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## OVERVIEW

The overall goal of this project is to improve our understanding of the vulnerability of boreal peatlands to wildfire by integrating field work, remote sensing, and modeling of the biophysical, hydrological, and climatic controls on wildfire.

**Three remote sensing products were developed under the project:**

**1) Peatland Type Maps** (fen vs. bog including treed vs. open vs. shrubby) based on multi-date, multi-sensor fusion (Optical-IR, C-band and L-band SAR).

**2) Burn Severity Maps** (percent unburned moss, and a burn severity index (BSI) based on the ground consumption; and Landsat pre- and post-burn imagery) specific to peatlands.

**3) Soil Moisture Maps** based on SAR backscatter and SAR polarimetry (polarimetric SAR algorithms  $R^2 \sim 0.77$ ) were developed for mapping forests with biomass less than 3.0 kg/m<sup>2</sup>.

**Two field-based products were also developed:**

**1) Estimates of fuel consumption to the ground layer** in peatlands that can be related to the burn severity indices;

**2) Biophysical data inputs for the various peatlands** (aboveground biomass – tree and shrub, plant heights, density, etc.)

## BURN SEVERITY MAPPING

Burn severity was measured in the field using the Burn Severity Index (BSI) (Dyrness and Norum 1987), a qualitative assessment of burnt moss that uses a 1-5 scale, with 1 being unburnt and 5 being severely burnt.

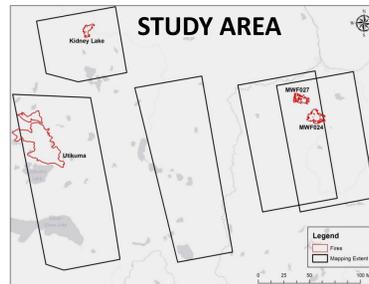


The field data were correlated with Landsat data to develop multivariate models for calculating burn severity and %-not-sphagnum-moss.

$$BSI = 72.6 + 504 * \text{diff}4:5$$

$$\% \text{-not-sphag} = -7.4 + (73.6 * \text{diff}2:7) + (70.6 * \text{diff}4:5)$$

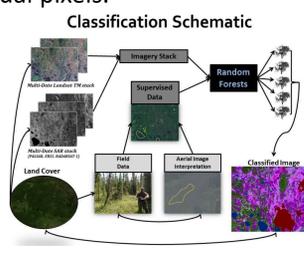
These models were used to generate the burn severity maps for four fires in northern Alberta, Canada seen in the second column to the right.



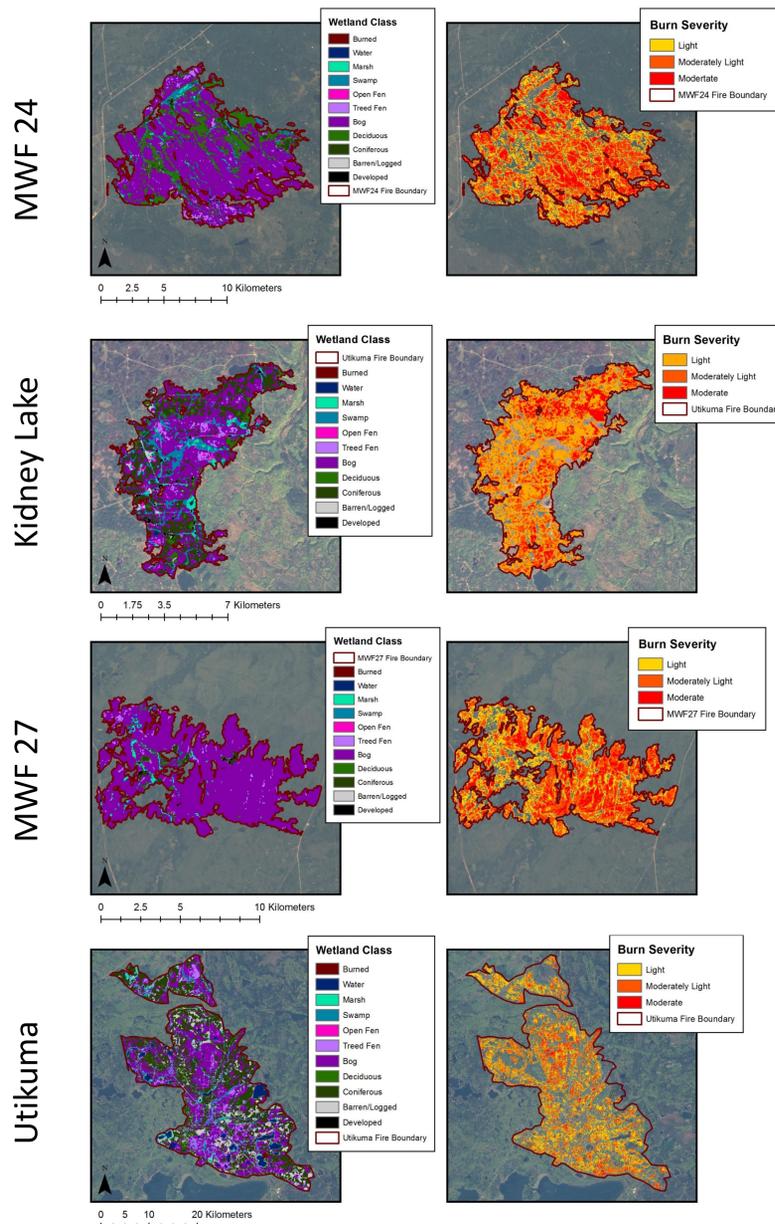
## PEATLAND TYPE MAPPING

Over 350 field locations were sampled in central Alberta to train and validate the peatland type maps shown below. Overall map accuracy was 97% using a Random Forests classifier. Random Forests is a machine learning algorithm that uses a series of decision trees to classify individual pixels.

Classification	Ground Truthed Values										Sum	Contrib	User Acc.
	Water	Marsh	Swamp	Open Fen	Treed Fen	Bog	Deciduous Upland	Coniferous Upland	Barren/Logged	Developed			
Water	1004	0	0	0	0	0	0	0	0	0	1004	0%	100%
Marsh	0	932	10	3	9	0	0	0	1	41	996	6%	94%
Swamp	0	18	944	1	4	0	6	3	35	2	1013	7%	93%
Open Fen	0	2	3	1007	59	10	0	0	0	0	1081	7%	93%
Treed Fen	0	21	33	16	893	81	0	0	0	8	1052	15%	85%
Bog	0	0	17	0	64	943	2	19	0	3	1048	10%	90%
Deciduous Upland	0	0	0	0	0	0	992	44	1	0	1037	4%	96%
Coniferous Upland	0	1	0	0	0	2	9	949	18	6	985	4%	96%
Barren/Logged	0	24	0	0	0	0	1	0	958	292	1275	25%	75%
Developed	0	5	0	1	1	0	0	0	2	667	676	1%	99%
Sum	1004	1003	1007	1028	1030	1036	1010	1015	1019				
Omission	0%	7%	6%	2%	13%	9%	2%	7%	6%	35%			
Prod. Acc.	100%	93%	94%	98%	87%	91%	98%	93%	94%	65%			



## INTEGRATION OF PEATLAND TYPE MAPS FOR BURN SEVERITY MAPPING

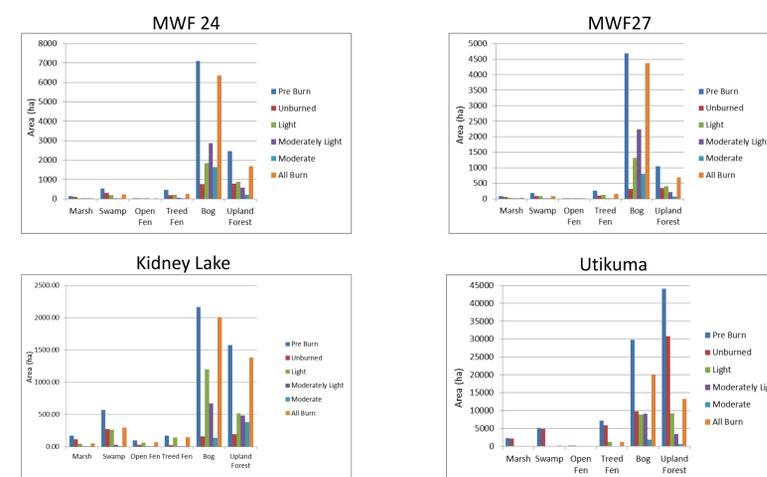


## DO PEATLANDS BURN AS SEVERELY AS UPLAND FORESTS?

To answer this question the land cover classification maps were integrated with the burn severity maps.

- In all cases treed sites experienced burning of a greater percentage of the total class area than non-treed covertypes.
- In all cases bog and upland forest experienced the greatest percentage of area burned within their covertypes.
- The Utikuma Fire of 2011 was a large early season fire. It had about 44,000 ha of upland forest and 30,000 ha of bog within its border. While 67% of the bog burned only 30% of the upland forest was burned.
- The percent of upland burned for the other 3 wildfires was much greater 67 to 88%, but in all cases the bog class experienced the greatest percentage of area burned.
- With the exception of the Kidney Lake fire, bog experienced more severe burning than upland or other classes.

Thus the assumptions that peatlands do not burn, or that they burn less severely, are shown to be false for these four wildfires of northern Alberta, Canada.



	Marsh	Swamp	Open Fen	Treed Fen	Bog	Upland Forest	Sum
<b>MWF 24</b>							
Pre Burn (hectares)	140.7	534.6	14.6	467.9	7114.7	2462.8	10735.3
% area burned	29.4%	42.7%	40.8%	57.2%	89.3%	67.9%	79.8%
Light	90.4%	87.4%	61.7%	76.5%	29.1%	52.6%	37.0%
Moderately Light	8.7%	10.9%	38.3%	21.7%	45.1%	34.1%	41.2%
Moderate	0.9%	1.7%	0.0%	1.7%	25.8%	13.3%	21.8%
<b>Kidney Lake</b>							
Pre Burn (hectares)	169.6	566.8	95.4	172.6	2163.5	1577.2	4745.3
% area burned	31.4%	51.7%	69.2%	86.4%	92.7%	87.7%	83.3%
Light	28.8%	45.8%	64.9%	83.8%	55.4%	32.6%	47.0%
Moderately Light	2.4%	5.3%	4.2%	2.5%	31.0%	30.8%	25.3%
Moderate	0.2%	0.6%	0.1%	0.1%	6.3%	24.3%	11.0%
<b>MWF 27</b>							
Pre Burn (hectares)	95.0	185.1	3.7	265.4	4691.7	1047.6	6288.5
% area burned	30.1%	52.6%	28.9%	59.9%	93.2%	66.8%	85.2%
Light	97.1%	91.2%	85.7%	85.5%	30.2%	57.1%	36.8%
Moderately Light	2.9%	8.2%	13.0%	14.2%	51.3%	32.0%	46.6%
Moderate	0.1%	0.6%	1.3%	0.3%	18.6%	10.9%	16.6%
<b>Utikuma</b>							
Pre Burn (hectares)	2262.7	5095.3	241.9	7206.7	29778.9	44116.6	88702.2
% area burned	1.4%	3.4%	0.5%	18.2%	67.3%	30.2%	39.3%
Light	86.7%	88.5%	95.3%	93.3%	44.5%	69.9%	56.3%
Moderately Light	12.7%	11.0%	3.1%	6.6%	45.8%	25.6%	36.4%
Moderate	0.7%	0.5%	1.6%	0.1%	9.8%	4.5%	7.3%

## CONSUMPTION AND EMISSIONS MODELLING

A fuel consumption and carbon emissions model (CanFIRE) is being used to model emissions from the four study fires. The schematic to the right shows typical inputs to the model in orange. CanFIRE was not created to model peatland fires so it had to be parameterized with remote sensing data, which are shown in gold.

