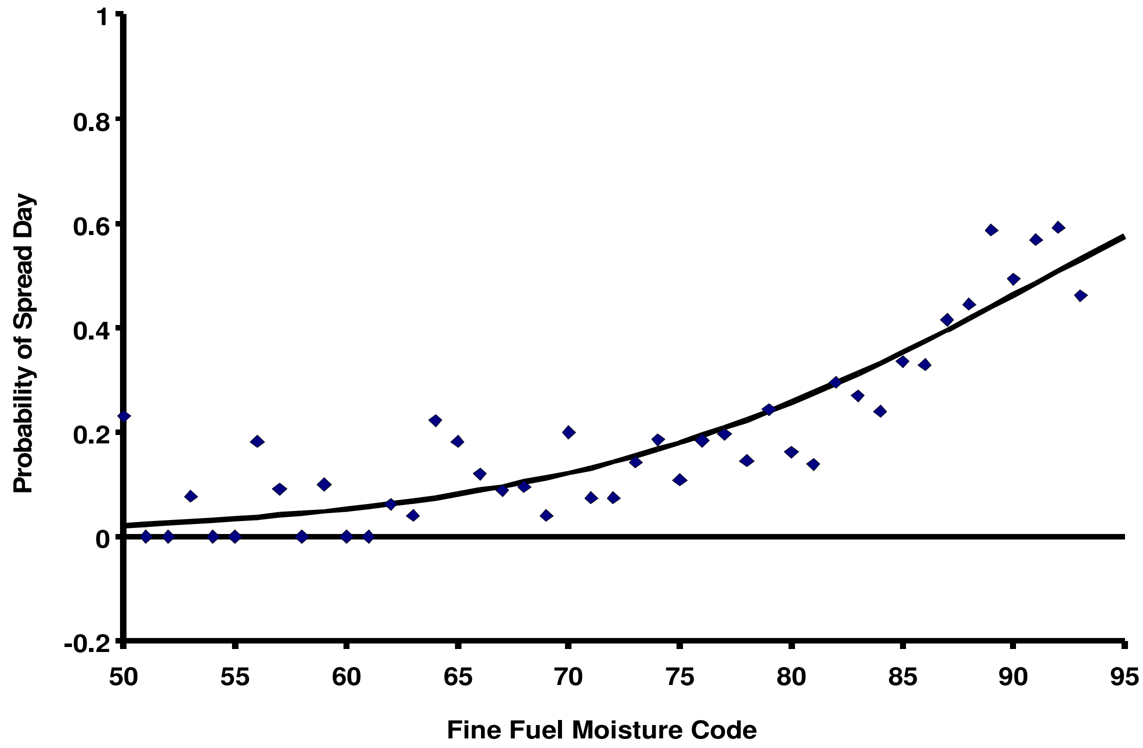
Probability of a growth day depends on FFMC



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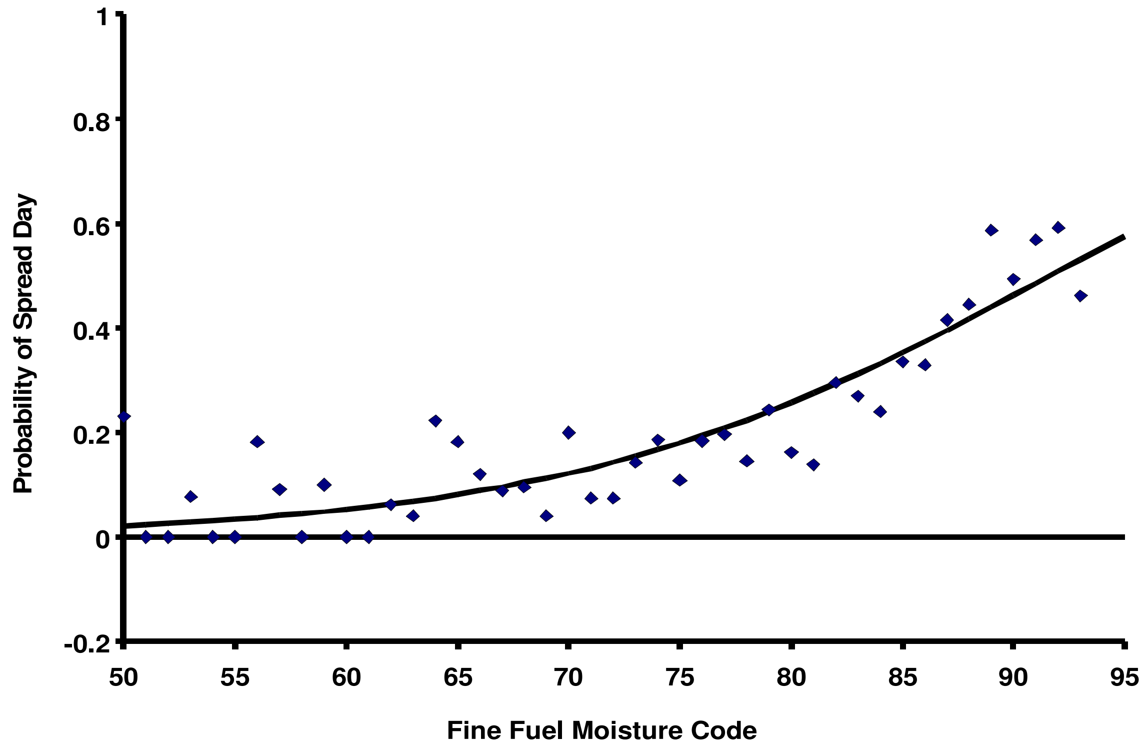
Probability of a growth day depends on FFMC



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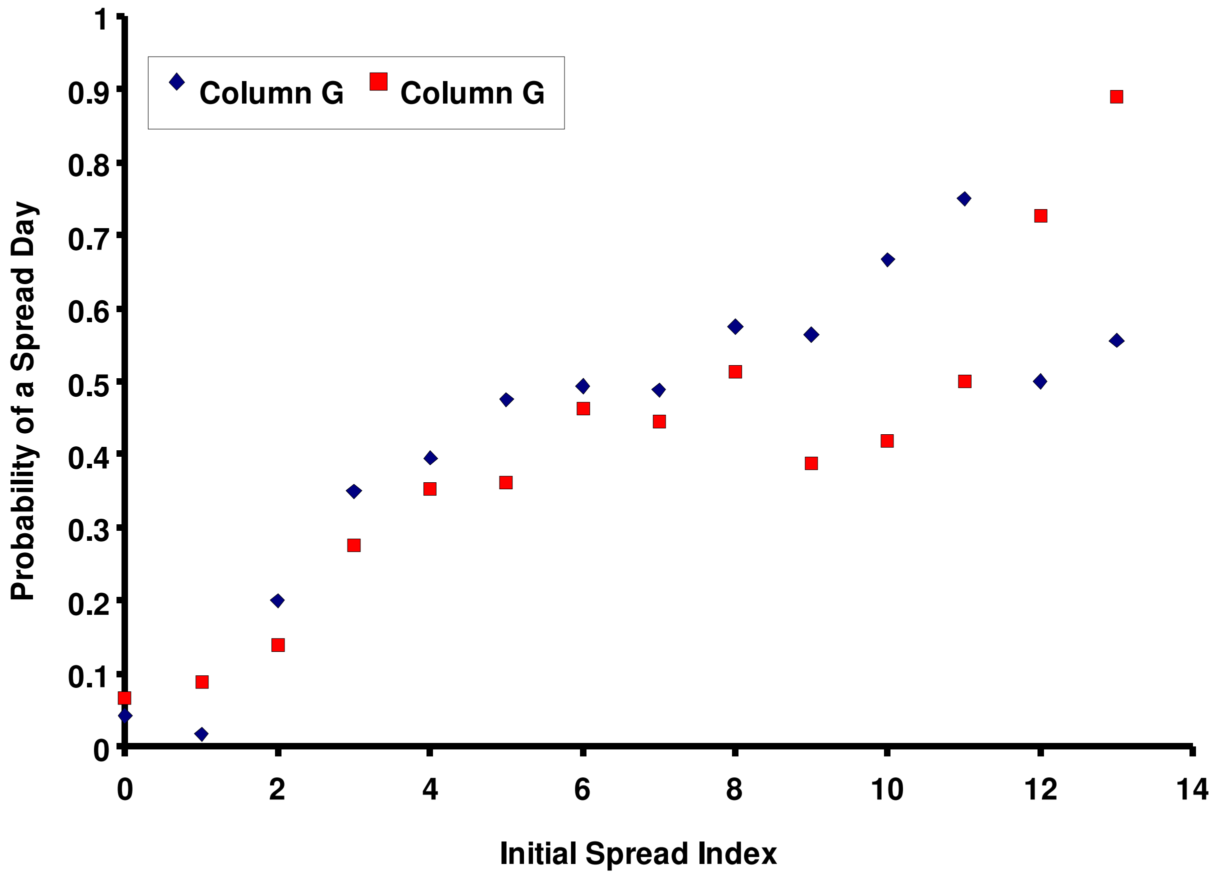
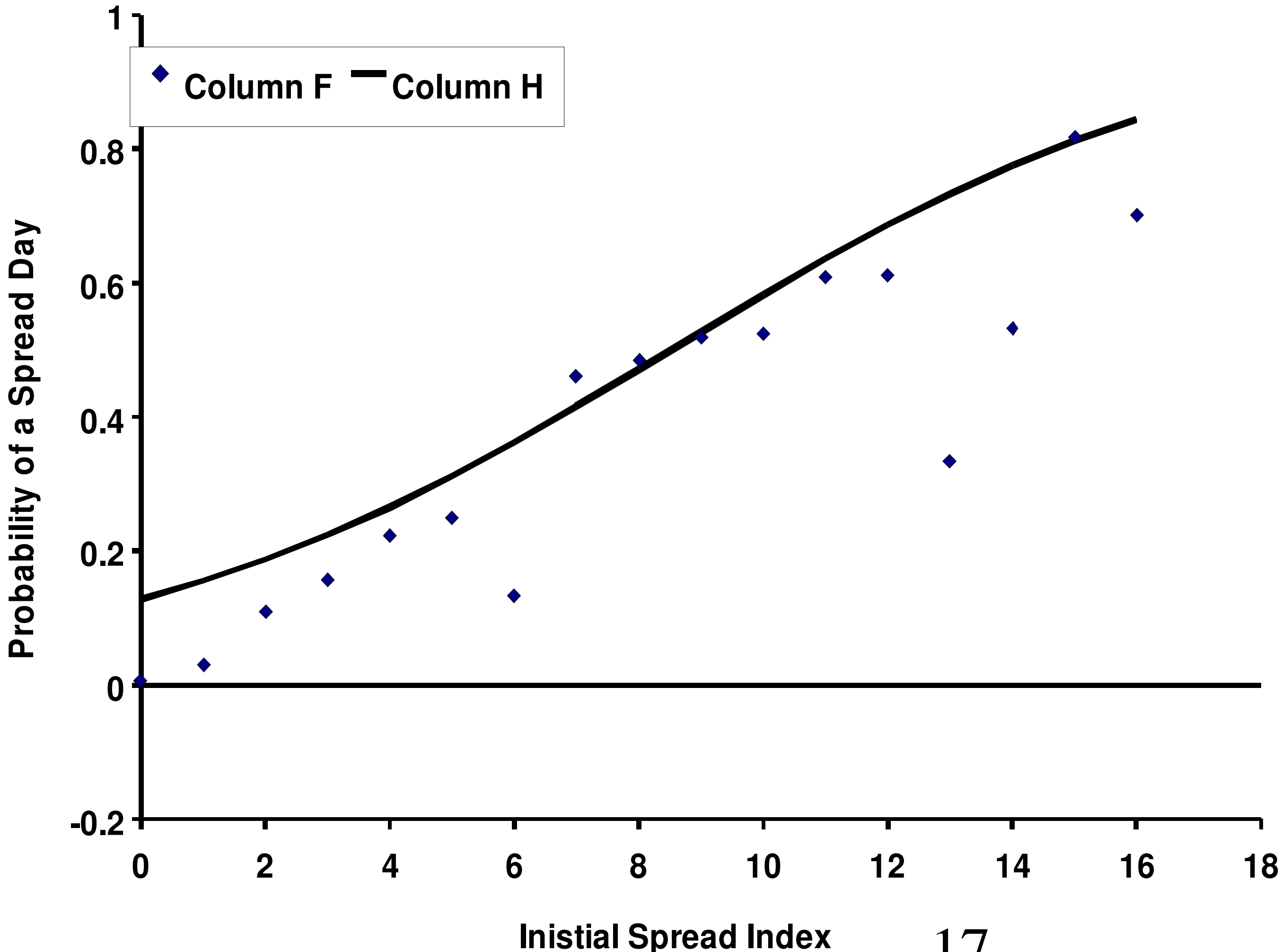
There is some difference between suppressed (blue) and observed (red) fires



Alberta data agree with Ontario data



Extinguishment day is the day after the last growth

Definition:

An extinguishment day is the day after the last growth day. All prior days could have been extinguishment days.

Hypothesis:

Extinguishment days should have more rain than prior days.

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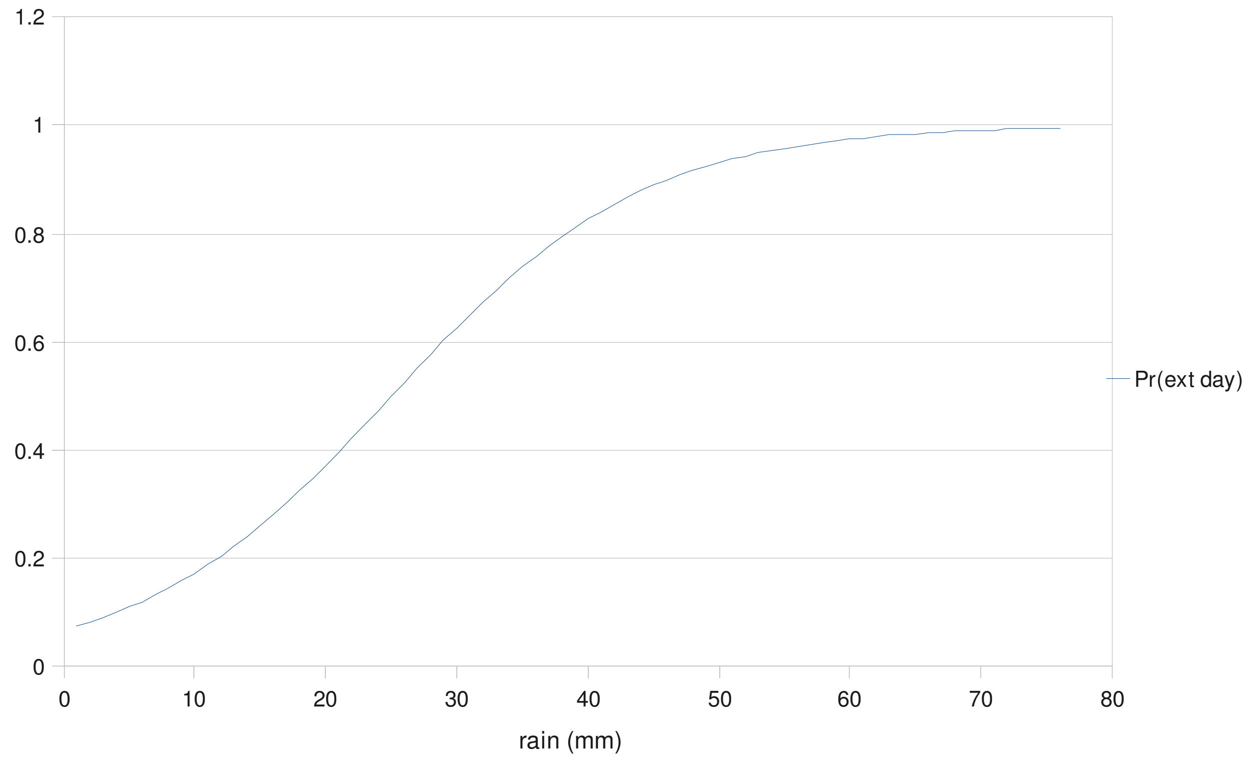
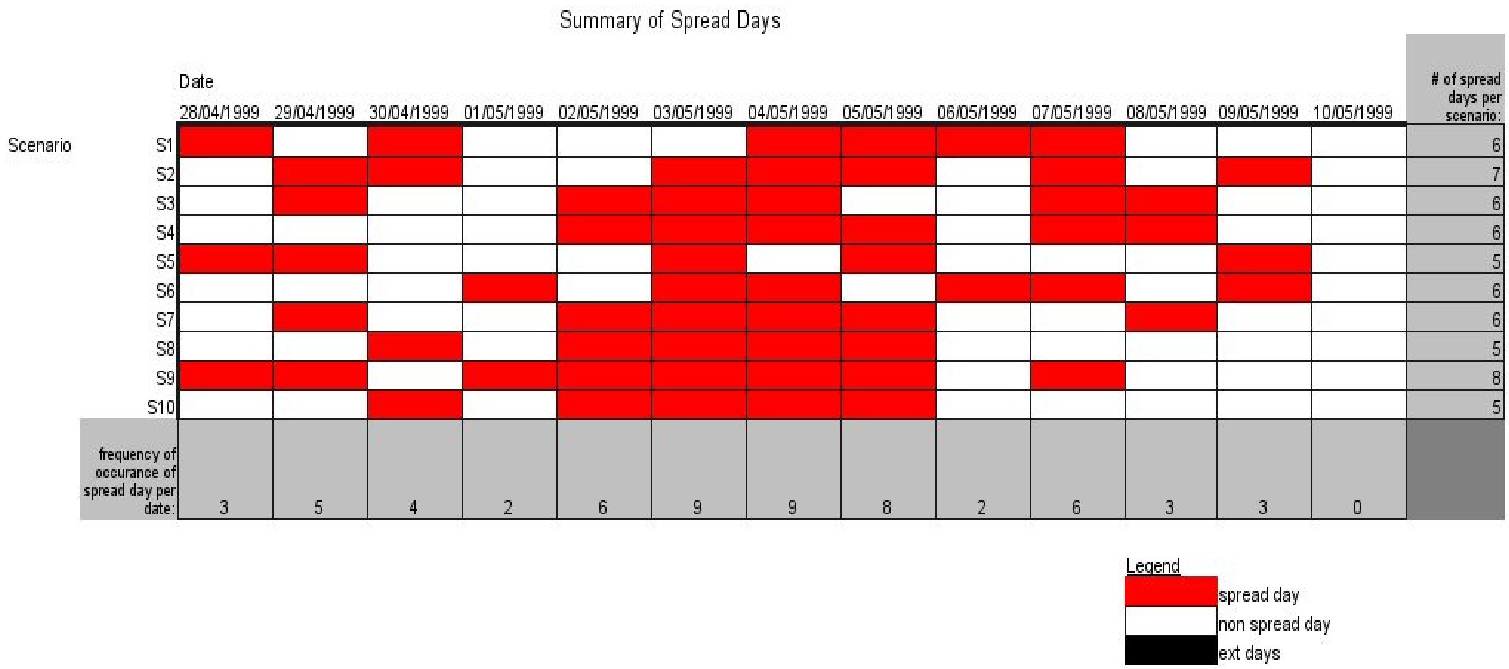
An inch of rain has a 50% probability of being an extinguishment day



The number of simulated spread days does vary



For CHA001-1999, the numbers of spread events and lengths of spread events varied in the simulation. Note, no extinguishment days.

Area burned varies with simulated number of spread days, and which days

For CHA001-1999 (actual size: 19745 ha)

Scenario	Spread days	Area (ha)
S1	6	11129
S2	7	28511
S3	6	27544
S4	6	25152
S5	5	10593
S6	6	17473
S7	6	30128
S8	5	19909
S9	8	38526
S10	5	19909

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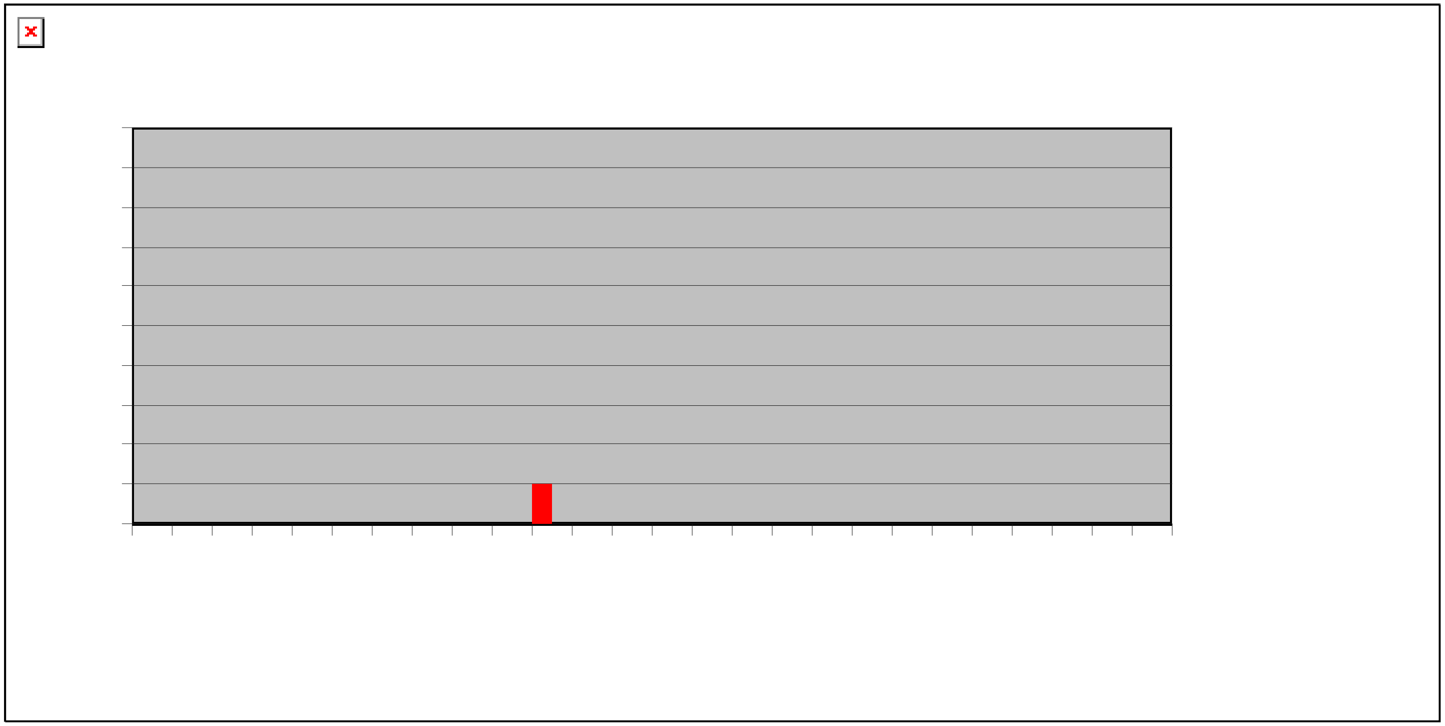
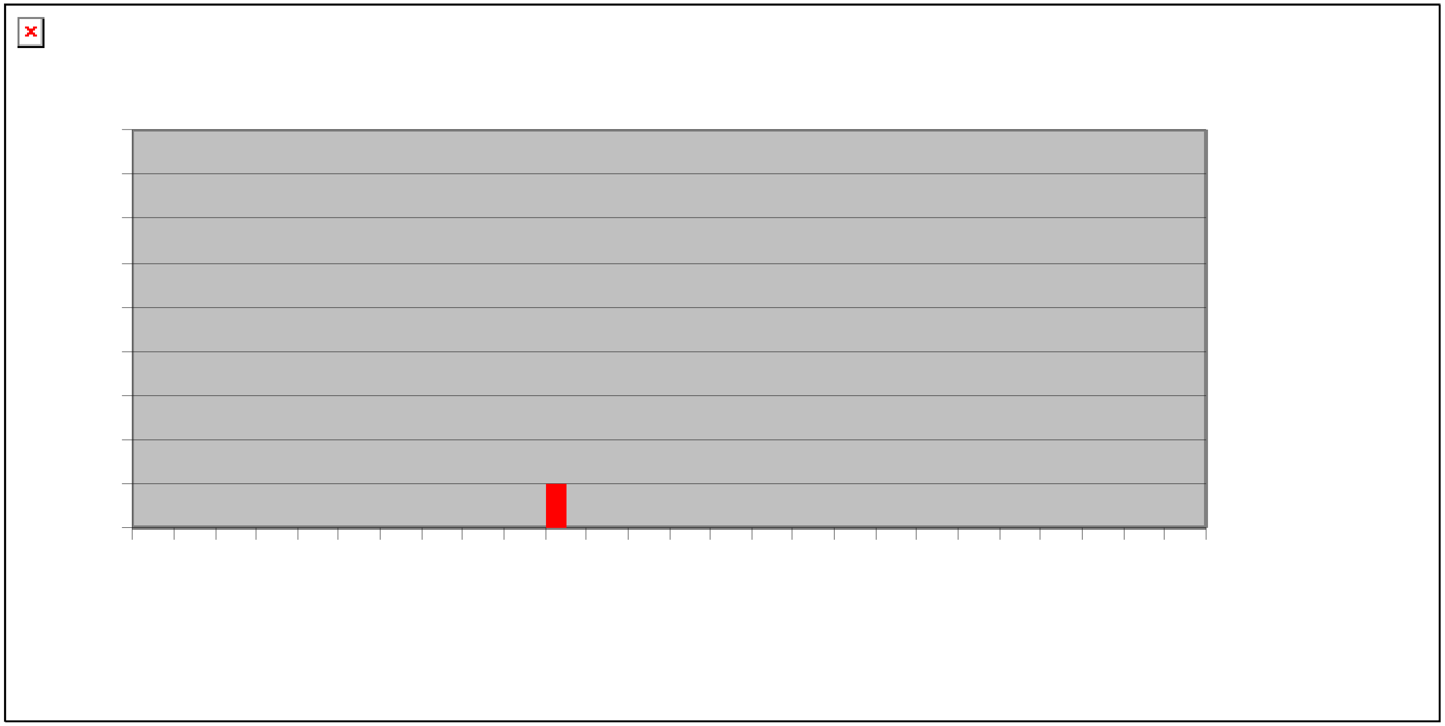
Days are classified as growth; non-growth; and extinguishment days

For DRY 010-2002



Days are classified as growth; non-growth; and extinguishment days

For DRY 010-2002



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There are several benefits to this approach

Unlike the other adjustment methods, spread events can be based on weather variables

Since area burned depends on the number of spread events, the concept can improve area burned predictions

Work is ongoing on applying the spread event and extinguishment models to more historical fires

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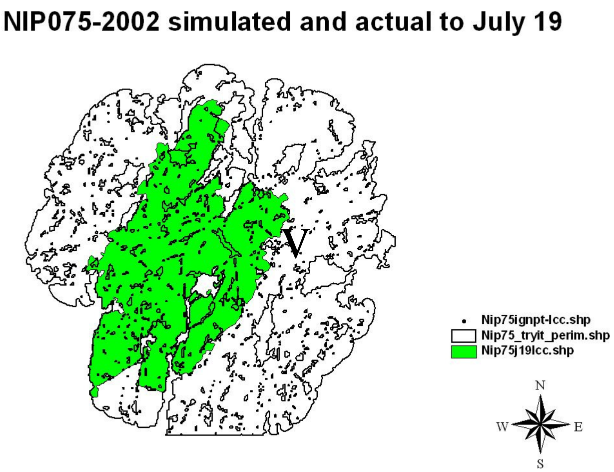

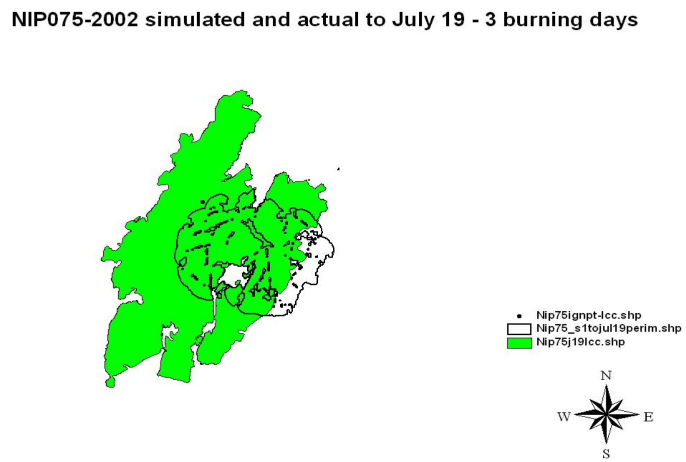

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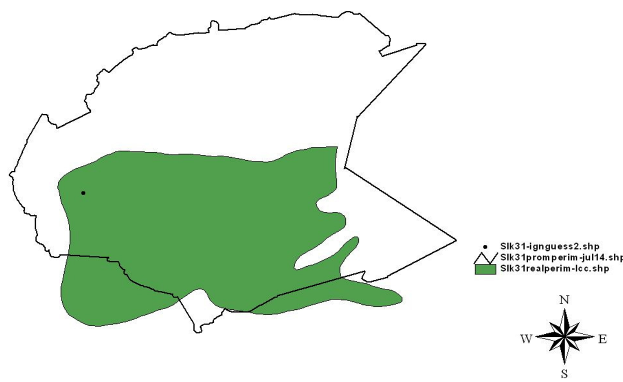
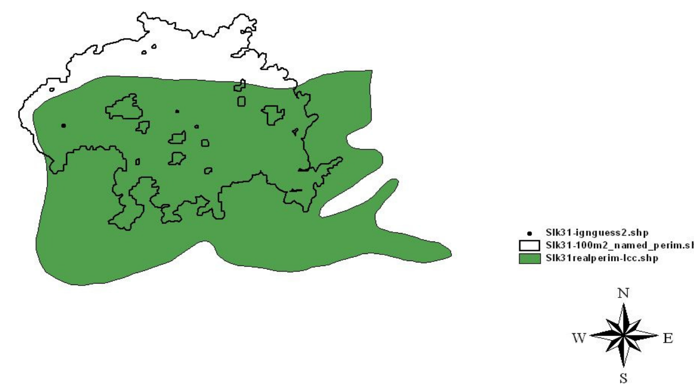
SLK-031-2002: Simulated and Actual perimeter



SLK031-2002: Simulated and actual perimeters (with spread events)



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Acknowledgements

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NSERC
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Data

OMNR
NASA
USFS

The logistic model gives probability of extinguishment

```
glm(formula = extdaymodela ~ rain, family =
binomial(logit)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.8992  -0.3985  -0.3771  -0.3771   2.3147

Coefficients:
                   Estimate  Error      z value    Pr(>|z|)
(Intercept) -2.60770    0.07307 -35.686   <2e-16 ***
rain               0.10422    0.01111   9.377    <2e-16 ***

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 1951.7  on 3257  degrees of freedom
Residual deviance: 1868.1  on 3256  degrees of freedom
AIC: 1872.1
```

Rain predicts extinguishment best

AIC for Rain: 1872
Coefficient: 0.1
P-value < 2e-16

AIC for Duff Moisture Code (DMC): 1951
Coefficient = 0.008
P-value = 0.04

DC and other indices are similar to DMC

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Oddly, wind speed did not seem to have an effect on probability of a growth day – this goes against what we know

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.9835	0.1042	89.0949	<.0001
ws	1	0.0106	0.00748	1.9919	0.1581