

# Project 4:

# West Nile Virus Prediction

## \_\_Problem Statement\_\_

**West Nile virus is most commonly spread to humans through infected mosquitos. Around 20% of people who become infected with the virus develop symptoms ranging from a persistent fever, to serious neurological illnesses that can result in death. The City of Chicago and CPHD needs a model that can help them to predict more efficiently and effectively where and when the mosquitos will become virulent so that they can allocate resources towards preventing transmission of this potentially deadly virus.**

By:

Samuel Koh (Group Leader)

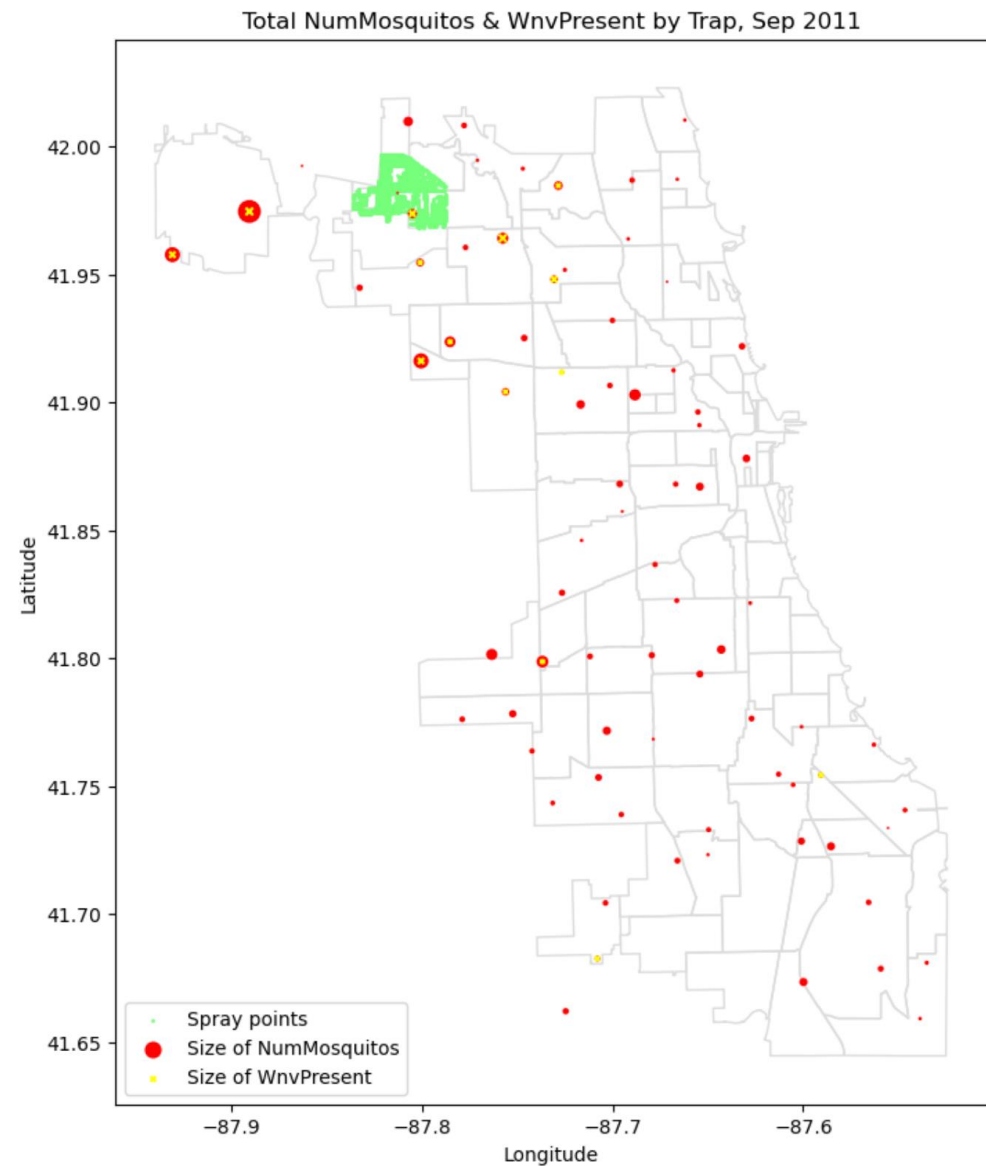
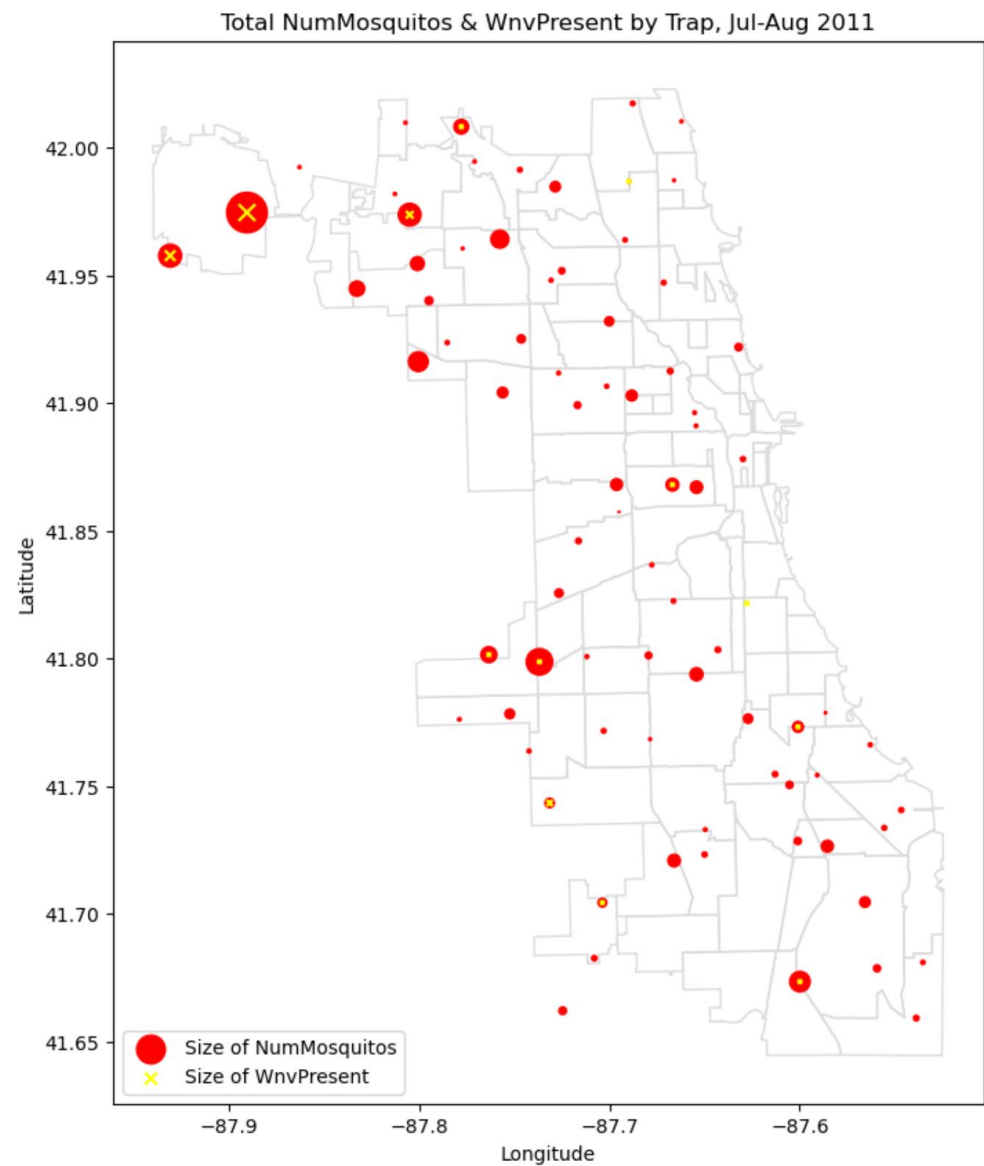
Benjamin Yen (Cleaner)

Tan Jun Jie (Cleaner)

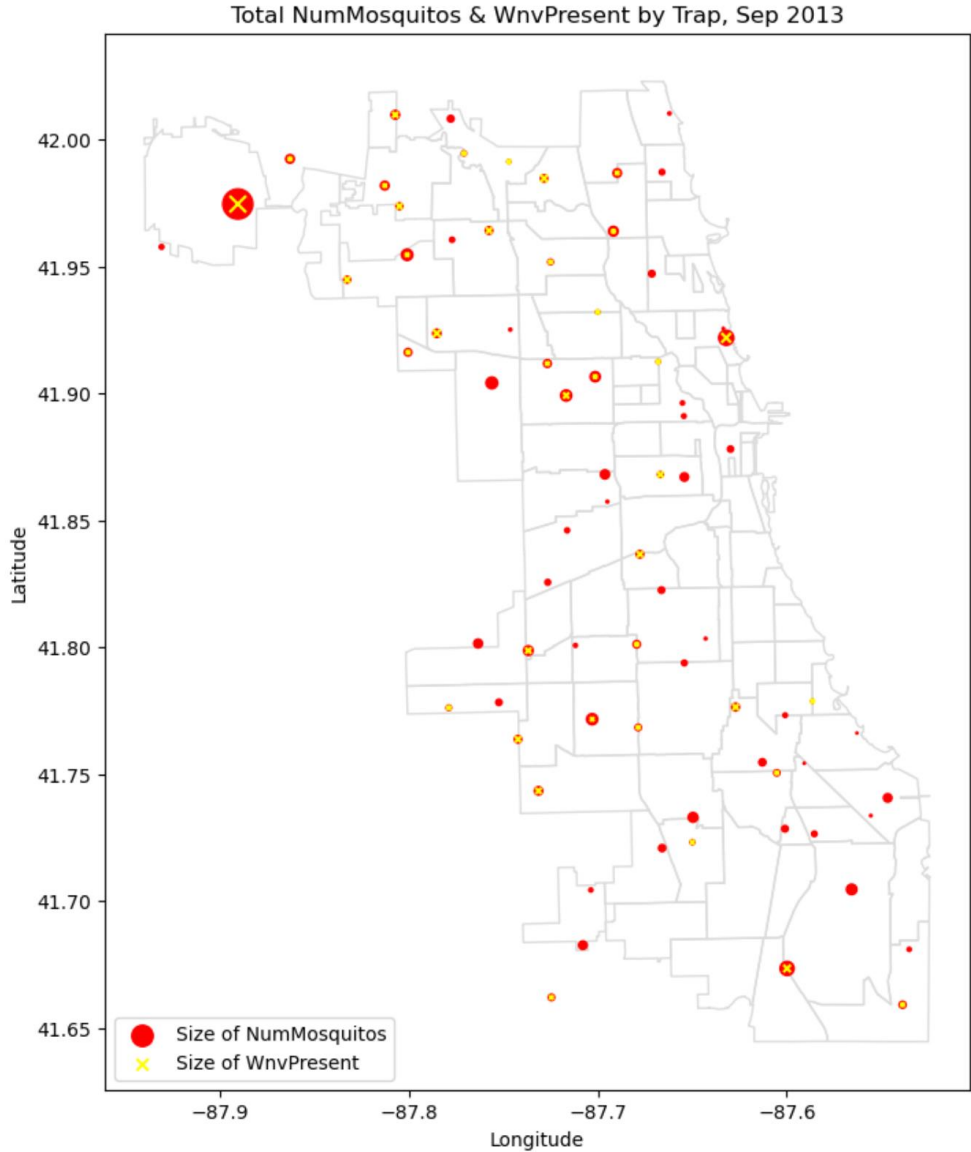
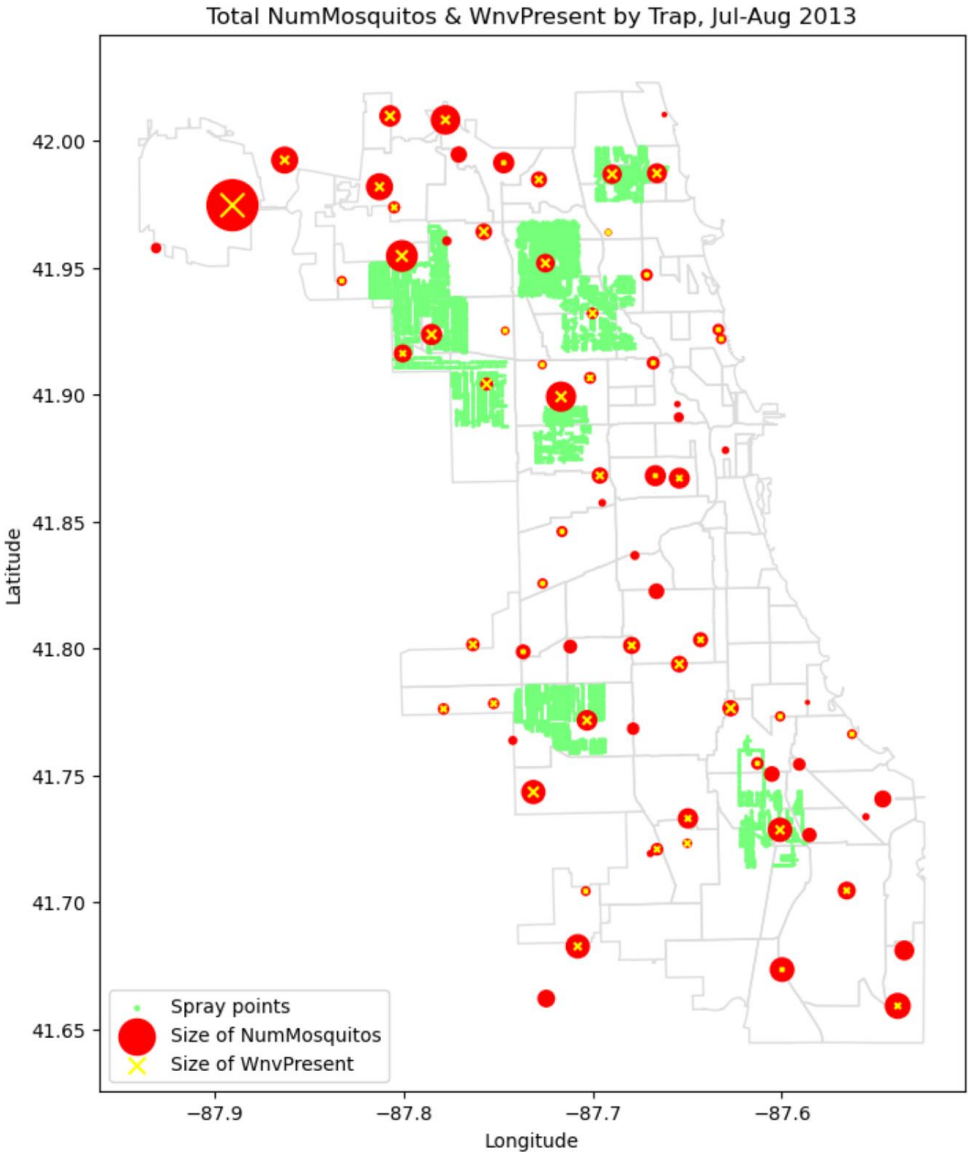
# Cost-Benefit Analysis

Chicago's Spray Program vs Our Model

Chicago failed to spray in time despite finding strong clusters of NumMosquitos and WnvPresent in Jul-Aug 2011. In Sep 2011, they sprayed a small area but it was not the hotspot for WnvPresent.



In Jul-Aug 2013, Chicago sprayed extensively but inaccurately as big NumMosquitos and WnvPresent clusters have been detected from their Traps in those months. And in Sep 2013, they did not spray at all despite big clusters still being discovered in the most Northwest region.



# Chicago's WNV Spray Program Post-Mortem



**MISSED THE MARK!**



**MISSED THE TIMING!**

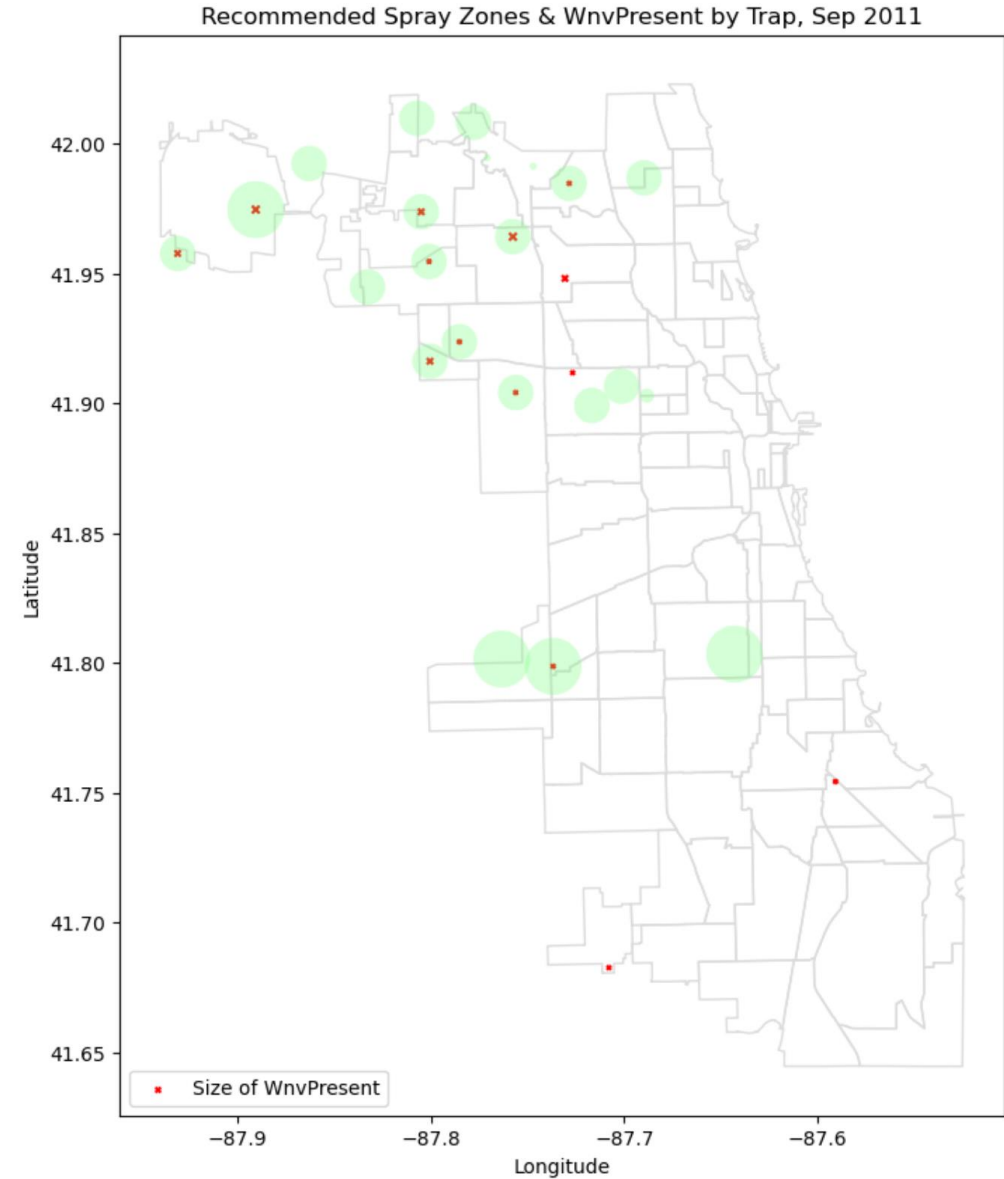
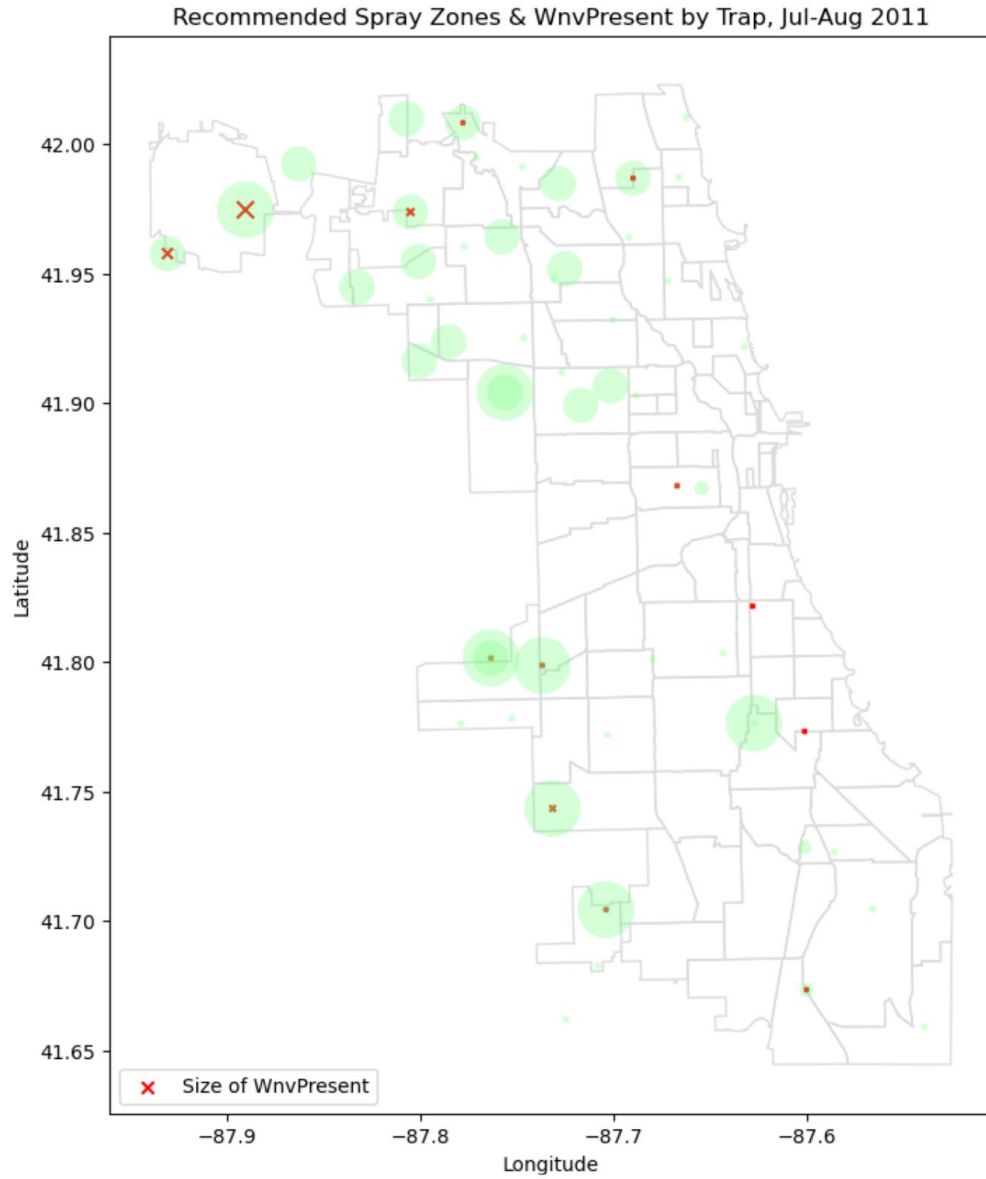


**REACTIVE SPRAYING IS FUTILE!**

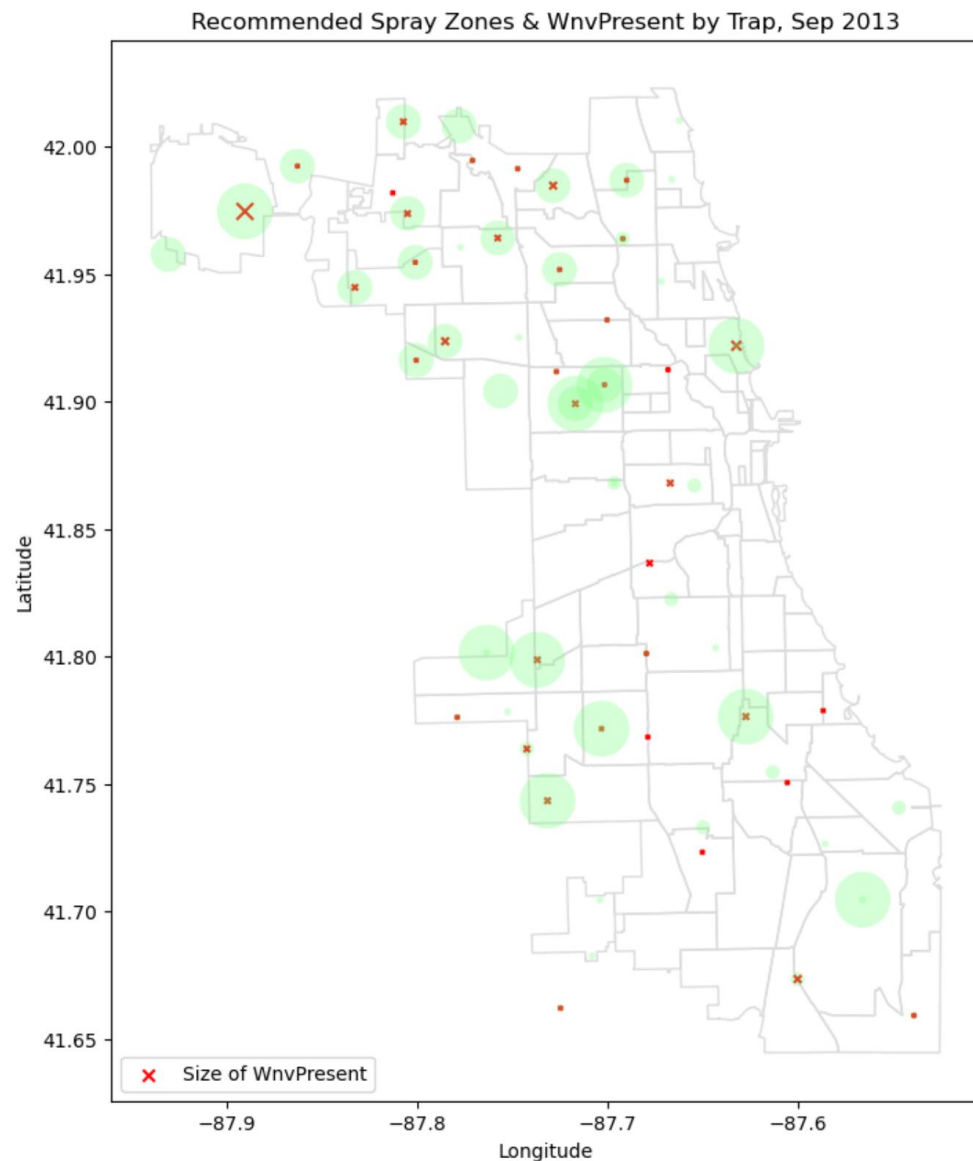
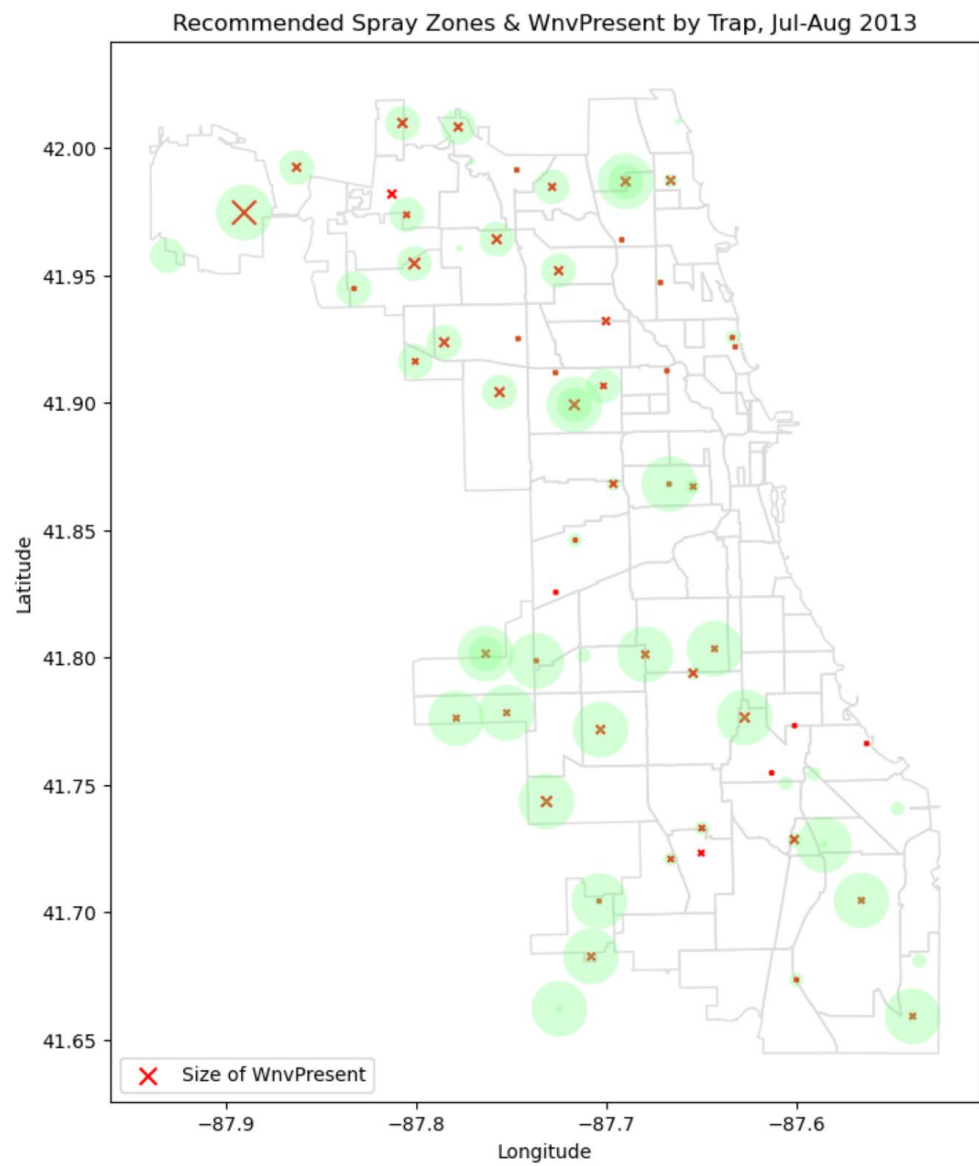
# Let our Model recommend when, where, and how much to spray

- High Recall Score (“True positive rate”) : 0.78
- Contains only Leading Indicators
  - Most indicators’ data are available weeks in advance
  - Only two late indicators at 2-days in advance
  - Helps in anticipating and planning weeks and days in advance
- Informs the necessary coverage of sprays around the Traps
- Spray **PROACTIVELY** and **ACCURATELY!**

Most recommended spray zones correspond well to the actual location and size of WnvPresent clusters.



# Even more accurate in 2013! Less False Positives!





# Case-study: Cost-Benefit Analysis for 2013

Table 2



Annual human WNV cases, average seasonal mosquito infection rate (MIR), and mosquito testing from 2005 to 2016 in Cook and DuPage counties.

Year	Number of human cases	Average MIR	Number of pools tested	Number of positive pools	Total number of mosquitoes tested
2005	181	5.33	7,165	1,939	271,235
2006	129	5.35	9,428	1,984	318,386
2007	43	2.65	12,131	1,259	375,520
2008	10	1.91	9,024	587	298,995
2009	1	1.14	9,450	298	311,220
2010	47	5.19	11,491	2,086	393,279
2011	24	3.10	8,911	939	287,774
2012	229	7.35	10,162	3,182	323,497
2013	66	4.26	11,078	1,967	407,326
2014	31	2.97	9,273	990	333,489
2015	36	3.57	7,725	1,046	314,363
2016	108	6.34	6,144	1,687	219,909

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MIR = Mosquito infection rate; WNV = West Nile virus

# Case-study: Cost-Benefit Analysis for 2013

	Chicago's Spraying	With our Model
Number of Infected Human Cases	66	14.52 <sup>*</sup>
Average Medical Burden Cost per case (US\$) <sup>1</sup>	21,000	21,000
<b>Total Medical burden costs (US\$)</b>	<b>1,386,000</b>	<b>304,920</b>
Average Spray Cost per acre (US\$) <sup>2</sup>	1.60	1.60
Total Spray(ed) Area, acres	60,234 <sup>^</sup>	338,081
<b>Total Spray Costs (US\$)</b>	<b>96,374</b>	<b>540,926</b>
<b>Total Costs (US\$)<sup>3</sup></b>	<b>1,483,000</b> 	<b>846,000</b> 

## List of Assumptions:

<sup>\*</sup> We assumed that the actual infected human cases could have been reduced proportionately by a factor of our Model's recall rate of 0.78:  $[(1-\text{Recall rate}) \times \text{Actual cases}]$

<sup>1</sup> According to a study published in the Journal of Infectious Diseases in 2014

<sup>2</sup> Assumed spray used is *Larvicide* which is less harmful to humans and environment and has a longer duration of 1-28 days depending on sunlight levels

<sup>3</sup> Total Costs=Total Medical Burden costs + Total Spray Costs

<sup>^</sup> Actual sprayed area is based on the spray data provided, added with an effective radial zone of 100meters from each spray point