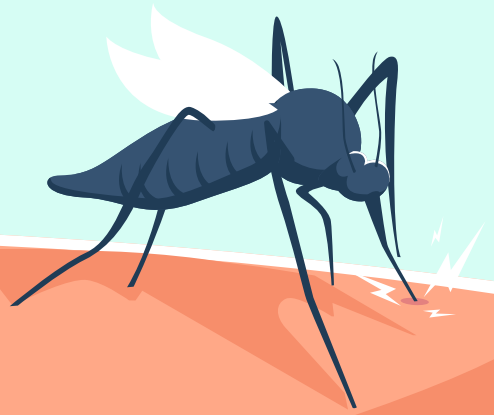
PREDICTING WEST NILE VIRUS IN CHICAGO

DSI-30 Project 4

Gary, Hao Ming, Jun Hong



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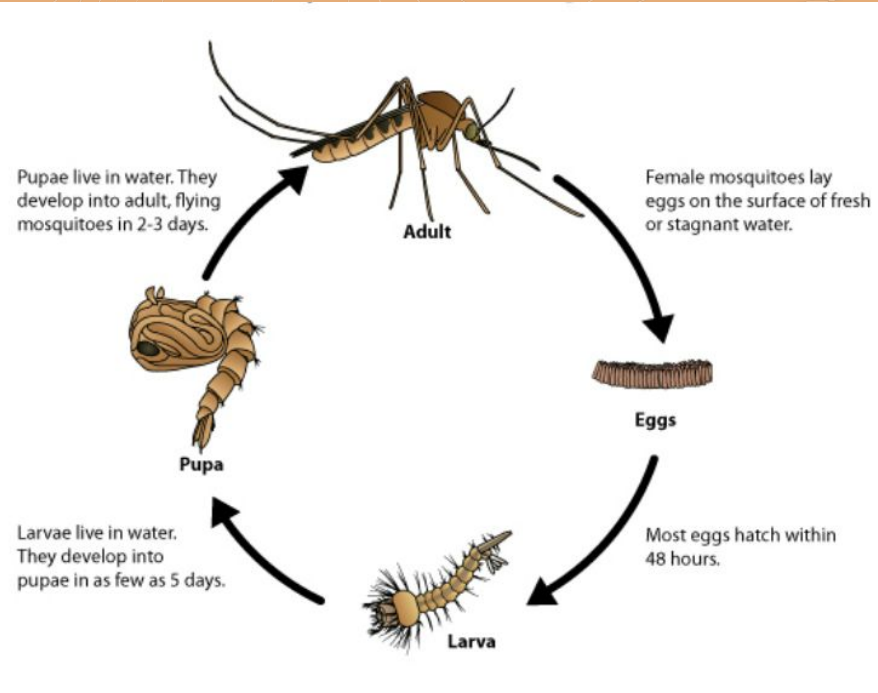
01 INTRODUCTION

PROBLEM STATEMENT

- Predicting the presence of West Nile Virus, given date, location and weather conditions
- Understand the top features that contribute to an accurate prediction
    - e.g. temperature, rainfall, mosquito species
- Conduct cost-benefit analysis on the effectiveness of insecticide spraying

MOSQUITO LIFE CYCLE



It takes 7-10 days for an egg to develop into an adult mosquito

WEST NILE VIRUS

NO SYMPTOMS IN MOST PEOPLE

About 8 out of 10 infected with WNV do not develop any symptoms

ABOUT 1 IN 5 PEOPLE DEVELOP FEVER

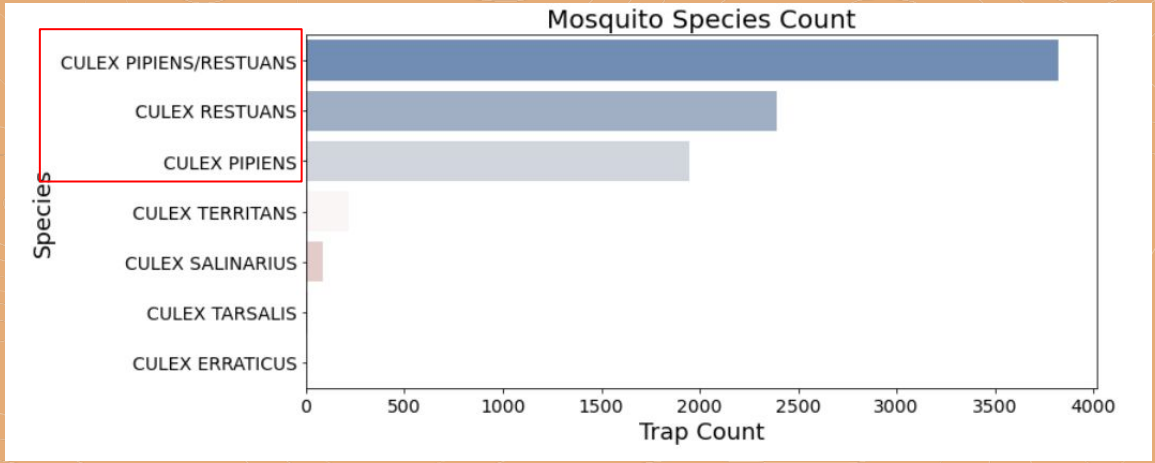
Including other symptoms such as headache, body aches, joint pains, vomiting or diarrhea

SERIOUS SYMPTOMS IN FEW CASES

About 1 in 150 infected develop severe illness affected the central nervous system

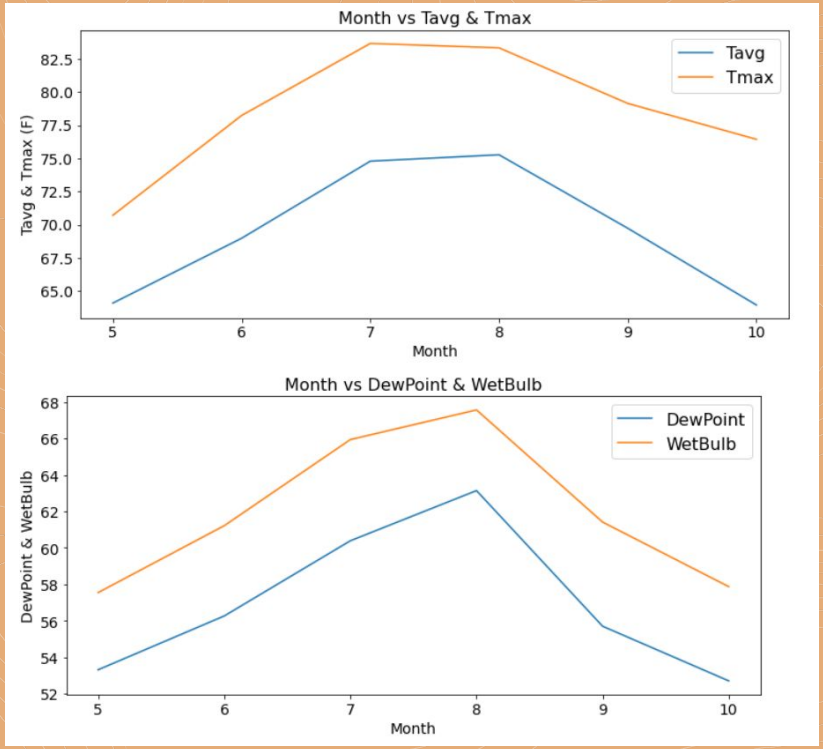
02 EDA

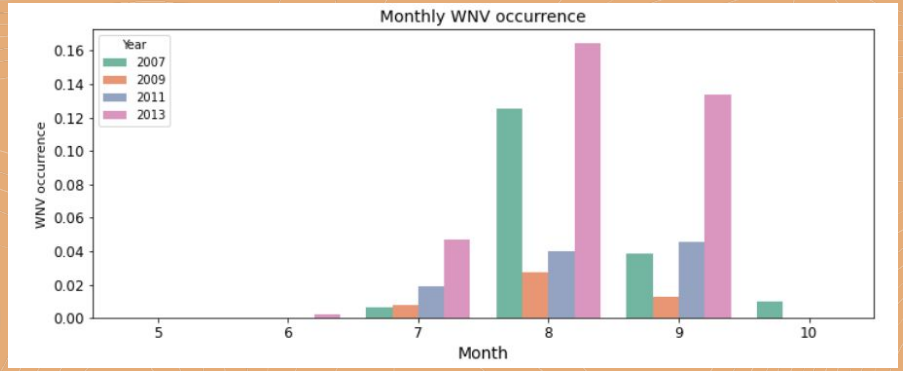
WEST NILE VIRUS DETECTED



5.3% of mosquitoes caught were detected with WNV

WNV DETECTED MONTHLY





Number of WNV detection similar to weather patterns:

- **increase in July**
- **peak in August**
- **decline in September**

FEATURES USED

MOSQUITOES SPECIES

- Culex pipiens
- Culex restuans
- Culex pipiens/ restuans
- Others

WEATHER CONDITIONS

- Tmax, Trange
- Wet Bulb
- Relative Humidity
- Precip Total
- Sea Level
- Wind Speed & Direction
- 7-day and 14-day rolling weather condition

OTHERS

- Month
- Latitude, longitude

03 MODELLING

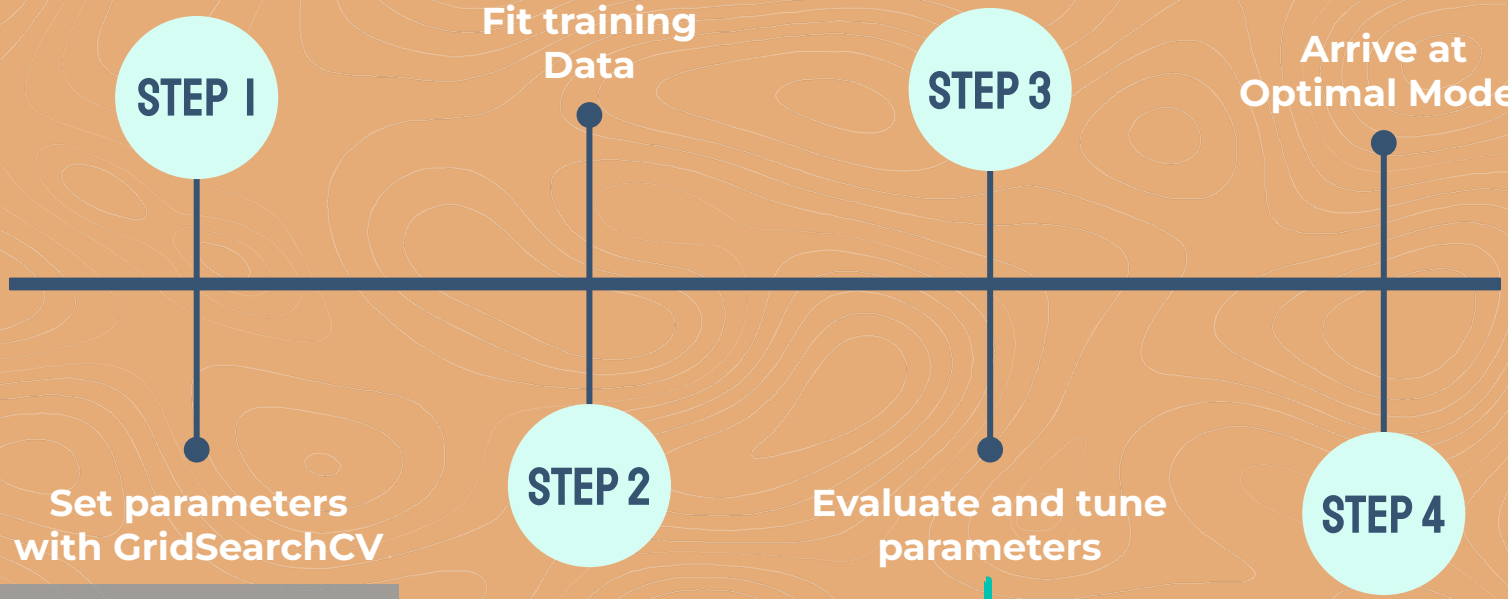
MODELLING - PIPELINE

PIPELINE

- SMOTE
- StandardScaler
- Classifiers

- Random Forest
- AdaBoost
- XGBoost
- Logistic Regression

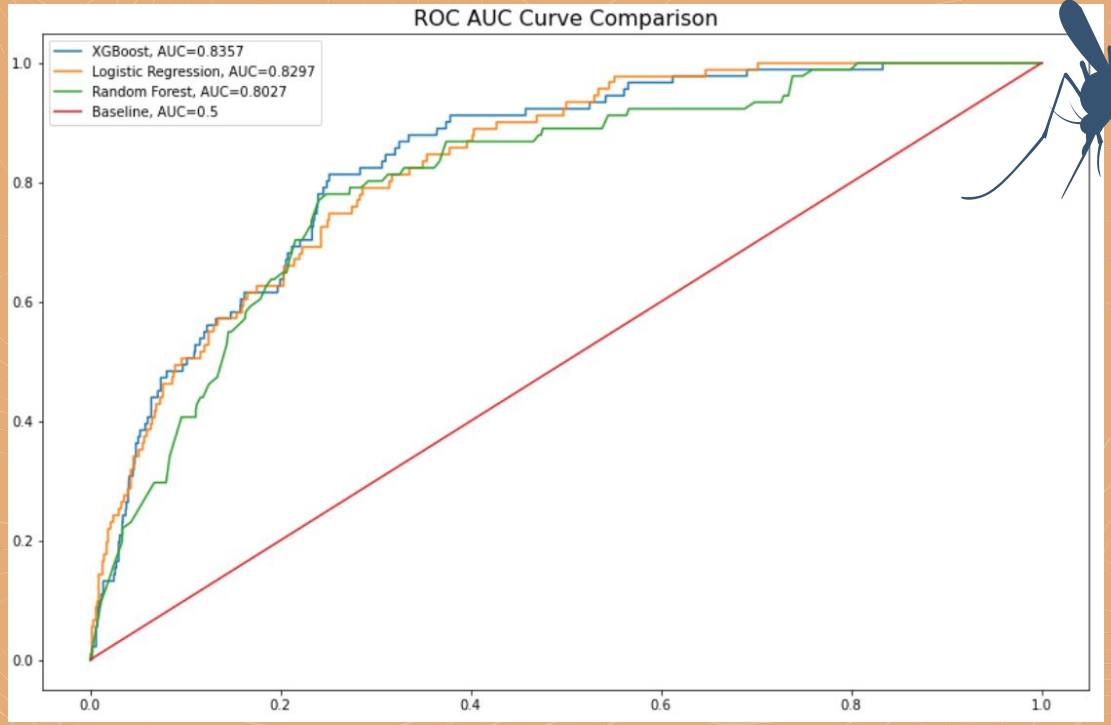
MODELLING PROCESS



MODEL EVALUATION

	Classifier	Train	Test	ROC_AUC CV	Train-Test
1	Random Forest	0.818	0.799	0.803	**0.019**
2	AdaBoost	0.856	0.818	0.831	0.038
3	XGBoost	0.895	0.841	**0.840**	0.054
4	Logistic Regression	0.851	0.829	**0.836**	**0.022**

MODEL EVALUATION

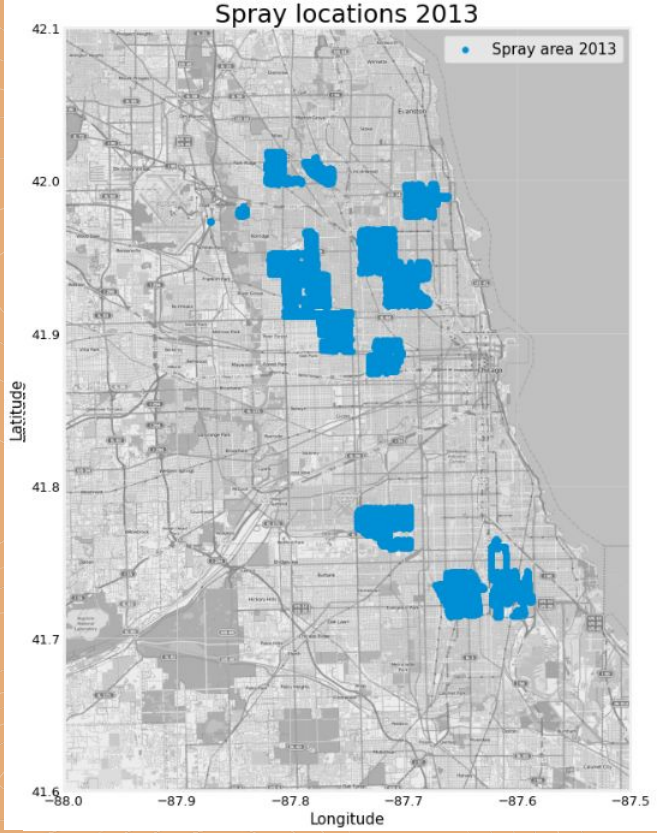


kaggle

0.716

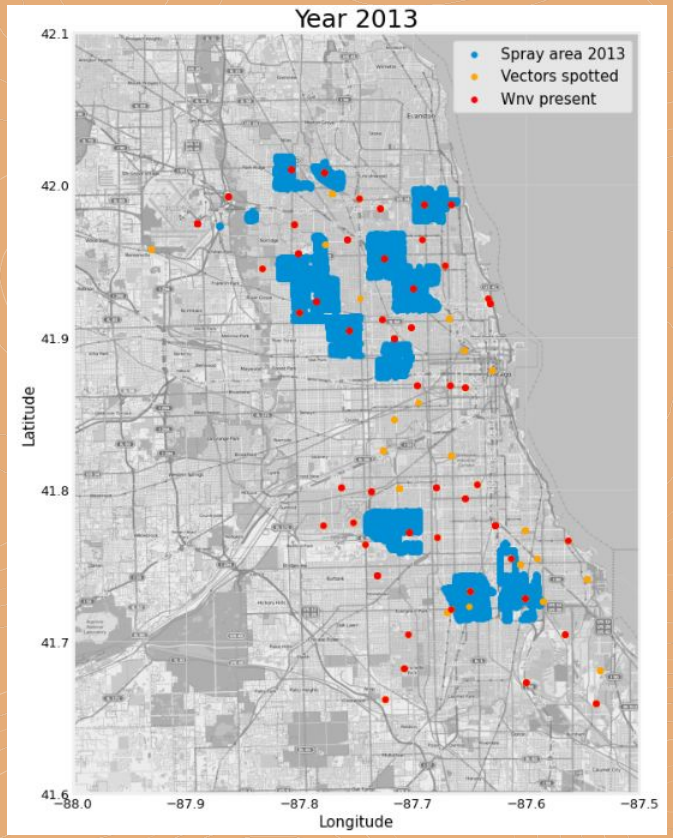
04 COST BENEFIT ANALYSIS

SPRAY LOCATIONS



SPRAY AREA

SPRAY AND TRAP LOCATIONS FOR 2013

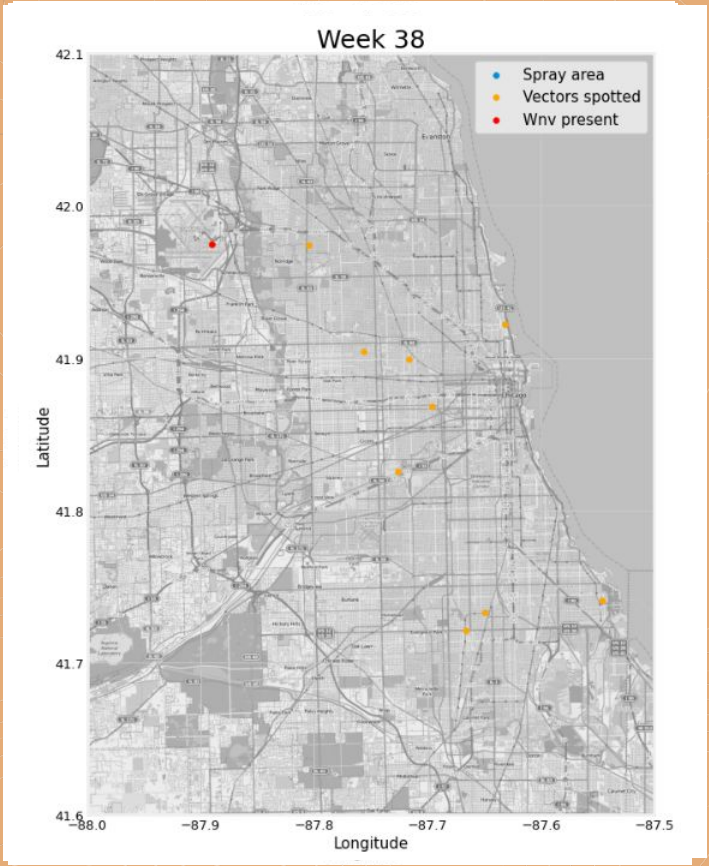


SPRAY AREA

VECTORS SPOTTED (>10)

WNV POSITIVE

SPRAY AND TRAP LOCATIONS FOR 2013



SPRAY AREA

VECTORS SPOTTED

WNV POSITIVE

COST OF SPRAY

ZENIVEX E4

Spray used for the program

1.5 OZ /ACRE

Ultra Low Volume (ULV) fogging rate of application

USD$33

Approx value per spray

COST OF PROGRAM IN 1 YEAR

US$6,100 Approx Cost of Zenivex

US$148,902 Approx Cost of traps and processing

US$155,002 Approx total cost / year

DAMAGE BY VIRUS

US$13,247

Average damage of medical fees for infected individual

US$5,042

Average economical damage based on missed workdays

US$1,207,074

Approx total damage / year

PREVENTION VS CURE

US$18,289

Average damages per infected individual

US$1,636

Approx Cost of prevention/day

1:12

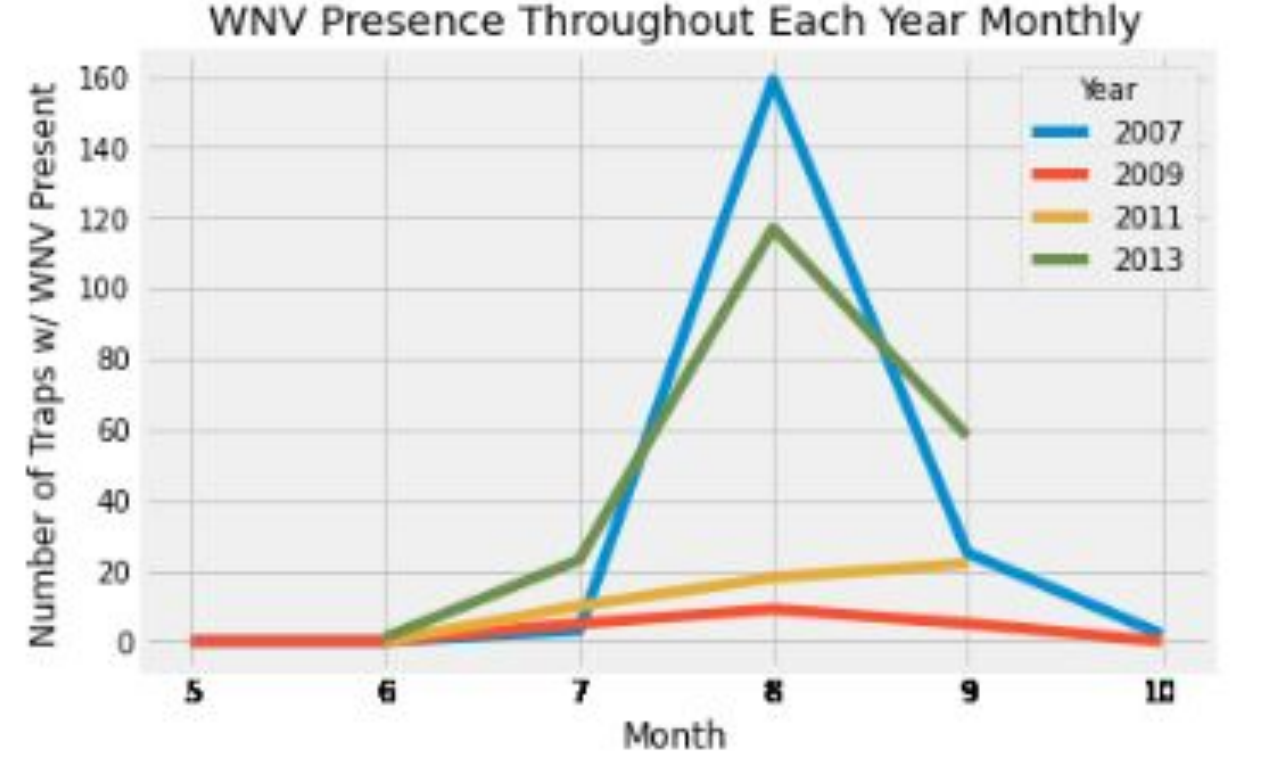
$1 on prevention in a day VS damages

RECOMMENDATIONS

Year	Total Spray Count	Total Mosquitos with Wnv +Ve	No. of Wnv Human case*	Ratio of Wnv Mos:Human
2011	1668	50	8	6.25
2013	12626	199	37	5.38
Differences (2013/2011)	7.57	3.98	4.63	0.86

- Spray count increase by 7.5 times
- Ratio of Wnv to infected decreased by 0.86
- Effort of spray to results is not proportional
- Spray efforts can be more efficient and planned for effectiveness

RECOMMENDATIONS



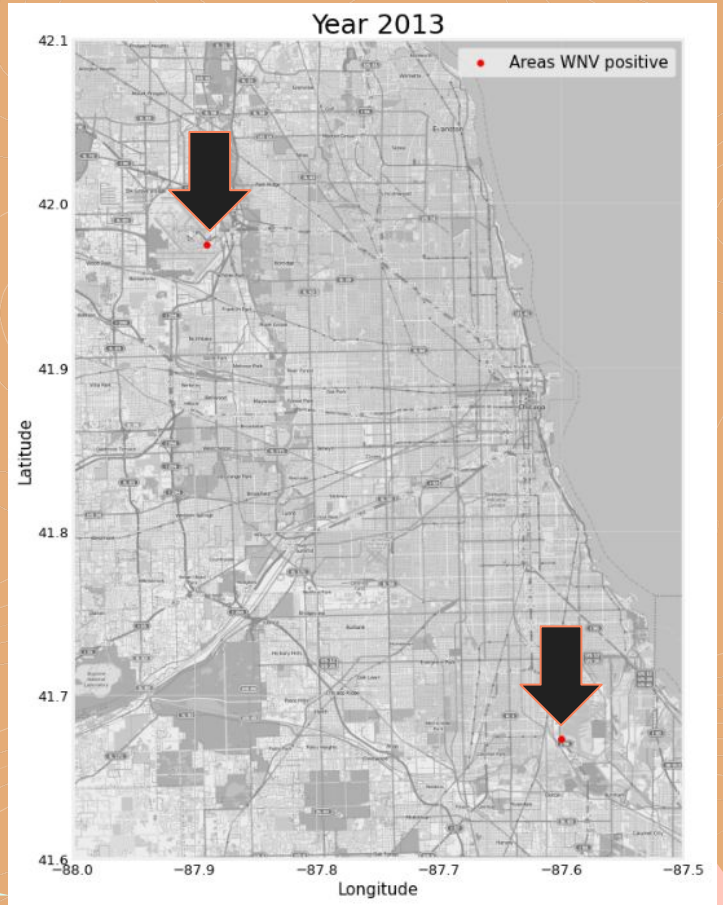
RECOMMENDATIONS

SPRAY PREDICTED AREA WITH 1 POS WNV

Approx **$416,658**

SPRAY PREDICTED AREA WITH 2 TRAPS WITH POS MNV

Approx **$1,220,213**



SPRAY AT TOP 2 TRAP LOCATIONS

Approx **$1,056**

GMO MOSQUITOES

Approx **$$3,599,880**

FURTHER STUDIES

STUDY WEATHER PATTERNS ON MOSQUITO BEHAVIOR

With better understanding on weather, we can better use weather features to train the model

UNDERSTANDING WNV TRANSMISSION

Mosquitoes may not be the root problem to the viral transmission.

MORE TRAINING DATA

We have very little data compared to test data

05 CONCLUSION

CONCLUSION SUMMARY

- Targeted mosquito spraying and data collection efforts
- One team to handle all data statistics
- Increasing speed and decreasing administrative lag
- Regular mosquito pre-spraying efforts at mosquito hotspots
- Mosquitoes hotspots can be the places where the traps have captured most mosquitoes or streets found with virus present

THANKS!

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REFERENCES

- https://www.chicago.gov/content/dam/city/depts/cdph/food_env/general/West_Nile_Virus/WNV_2018databrief_FINALJan102019.pdf
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3322011/#:~:text=Vector%20control%20cost%20%E2%89%88%24701%2C790,the%20emergency%20spray%20cost%2Deffective
- http://legacy.elpasotexas.gov/purchasing/docs/2016-741%20BID%20TAB.pdf?6/28/2021%209:39:13%20AM
- https://www.chicago.gov/content/dam/city/depts/cdph/Mosquito-Borne-Diseases/Zenivex.pdf
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4340646/
- https://www.channelnewsasia.com/news/singapore/wolbachia-mosquitoes-new-facility-aedes-aegypti-dengue-12145012
- https://www.cdc.gov/westnile/statsmaps/cumMapsData.html
- https://chicagoflaneur.com/2016/06/20/a-different-way-of-looking-at-density-in-chicago/
- https://www.sporcle.com/games/No1LesbroinChi/populated_chicago_neighborhoods/results
- https://www.sciencedaily.com/releases/2014/02/140210184713.htm
- http://www.cidrap.umn.edu/news-perspective/2004/07/west-nile-magnifies-need-mosquito-control
- https://www.cdc.gov/mosquitoes/about/life-cycles/culex.html
- https://www.cdc.gov/westnile/symptoms/index.html