

Chicago West Nile Virus Epidemic

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Background of West Nile Virus

- Viral infection typically spread by mosquitoes.
- ~ 75 % of infected people show no symptoms.
- Others develop fever, headache, vomiting or rash.
- Complications : Encephalitis and Meningitis.
- 10 % risk of death to those seriously infected.



Background of West Nile Virus

- First discovered in Uganda in 1937, and first detected in America in 1999.
- West Nile Virus has had outbreaks in Africa, Europe, Asia, Australia and North America.
- Oddly South America has never had an outbreak.
- First detected in Illinois in 2001. Found in 2 dead crows.
- First Human cases observed in 2002.



Problem at Hand

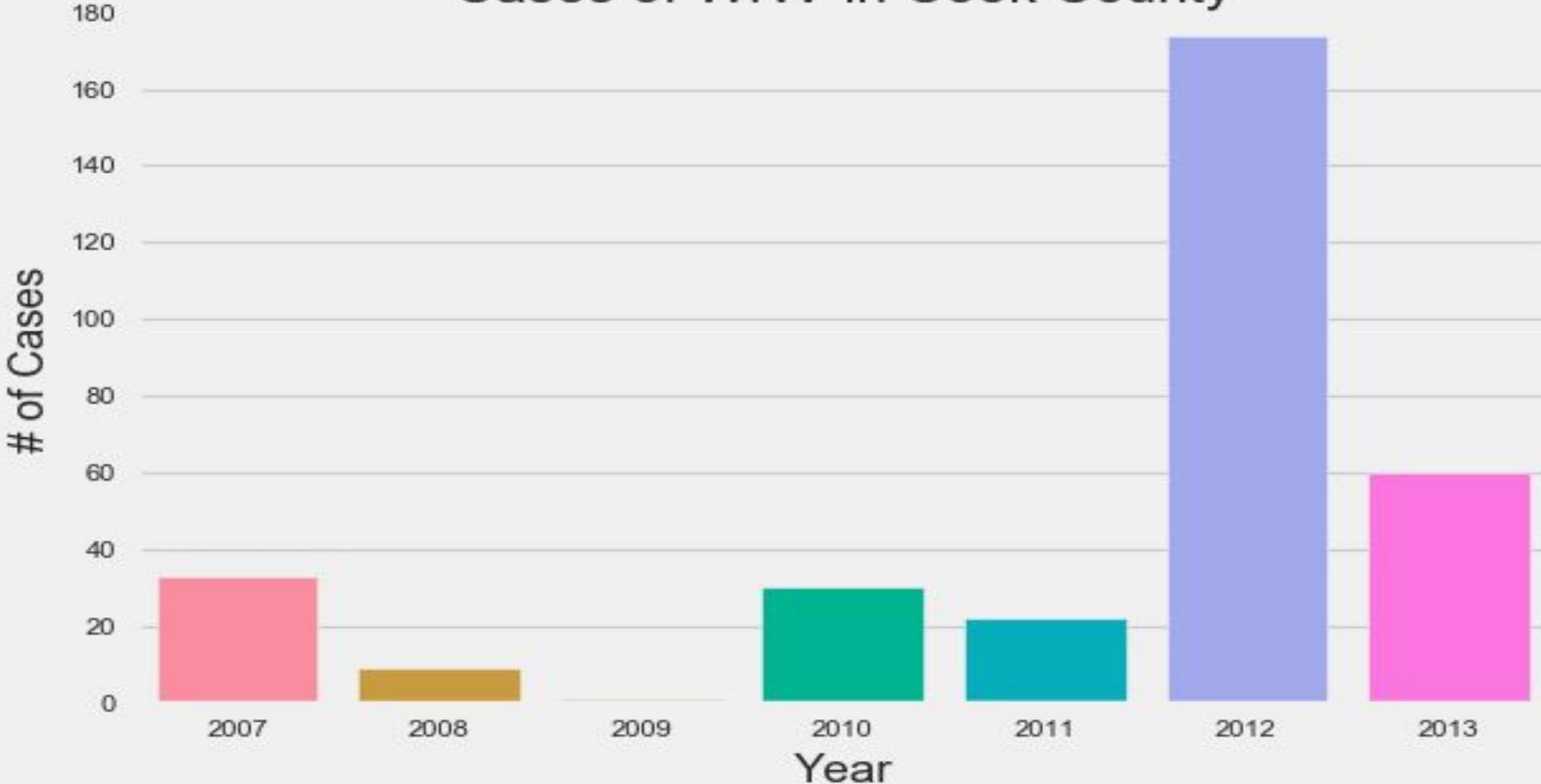
- Overspraying vs Underspraying
 - Overspraying is costly
 - Underspraying is cheaper, but could lead to increase health costs if West Nile prevails
- The data showing where West Nile was detected fluctuated year to year

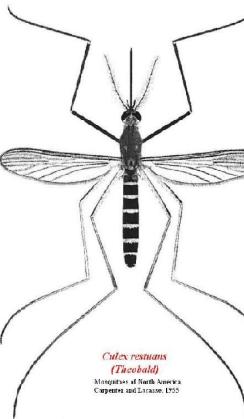
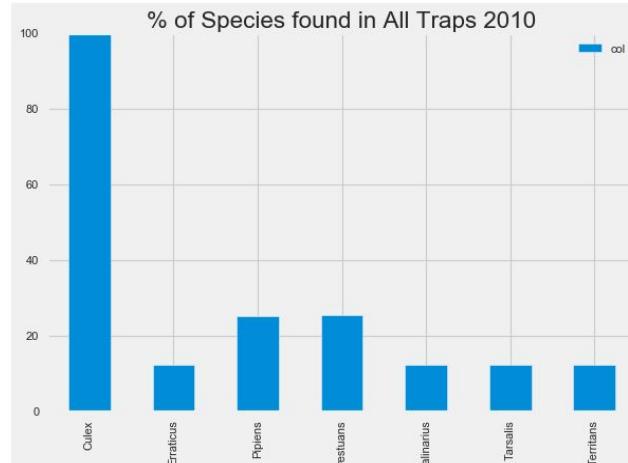
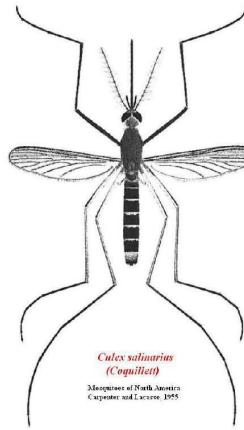
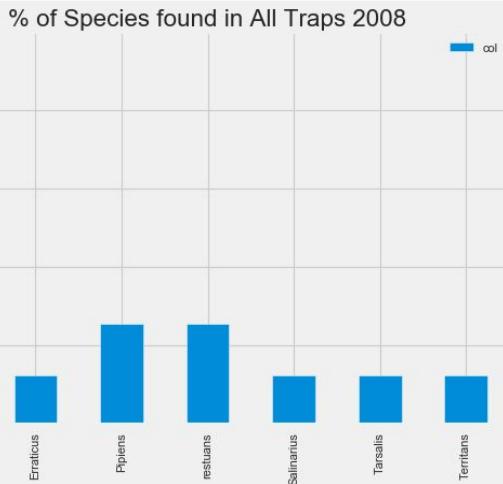
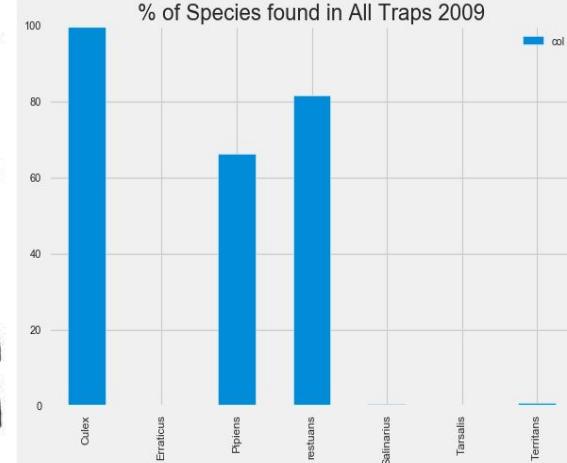
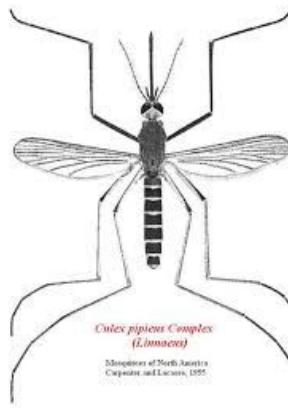
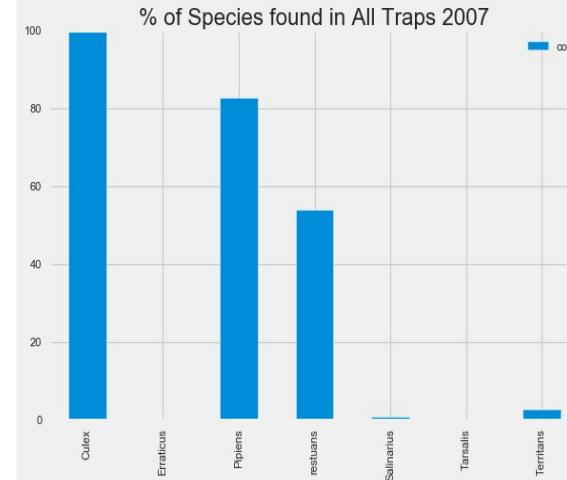
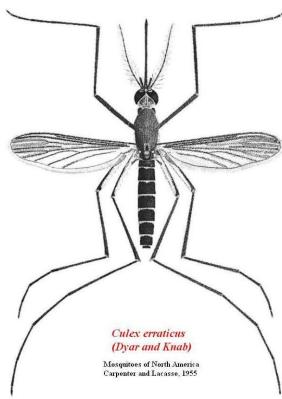


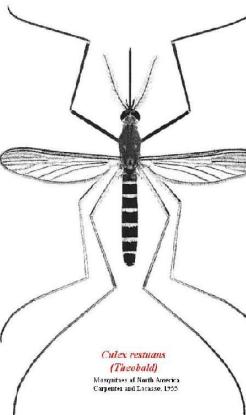
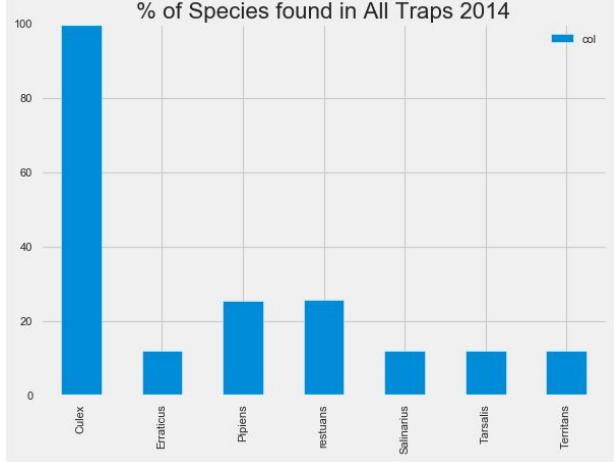
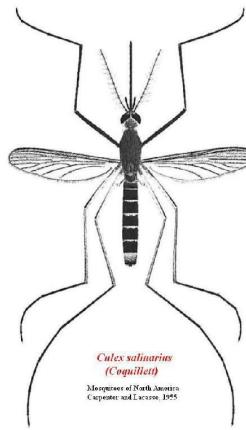
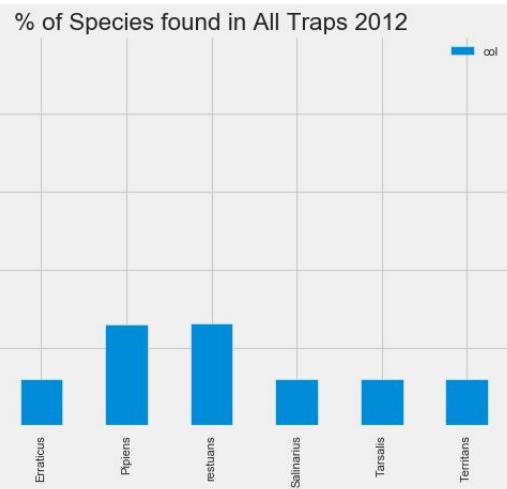
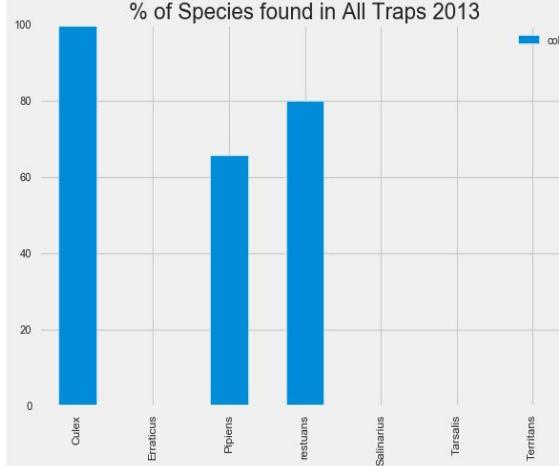
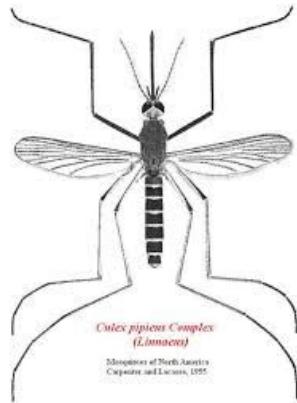
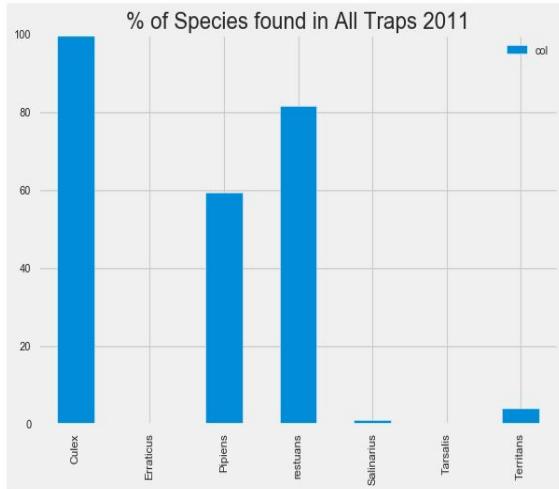
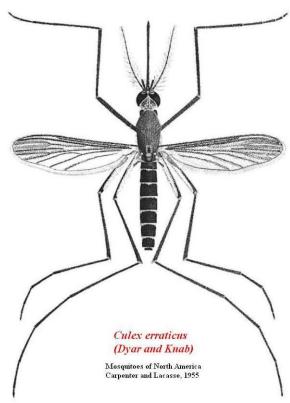
Problem at Hand

- Difficult to predict due to so few instances of West Nile
 - Naturally the model accuracy would be better if we always predict no virus present
 - But costly to assume that, have to customize model to focus on optimizing the rate at which we actually predict West Nile occurring
- Were given limited data
 - Weather, spray, and trap geo-location
 - And whether West Nile was found in the trap
 - Also looked into outside data including distance from water sources and parks

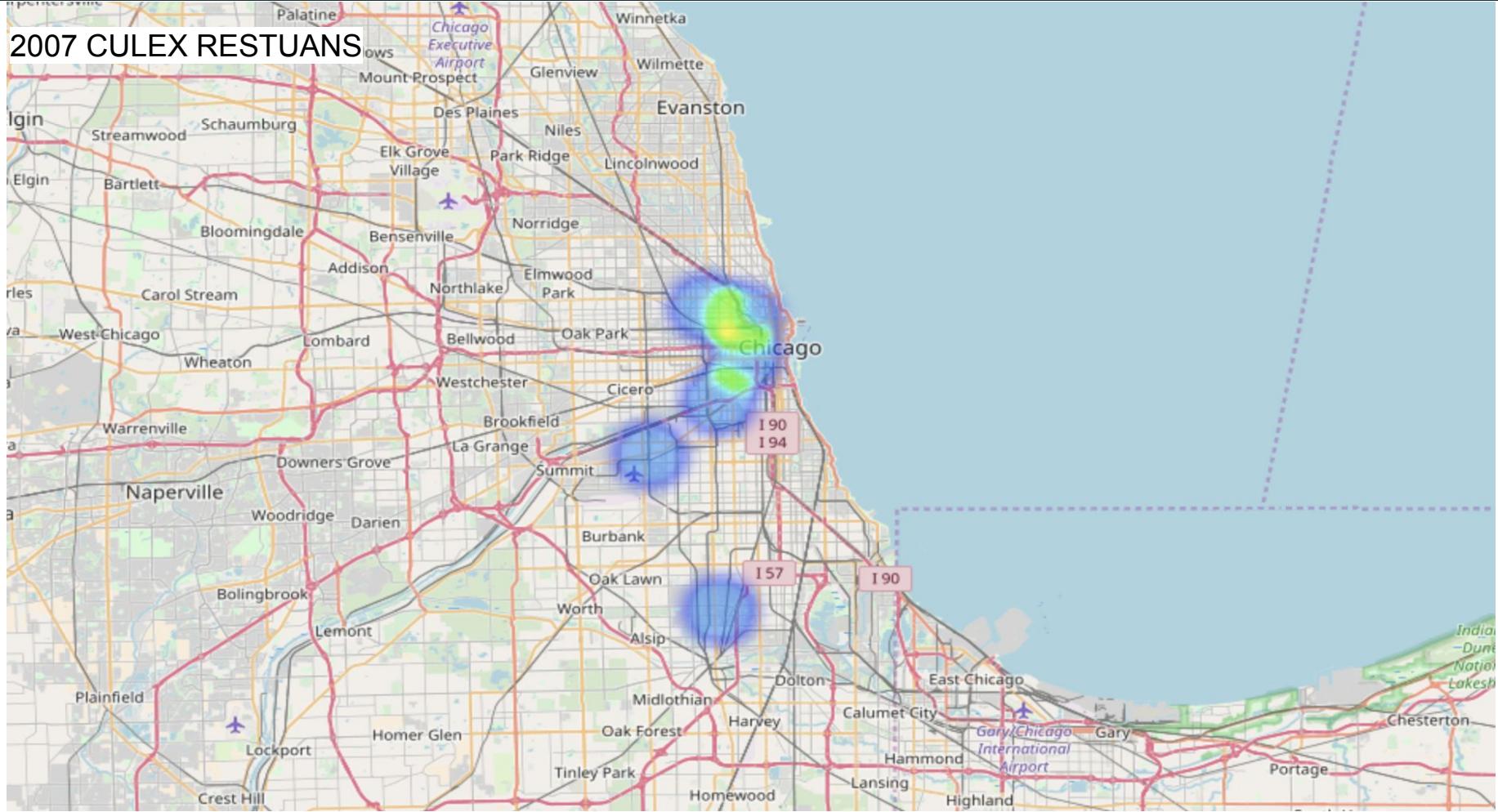
Cases of WNV in Cook County



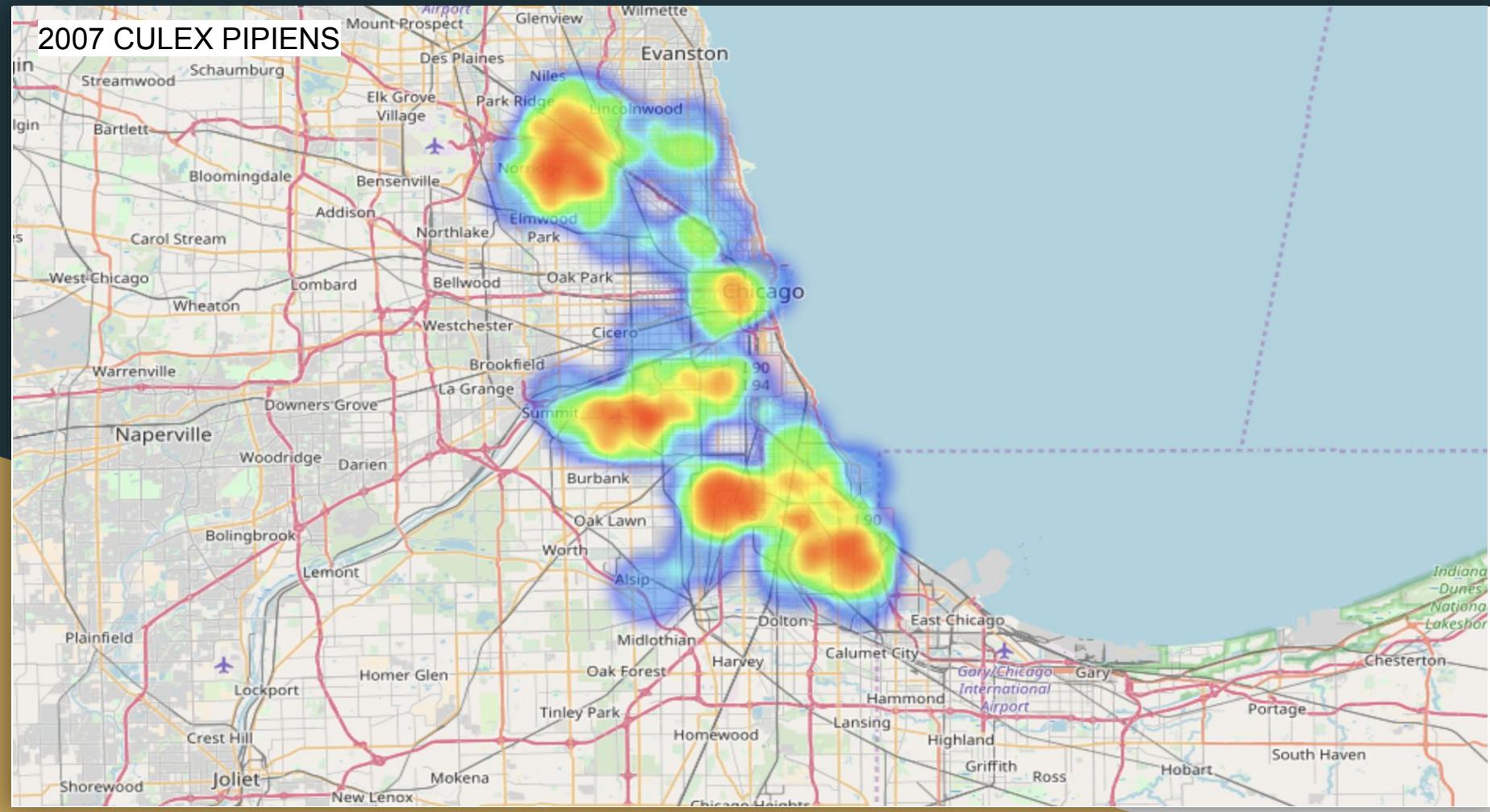




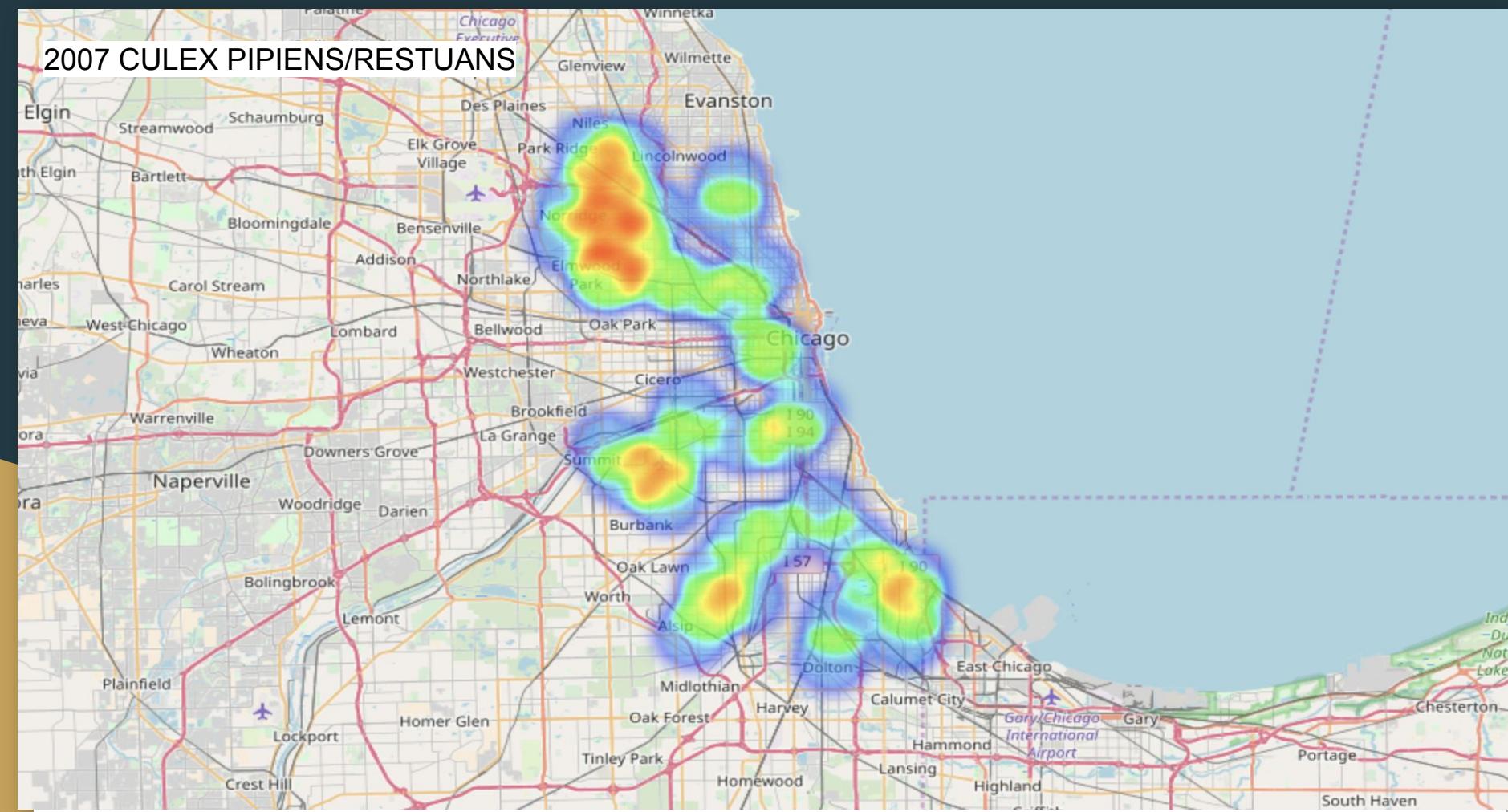
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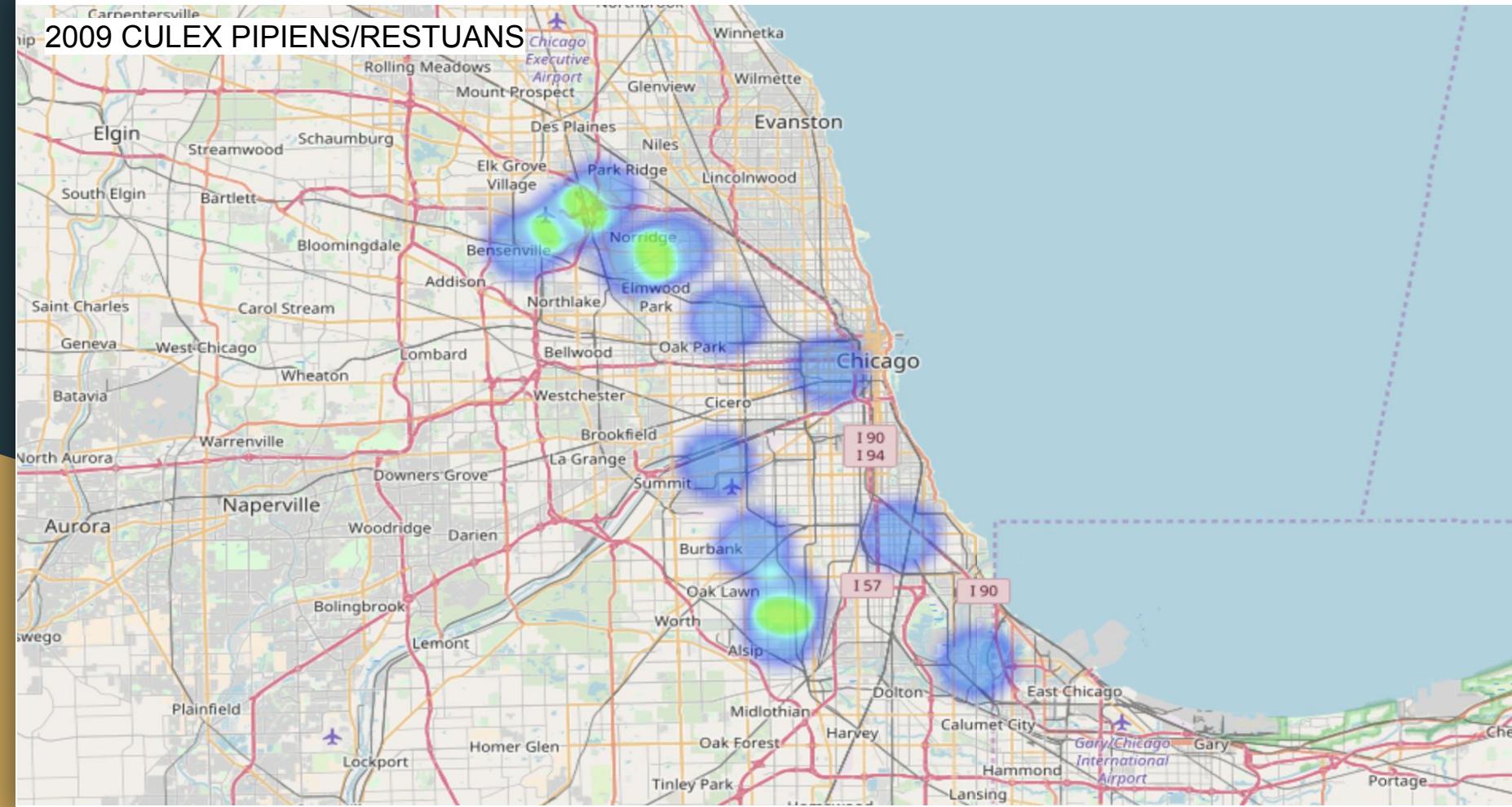
2007 CULEX PIPiens



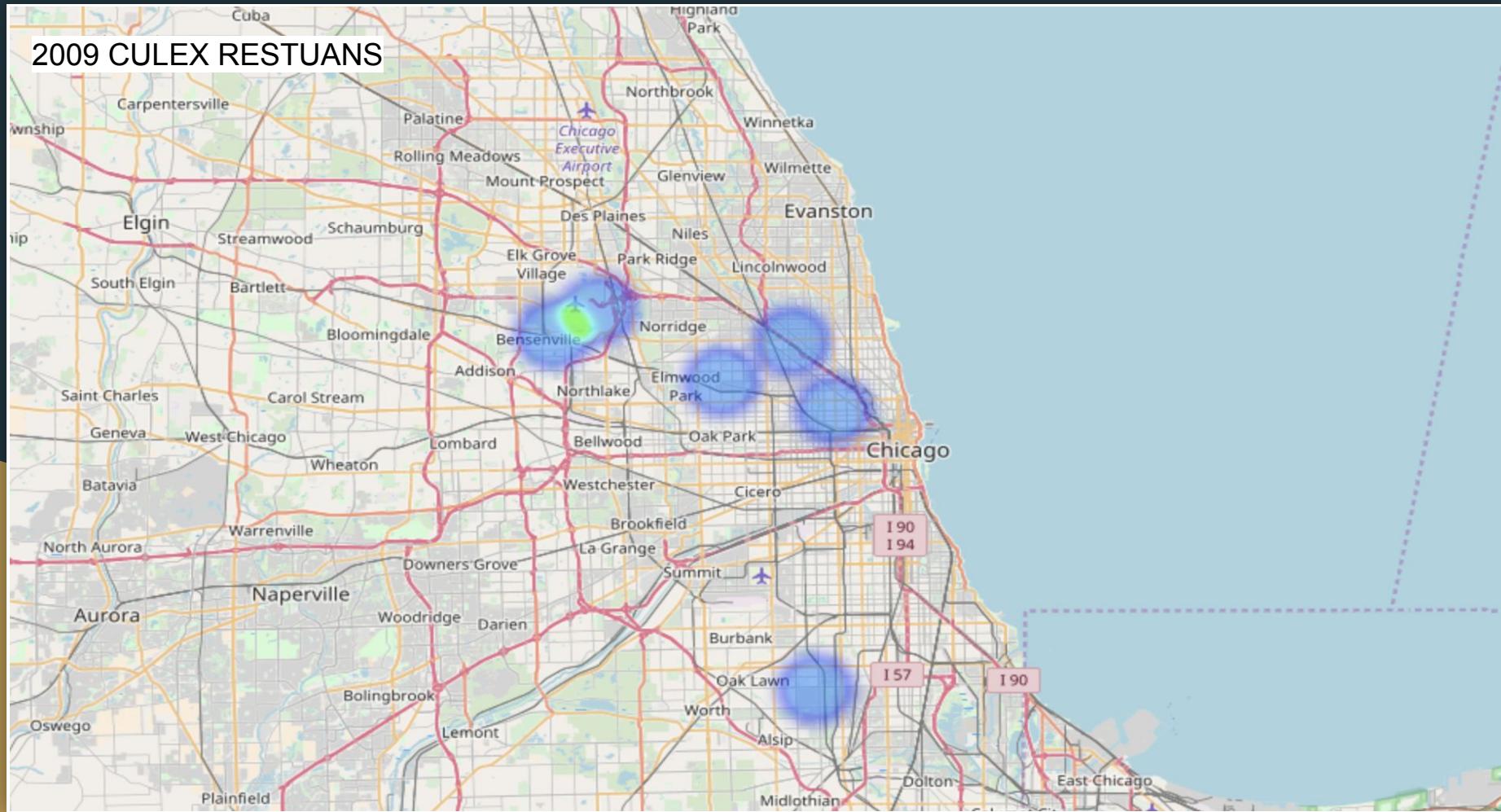
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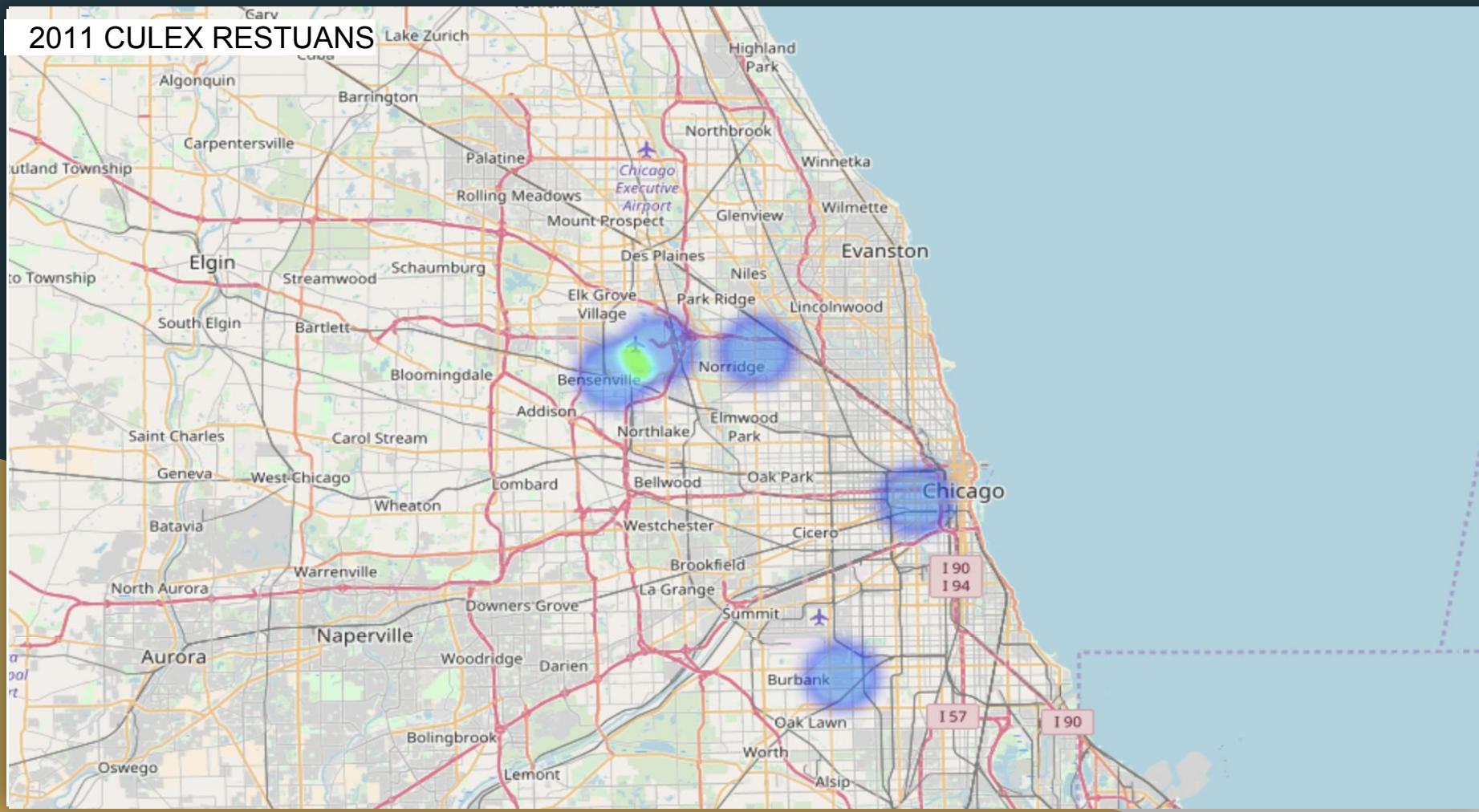
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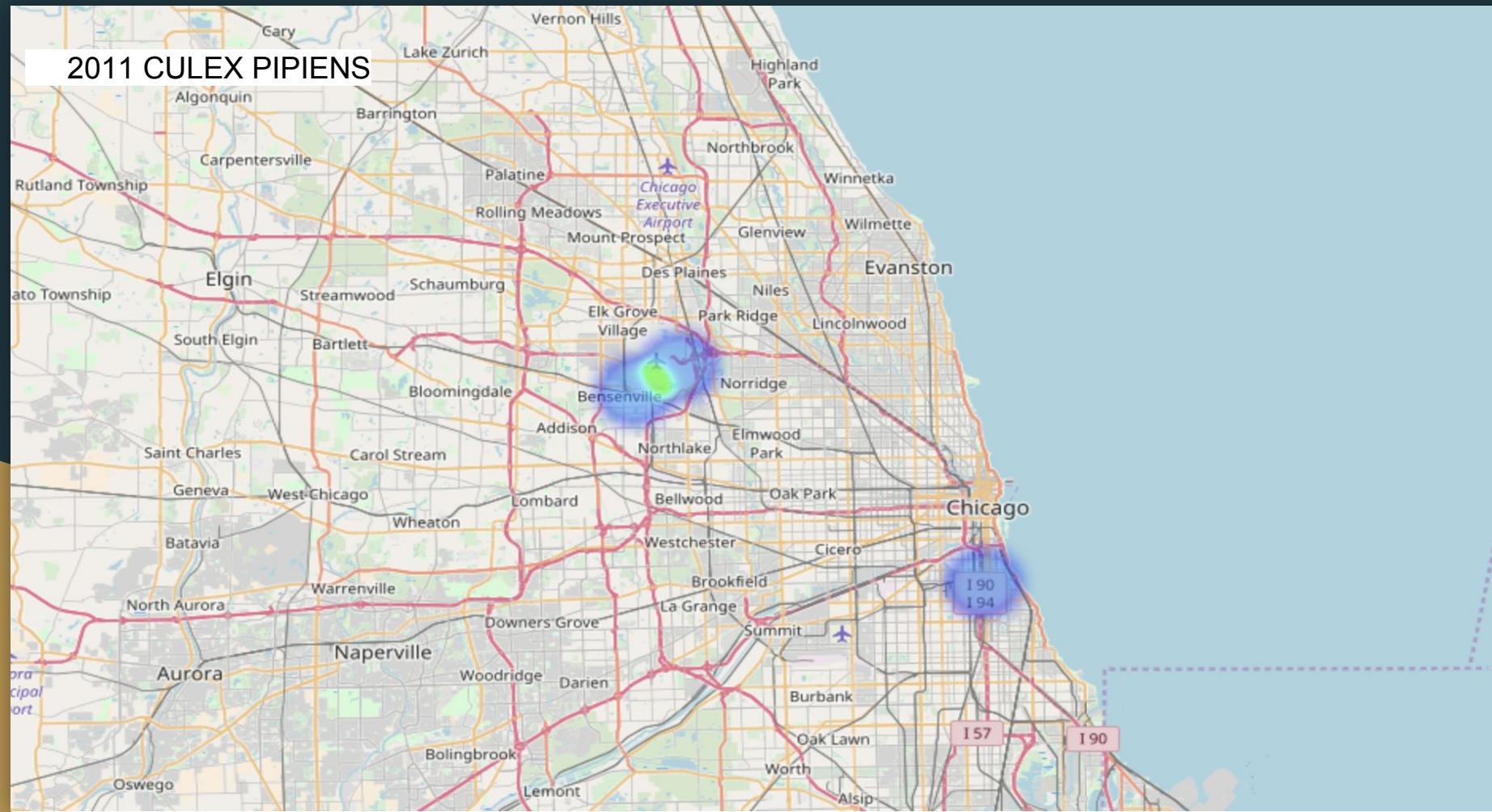
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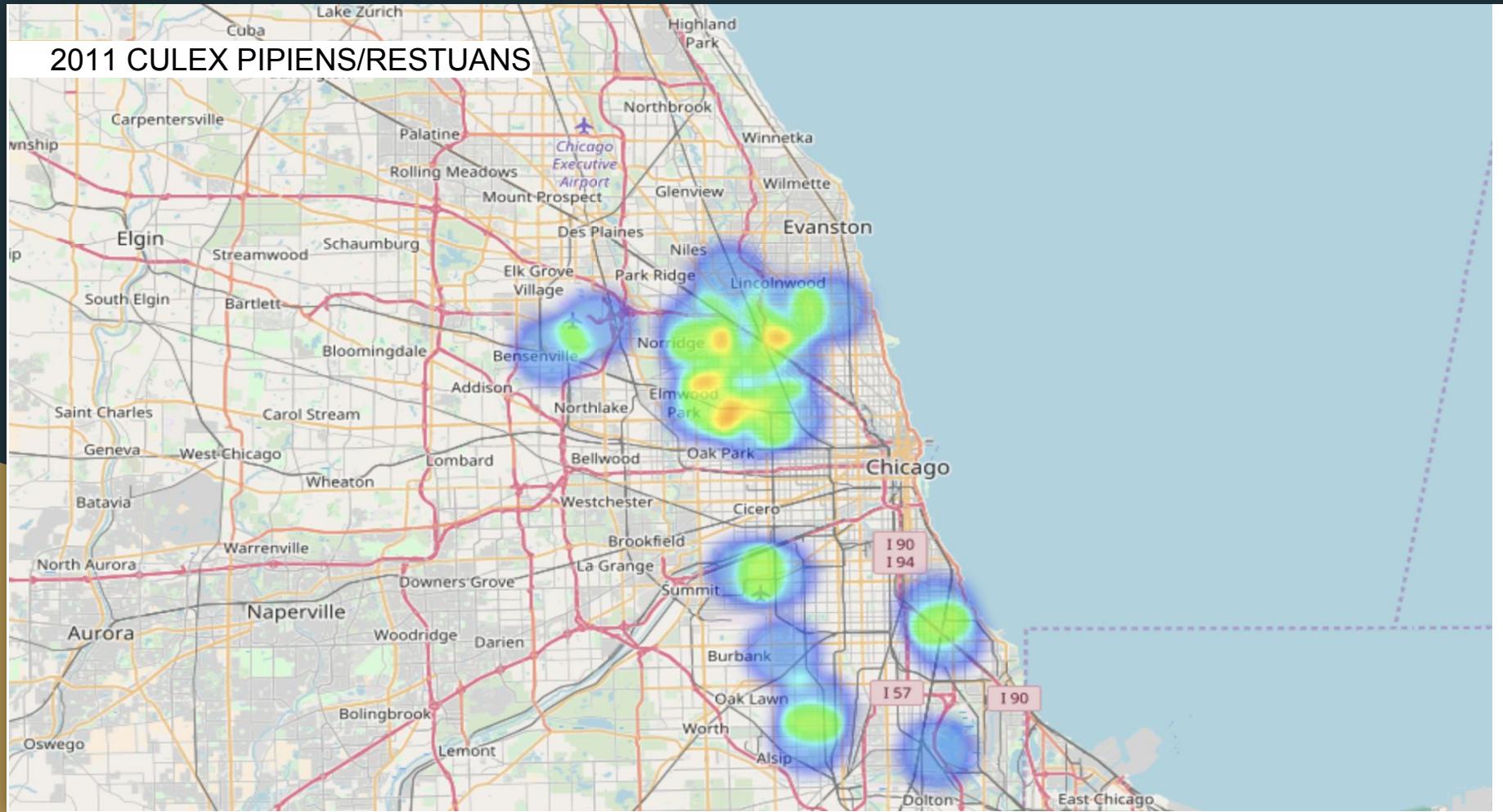
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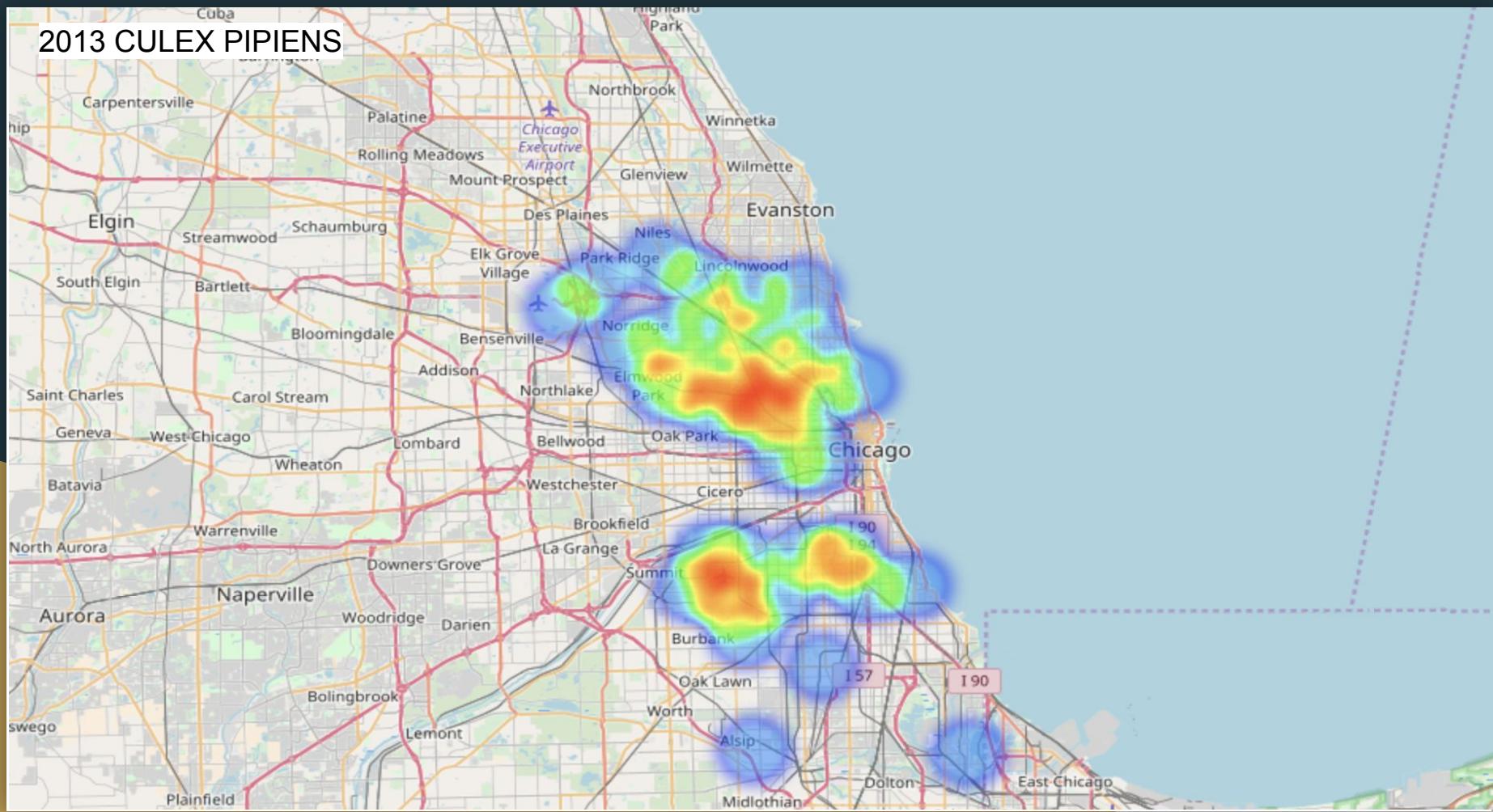
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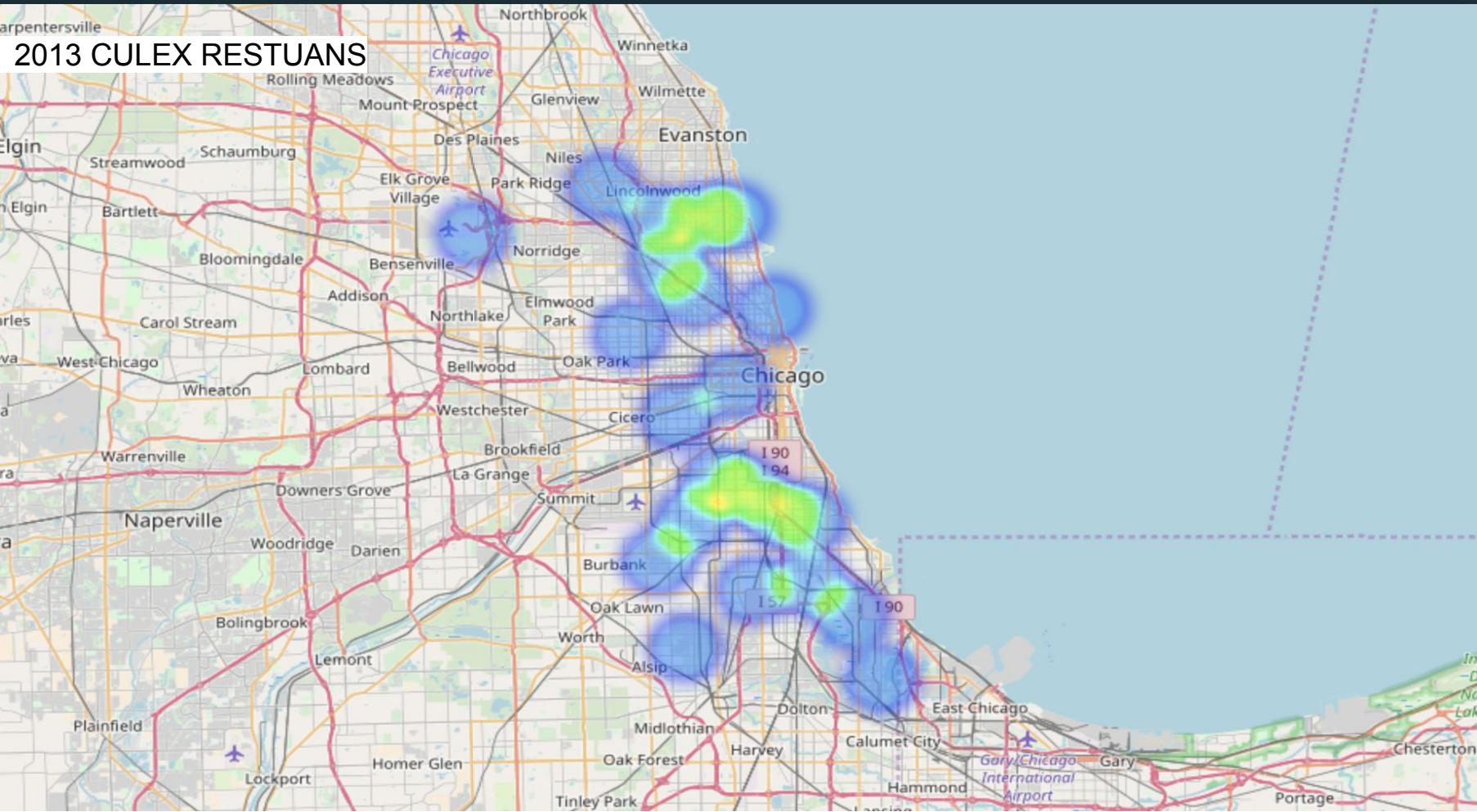


2011 CULEX PIPiens/RESTUANS



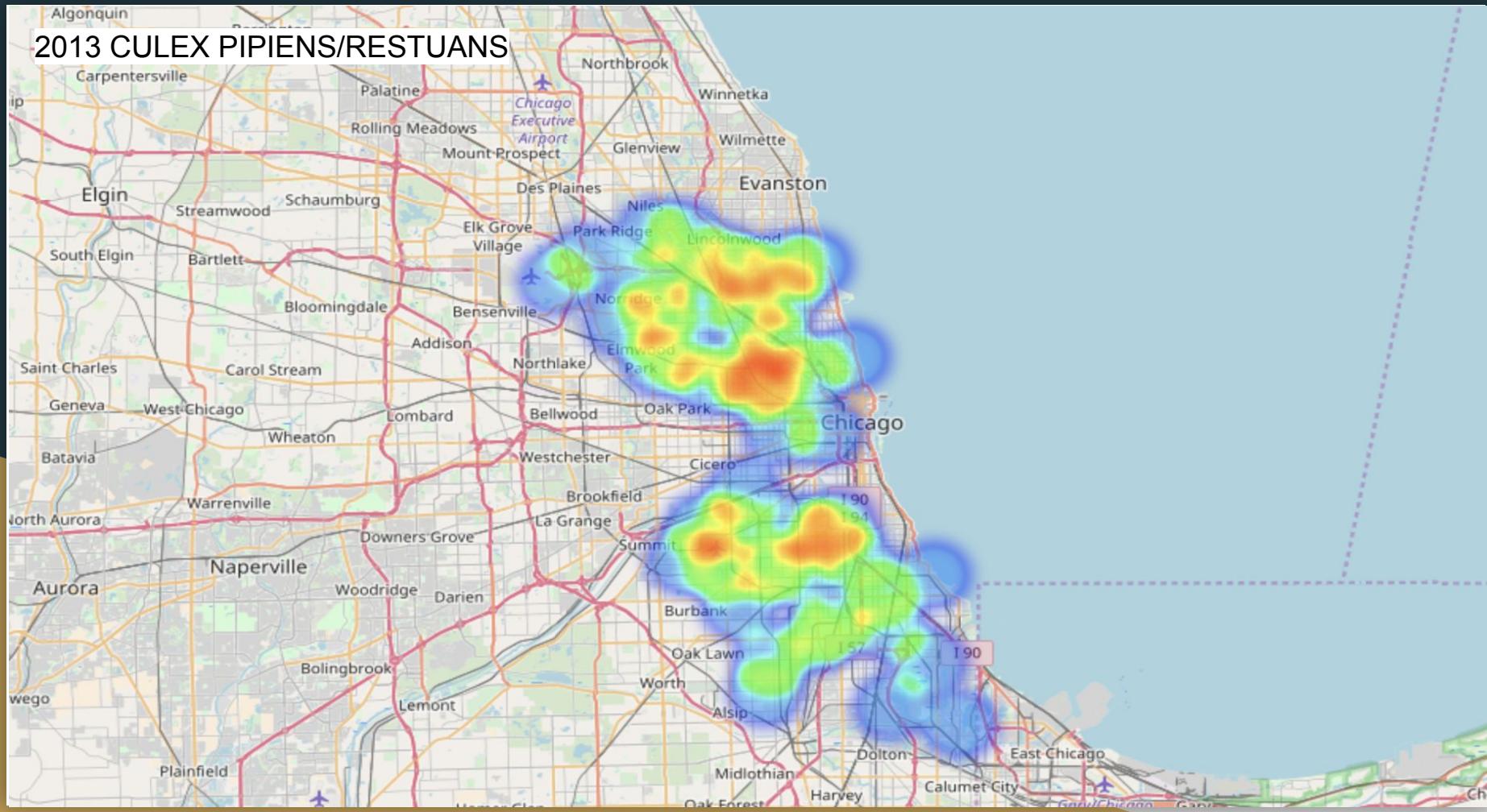
2013 CULEX PIPiens

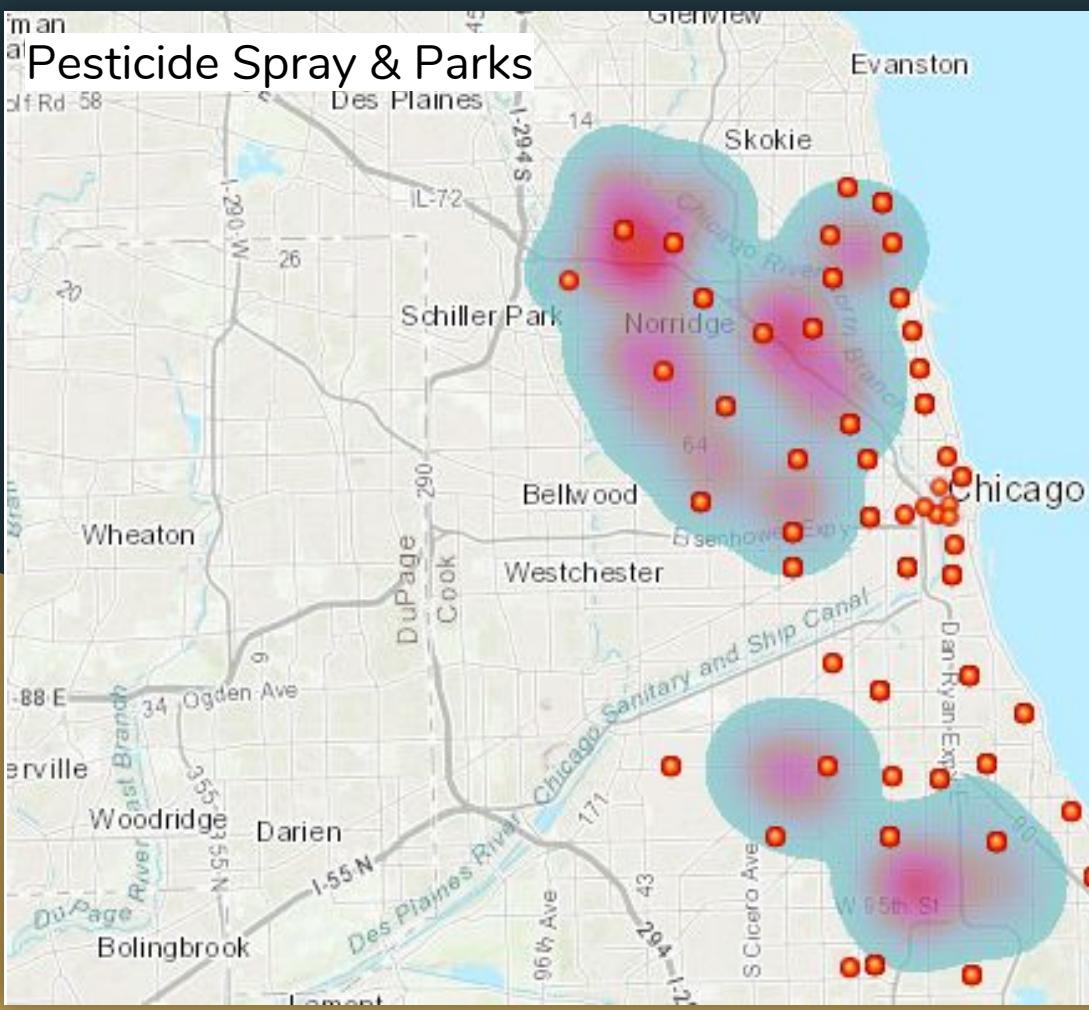




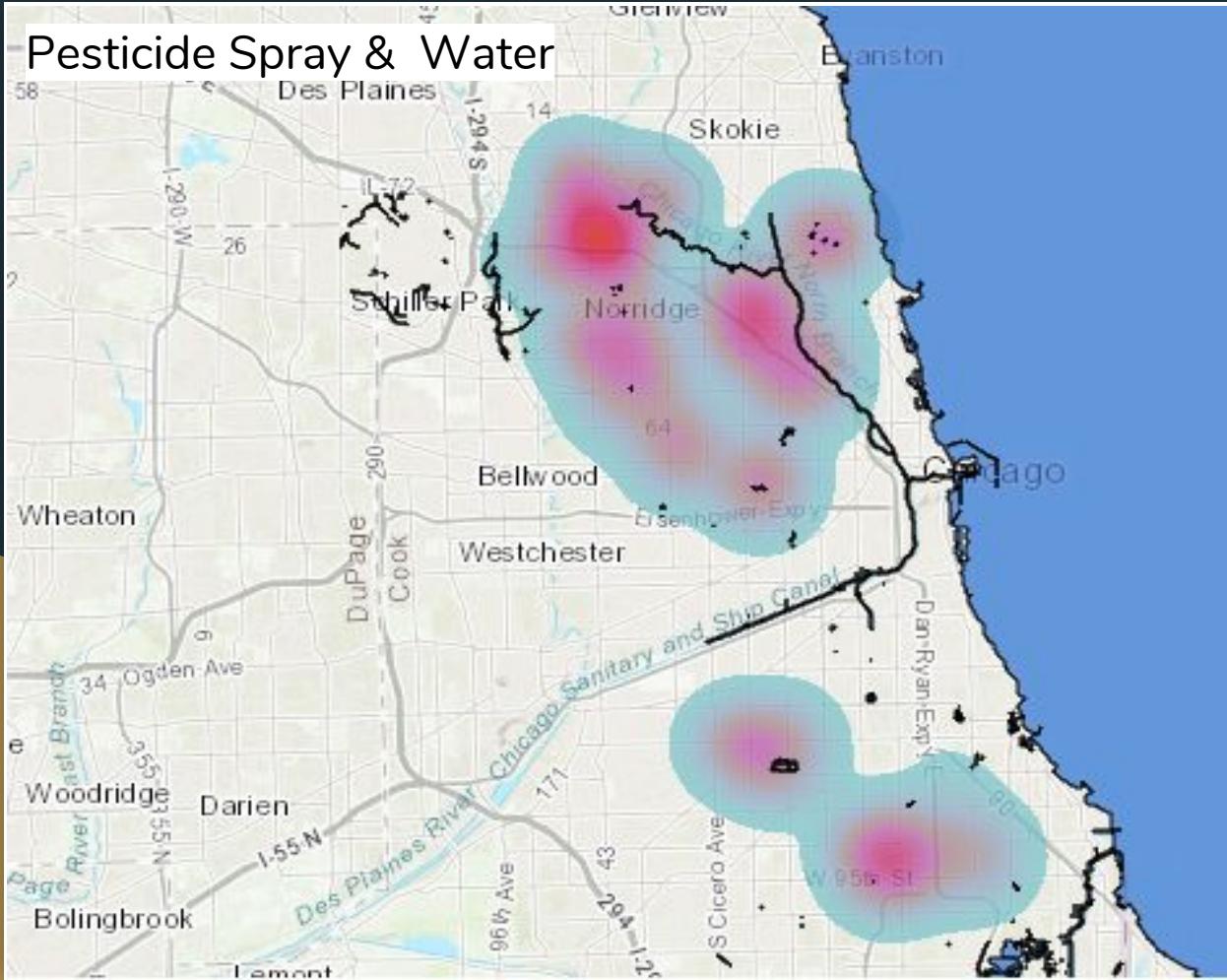
Algonquin

2013 CULEX PIPiens/RESTUANS

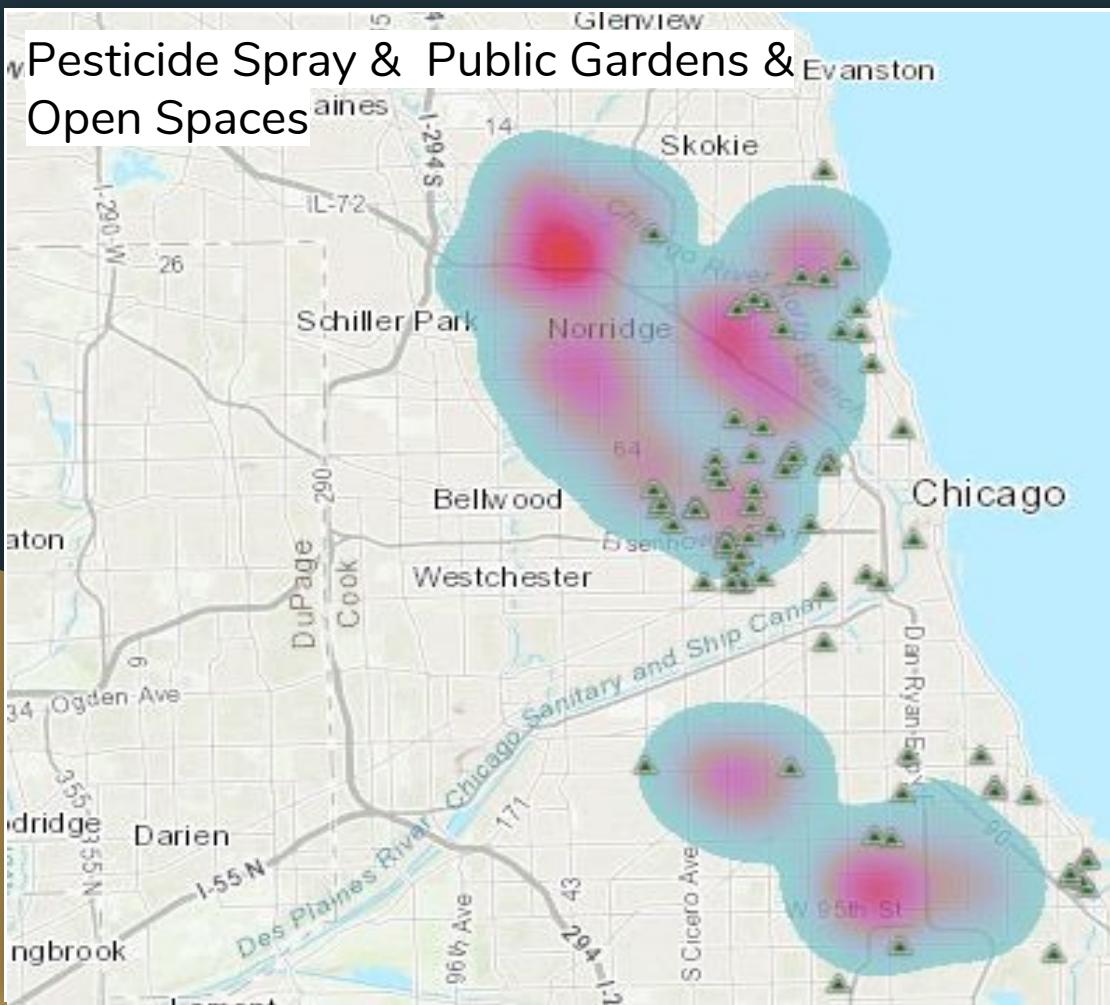




Pesticide Spray & Water



Pesticide Spray & Public Gardens & Open Spaces



Protecting the Public: Steps Taken

- Approx. 135 mosquito traps have been placed throughout Chicago
- Mosquitos from each trap are tested on a weekly basis
(from late spring through the fall)
- 10,500 traps tested - Only 551 West Nile cases identified
- Pesticide sprayed on a reactionary basis

Predict Cases Before They Happen!

Efficient implementation of pesticide spray

How do we predict when and where West Nile Virus will pop up next?

- 3 Classification Models (virus: yes/no)
- Over 230 variables examined (weather, spray, geolocation)

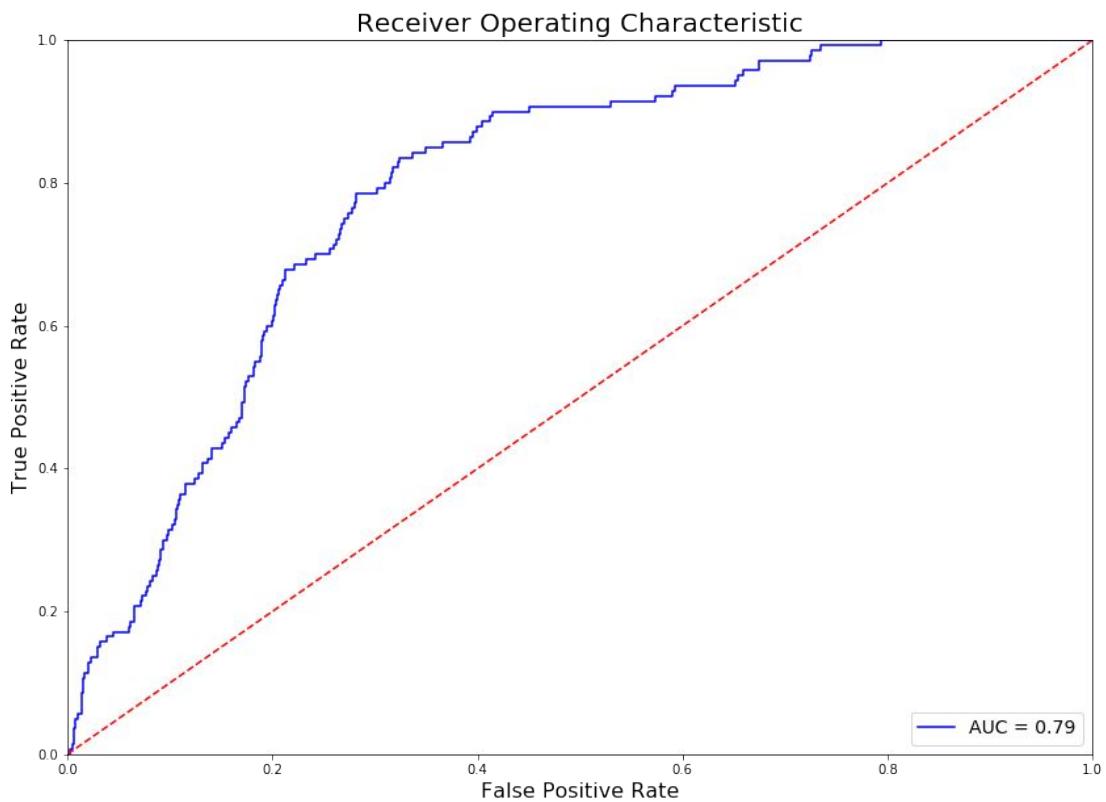
What factors determine the presence of
West Nile?

Top 5 Features Affecting West Nile Cases

	Feature	Importance	
0	Sunset	0.083813	→ Seasonal Indicator
1	DayofYear	0.081558	→ Seasonal Indicator
2	pieniens	0.075330	→ Mosquito Type
3	Hours_in_Day	0.055668	→ Seasonal Indicator
4	restuans	0.047126	→ Mosquito Type

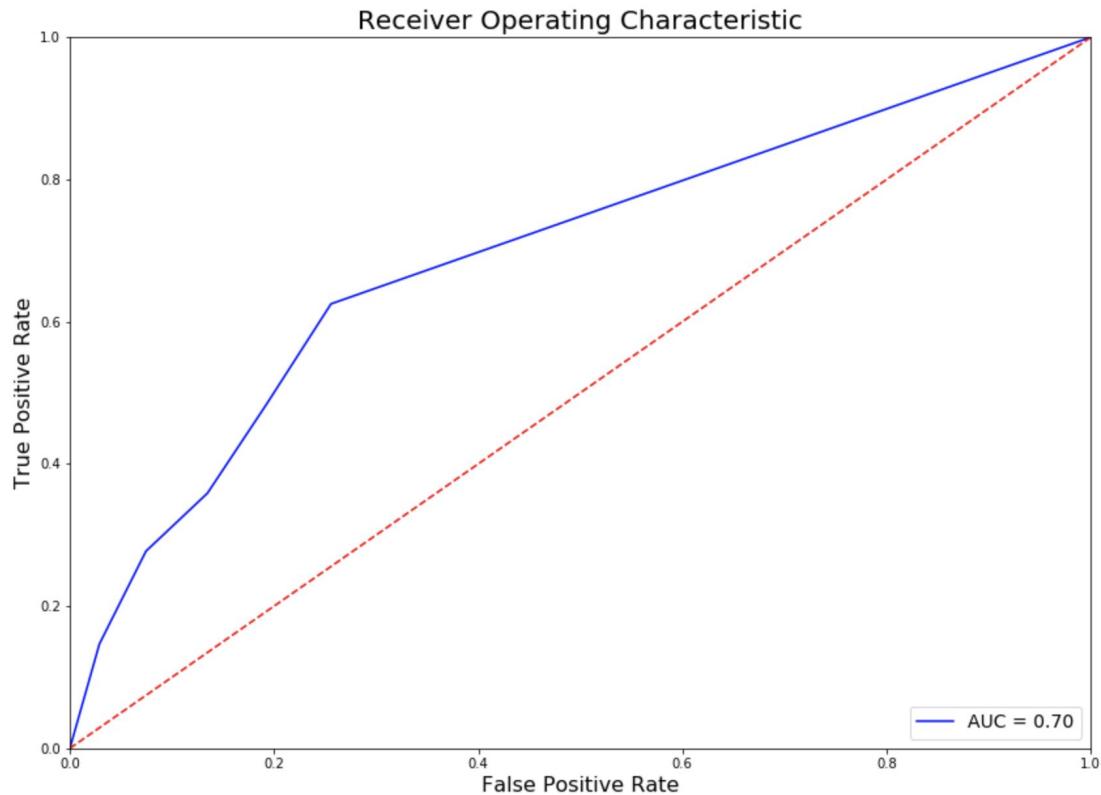
Model 1

	Pred -	Pred +
Act -	1533	930
Act +	20	120



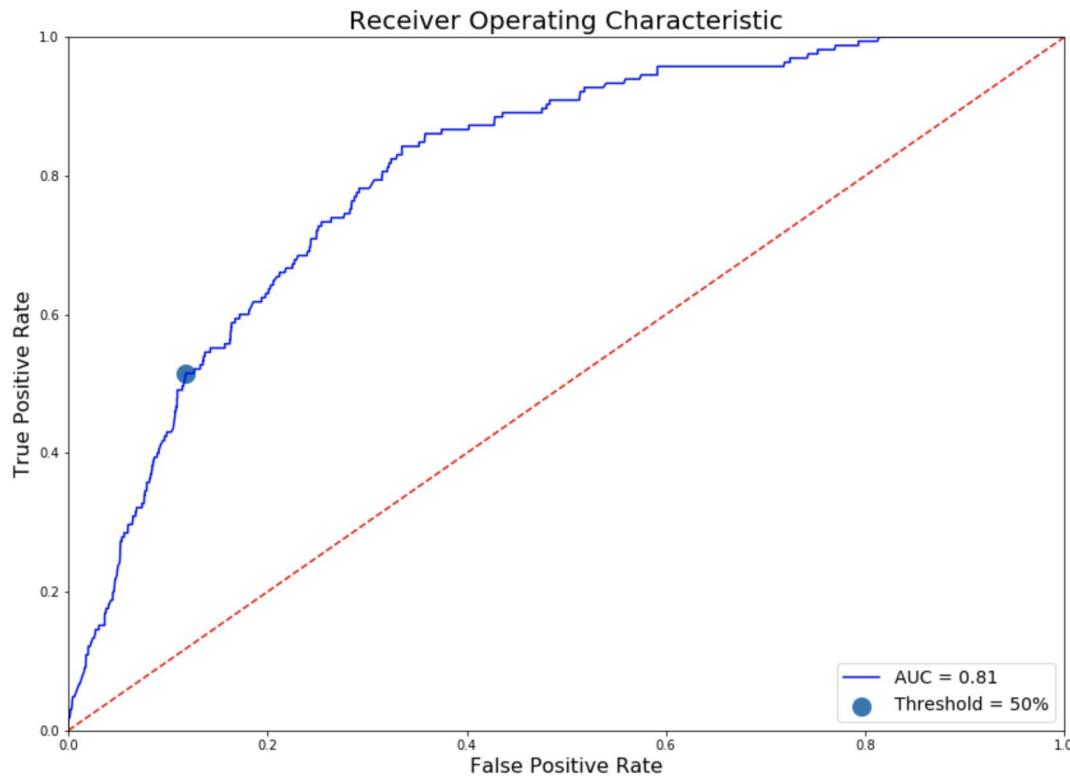
Model 2

	Pred -	Pred +
Act -	2544	396
Act +	118	66



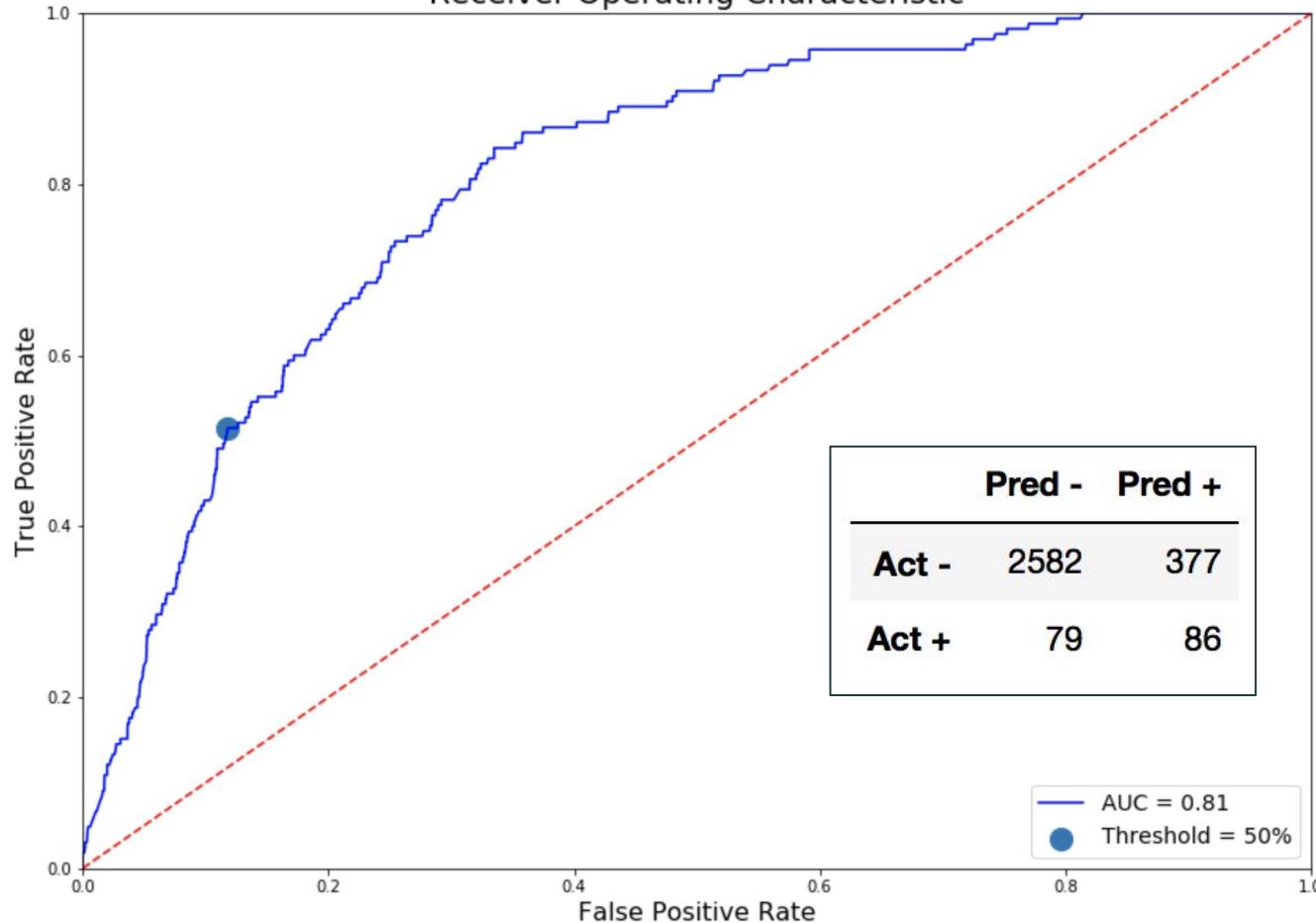
Model 3

		Pred -	Pred +
Pred -	2582	377	
Pred +	79	86	

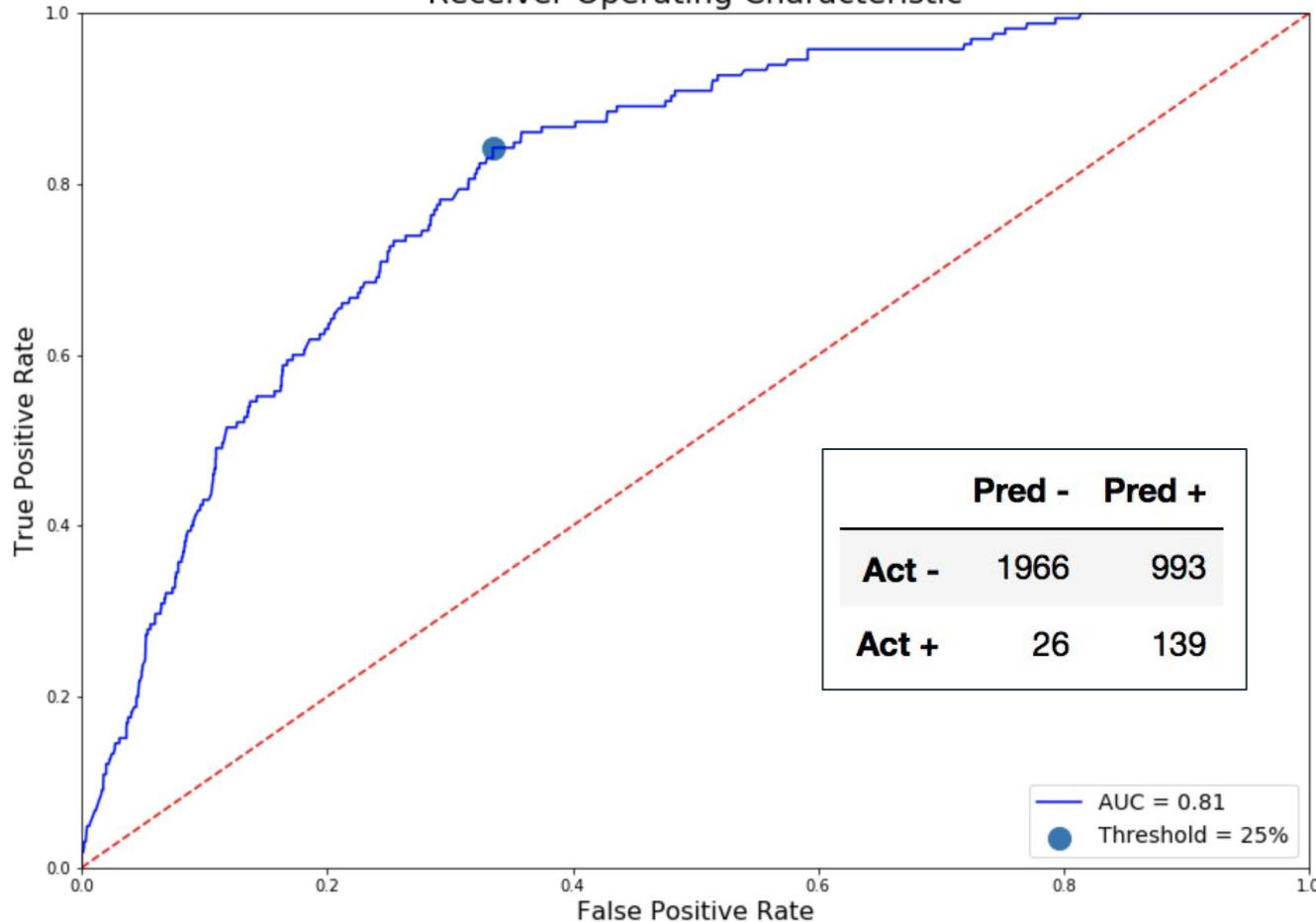


MODEL 3
was the BEST

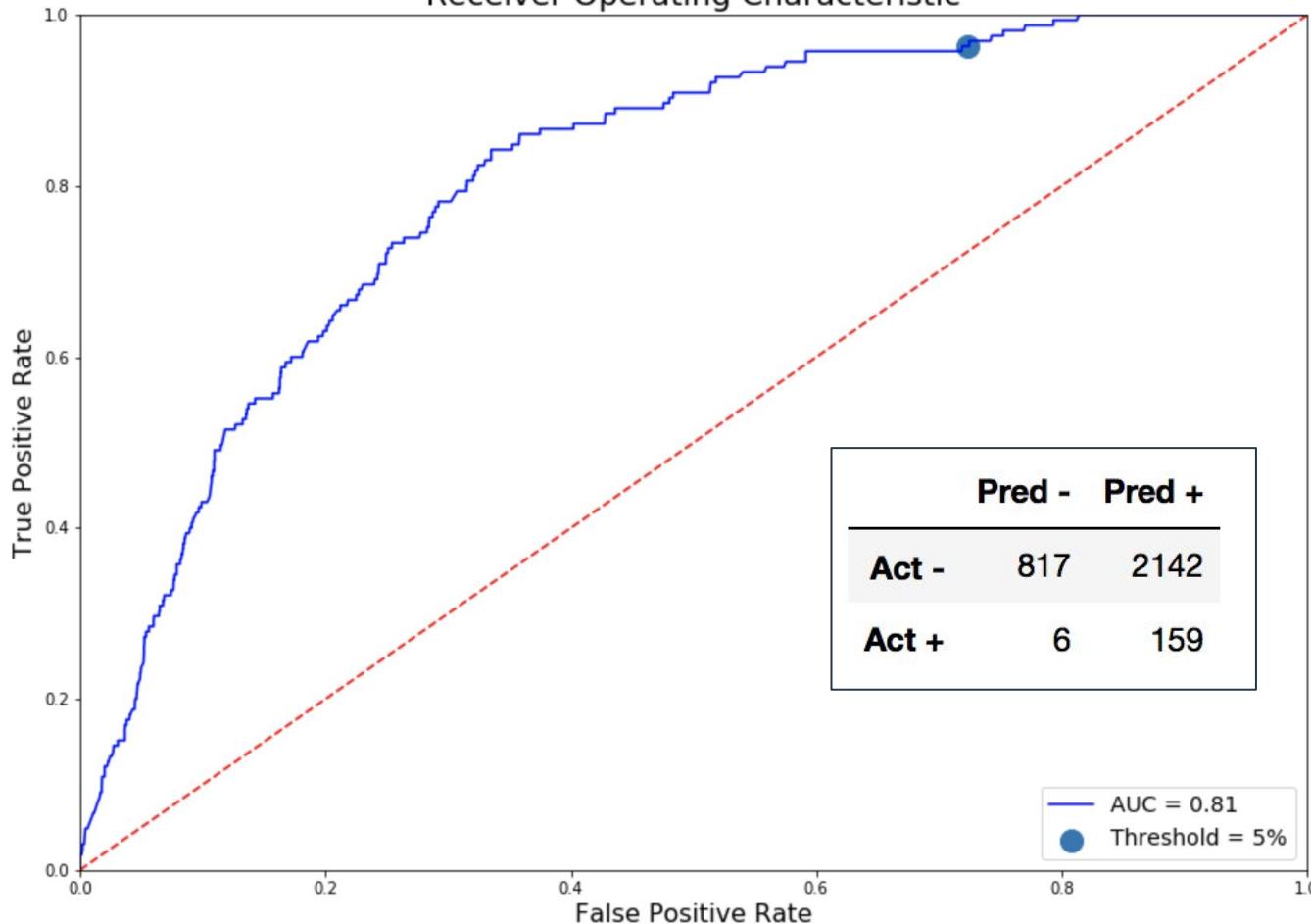
Receiver Operating Characteristic



Receiver Operating Characteristic



Receiver Operating Characteristic



Cost/Benefit of Threshold Adjustment

TS: 463

CC: 86 of 165

	Pred -	Pred +
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Act -	2582	377
Act +	79	86

50% Threshold

TS: 1132

CC: 139 of 165

	Pred -	Pred +
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Act -	1966	993
Act +	26	139

25% Threshold

TS: 2301

CC: 159 of 165

	Pred -	Pred +
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Act -	817	2142
Act +	6	159

5% Threshold

TS = Traps Sprayed

CC = Cases Caught

For future work

- Get the budget for spray so we know how to assess overspray vs. underspray
- How many mosquitoes had West Nile in each trap
 - Would help to find a concentration of the virus
- Incorporate other features more
 - Hard to properly implement distance from water sources and parks in our given time
- Population data - if spray is limited, more dense areas would be a higher priority



Fighting Back Against Mosquitoes in Illinois and Abroad

Questions?

