A Decision Support System for Daily Aerial Detection Planning in Ontario

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We describe ongoing research and development of a decision support system for daily aerial detection planning. The components of the system include:

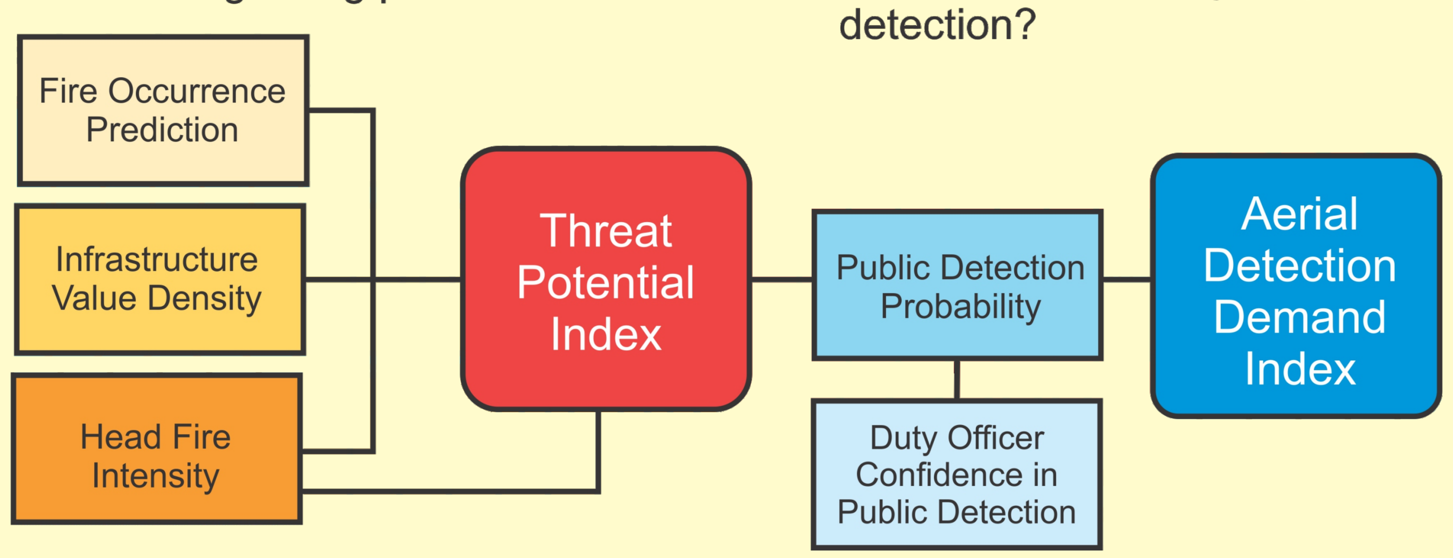
(1) a new spatially explicit person-caused fire occurrence model,
(2) a lightning fire ignition model,
(3) public detection probability models,
(4) a risk assessment process to prioritize grid cells with respect to the need for aerial detection, and
(5) a detection patrol routing optimization model. *(to be developed)*

A prototype system was tested in the Sioux Lookout district in Ontario, and an expanded system is currently being developed for testing in the Northwest Fire Region during the 2014 fire season.

The Process

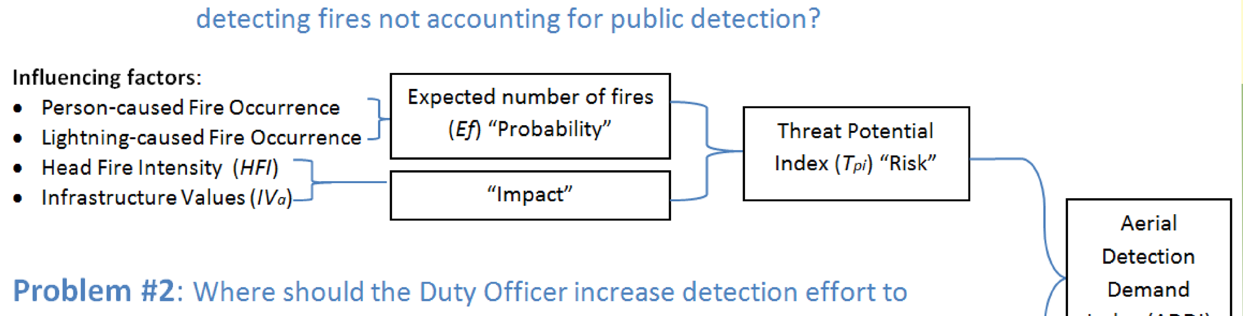
Question #1
How important is it to look at each cell 'ignoring public detection'?

Question #2
How important is it to look at each cell accounting for public detection?



The Model

Problem #1: Where should the Duty Officer be concerned about wildland fire conditions for each 20x20km cell in the NWR with regards to detecting fires not accounting for public detection?



Problem #2: Where should the Duty Officer increase detection effort to address the threat potential accounting for public detection?

- Public Detection Probability (P_{pd})

Threat Potential Index $Tpi = Ef*(HFI^2)*(\sqrt{IVa}) + k*HFI^2$

Aerial Detection Demand Index ADDI= $Tpi*(1-(Ppd*Ck))$ where *Ppd* is determined by:

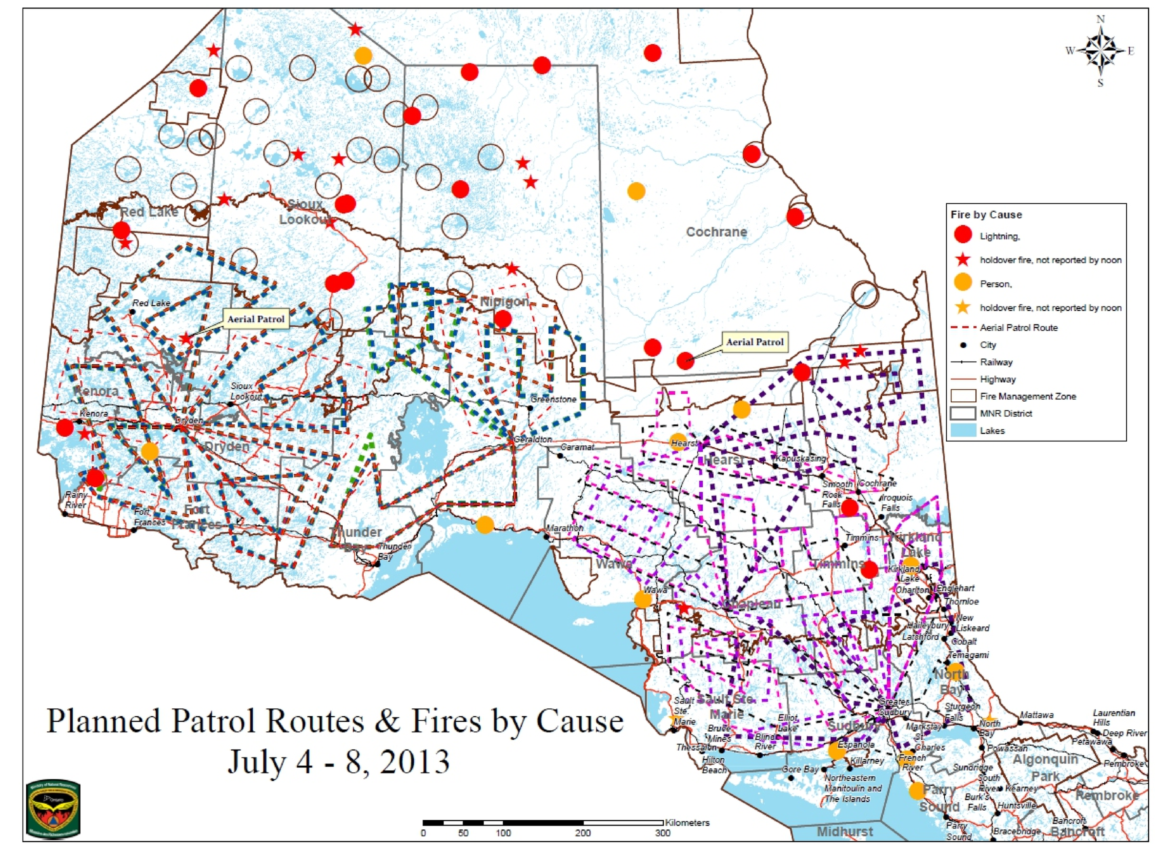
Tpi Range	0 - 2	2 - 5	5 - 10	10 - 15
Ppd Model	=<24 hrs.	=<12 hrs.	=<8 hrs.	=<4 hrs.

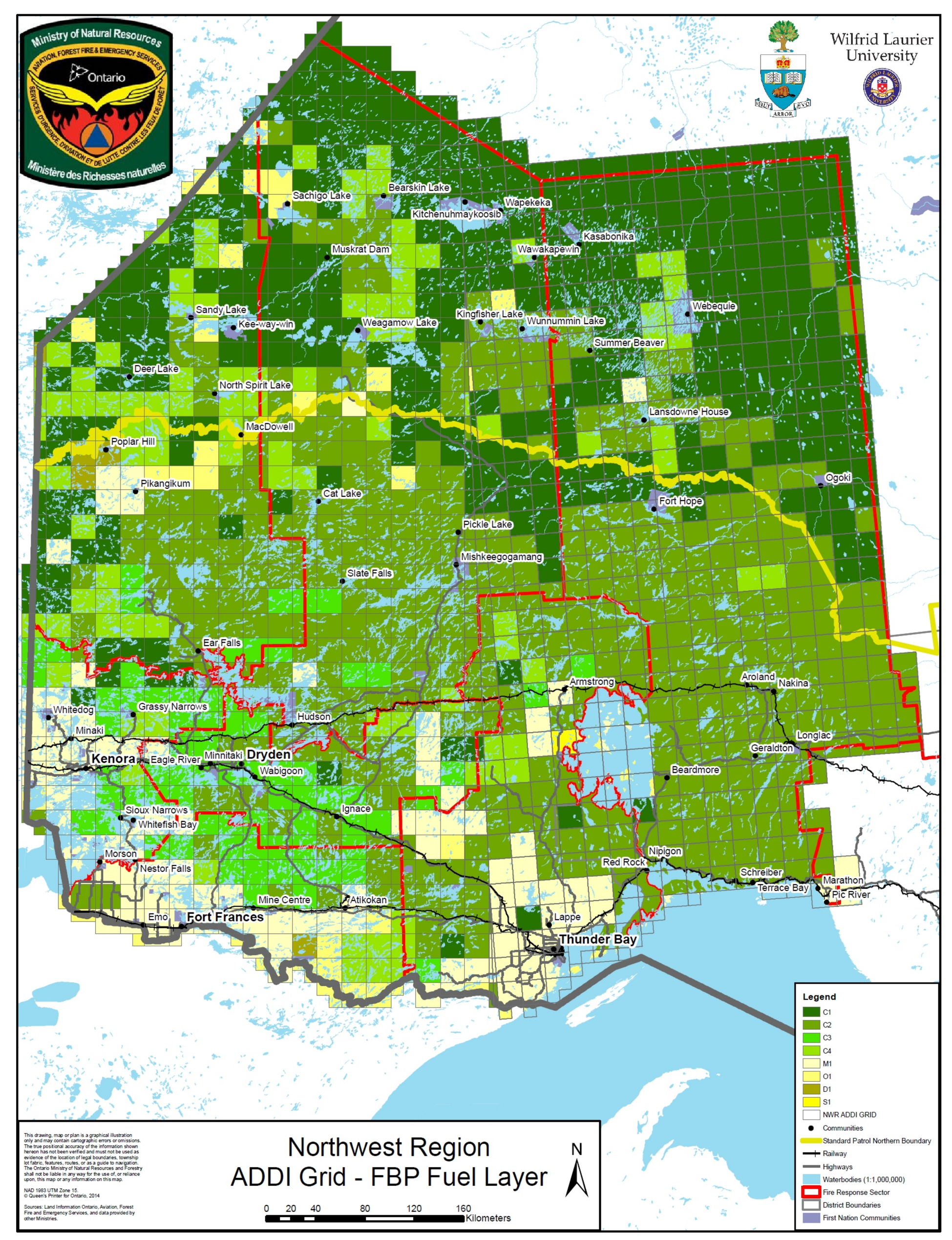
Ck factor *is the Duty Officer's (DO) subjective confidence in public detection for that day.*

K factor *– Weighting for how much a DO wants to look at a cell solely because of predicted fire intensity, regardless of the values & expected fires.*

The Question

- We spend millions of dollars flying aerial detection, and we find 15% of the fires. The public finds 60%, and suppression aircraft the remainder.
- Important to find the **right** fires, under the **right** conditions. Are we doing this?
- Solution: We are developing a decision support framework to help guide where/when patrols are needed





The Grid

The Northwest Fire Region of Ontario was partitioned into 20 x 20 kilometer cells.

The spatial resolution provides enough detail to for precision in flight planning and assessing risk. The grid is comprised of four UTM basemaps. Many static values are contained in the grid attributes and used to assist in model calculations. For example, FPB fuel type (left), values, area calculations etc.

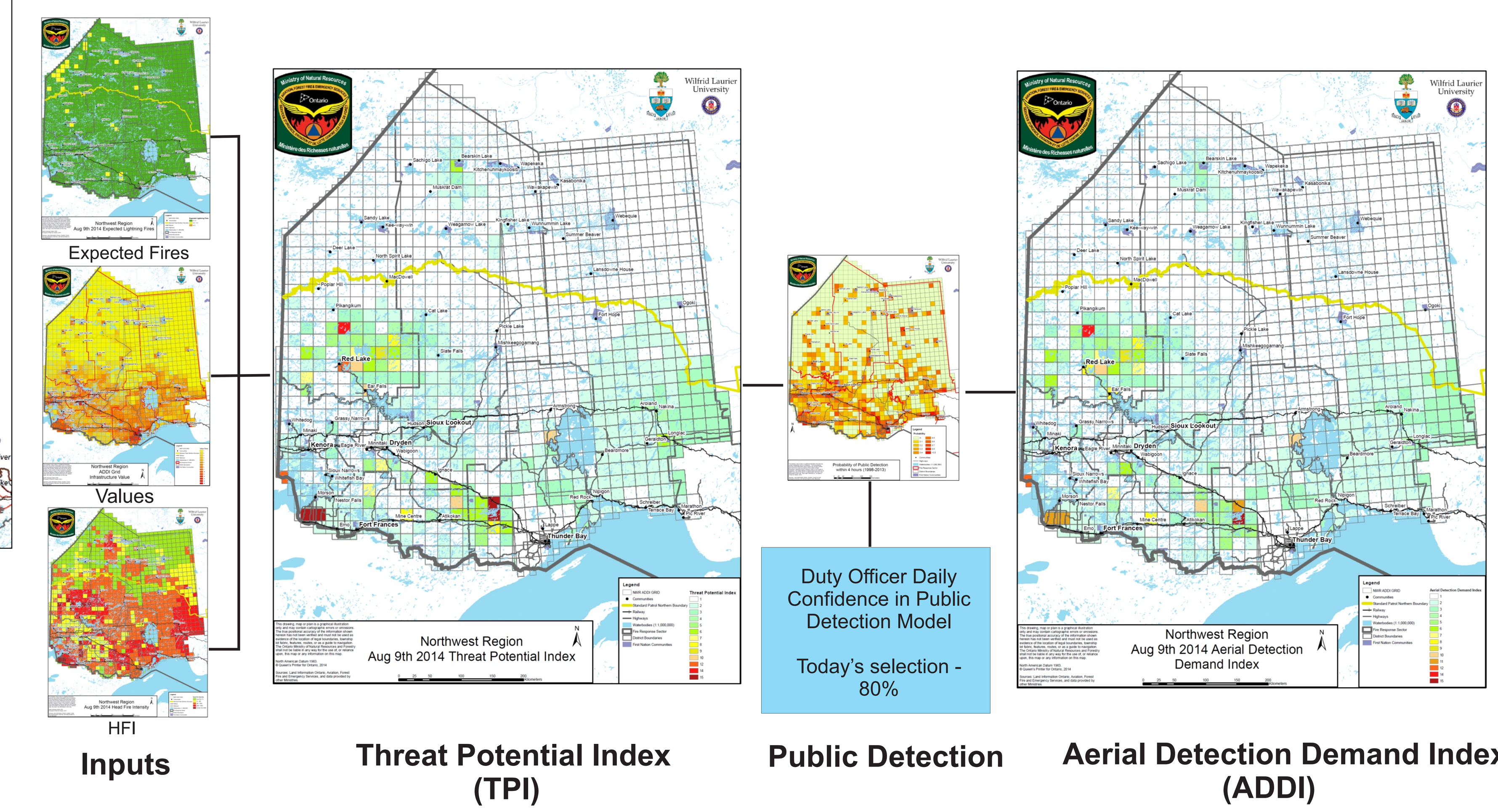
Historically when planning aerial detection patrols 20 km is considered the optimum scanning range for an Observer.

Each primary component of the model is categorized and displayed using the grid cells.

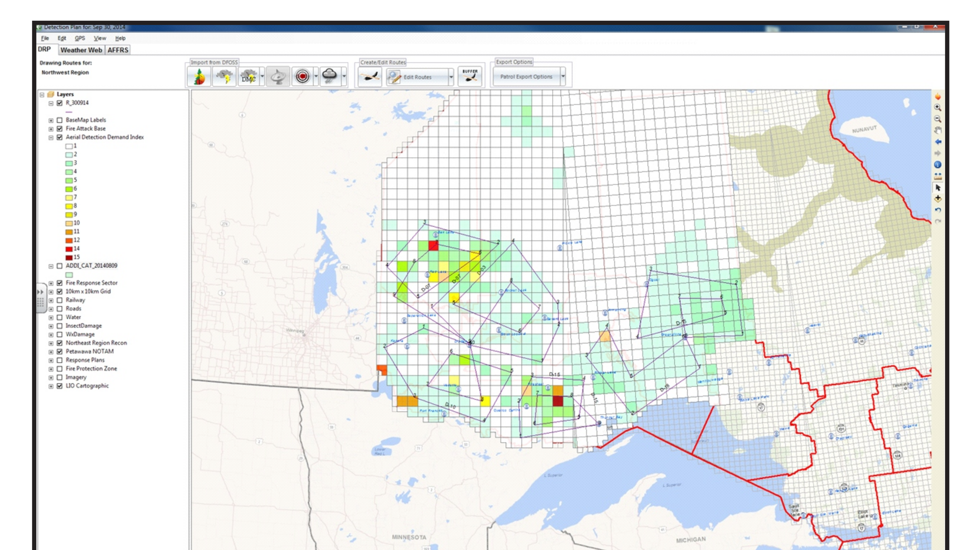
This includes:
- Lightning-Ignition Model
- Person-Caused Fire Model
- Head Fire Intensity (HFI)
- Values (Infrastructure)
- Threat Potential Index (TPI)
- Public Detection Probability
- Aerial Detection Demand Index (ADDI)

An Example

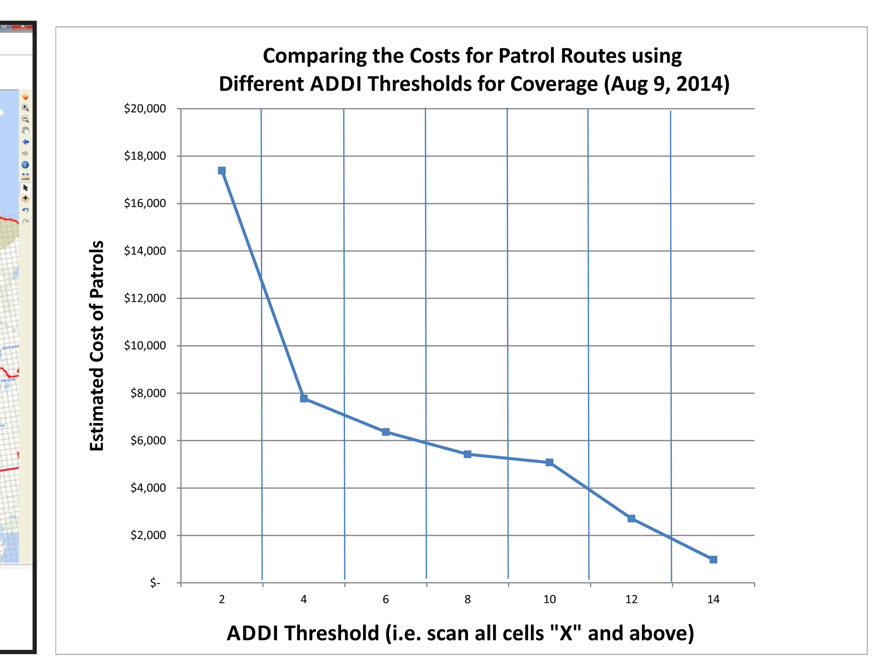
- On August the 9th, the FWI was Moderate to High across the majority of the Northwest Fire Region. Below is an example of the model components and an illustration of how the ADDI combines the factors.



- After reviewing the results, let's say the Duty Officer directs the detection route planner to design a set of routes that cover off all cells greater than an Aerial Detection Demand Index of a certain value, e.g. view cells 3 and above.



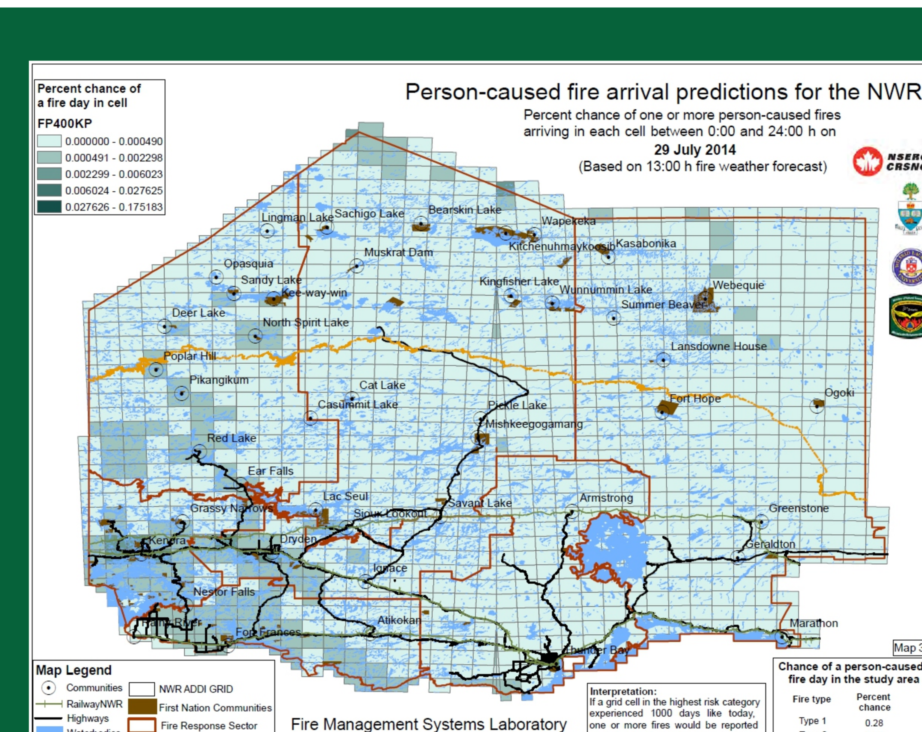
Example of importing the ADDI as a GIS layer in the Aerial Detection Flight Planning Tool



At what ADDI threshold level should we look at a cell (launch patrols) is a question for further study.

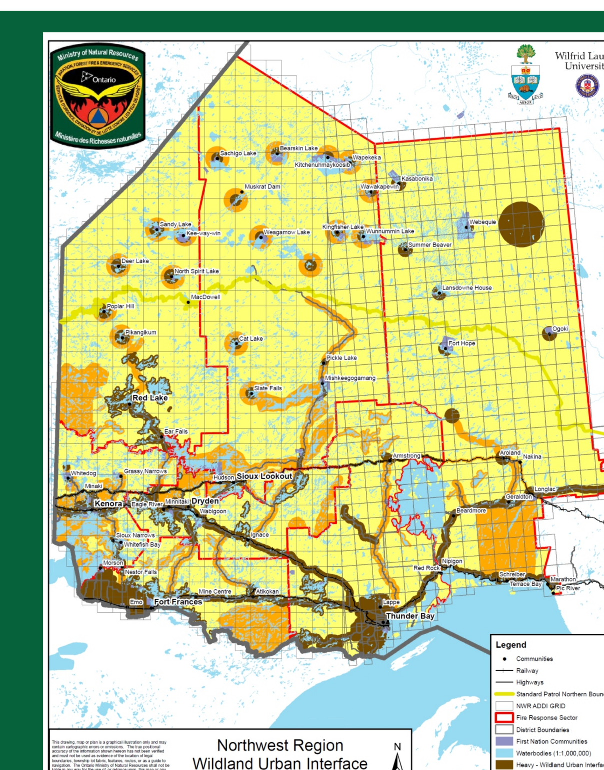
For now, the ADDI could be used to reduce the cost of achieving a level of coverage that is implicit in whatever ADDI threshold the Duty Officer wants to go with each day. Routes are drawn subjectively by assessing multiple criteria, including regulatory requirements and safe operations.

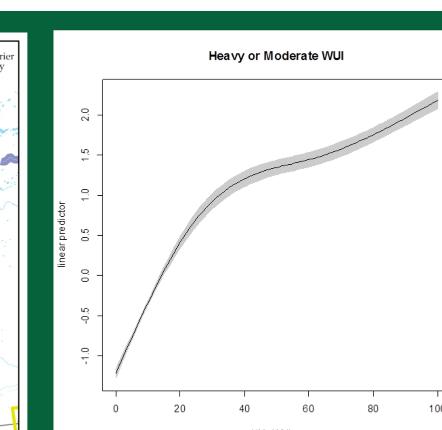
We are exploring a couple of routing optimization methods such as the traveling sales vendor model and a heuristic search model.

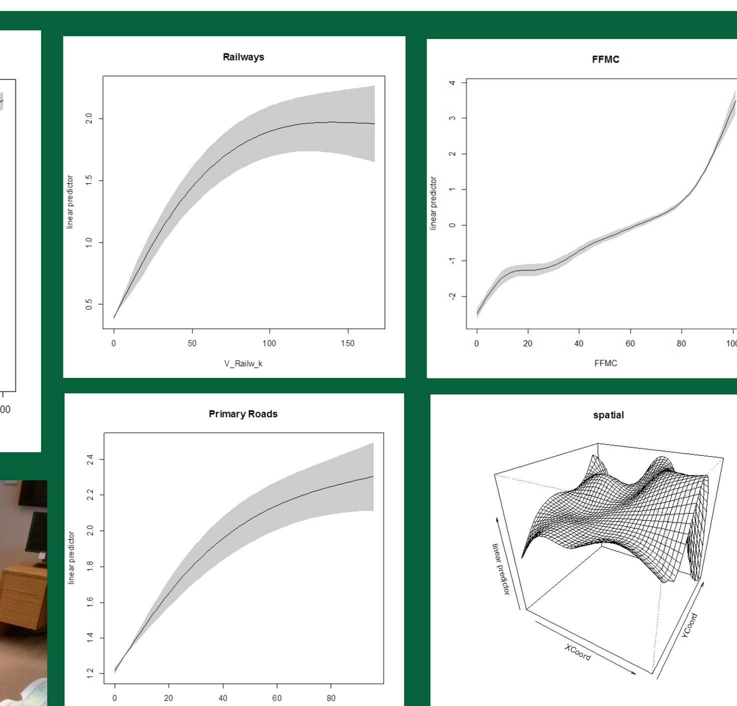


A new spatially explicit person-caused fire ignition model for Ontario was developed for this project. Two categories of ignition sources; category 1 includes (REC, IDF, IDO, INC) and category 2 includes (RES, MIS, RWY, UNK). The model captures seasonal trends such as spring peak behavior. Models have been fit to account for space, time and other factors such as fine fuel moisture codes, railway, road type, and wildland urban interface (WUI).

The wildland urban interface variable was mapped by senior staff at each Fire Management Headquarters in the Northwest Region. This exercise is a means to incorporate expert knowledge directly into the model.







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