West Nile Virus in Chicago

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Overview

- About Us
- Objective
- West Nile Virus
- Need for prediction
- Data Science Process
- Outcomes
- Cost Benefit Analysis
- Recommendation

About *DSI Vector Control*

Getting rid of mosquitoes is no job for amateurs

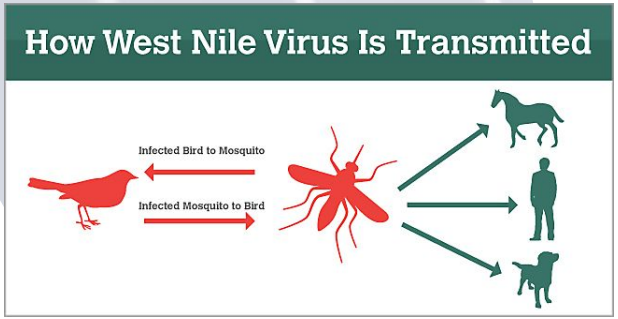
- If you have them, you're almost certainly going to need professional help to get rid of them.

- The mosquito exterminators at DSI have the experience needed to provide exceptional residential and commercial mosquito removal services.

Objective

- To predict West Nile Virus Mosquitoes presences in traps
- To propose preventive approach to deter outbreaks
- To provide cost benefit analysis of vector control

West Nile Virus



Since its introduction to the US in 1999 and first found in Illinois in 2002, it is now found in all states except for Hawaii and Alaska.

The primary hosts for the virus are birds, but it can be transmitted from birds to human via mosquitos.

West Nile Virus

80% of the infected people are asymptotic, while 20% develop mild symptoms.

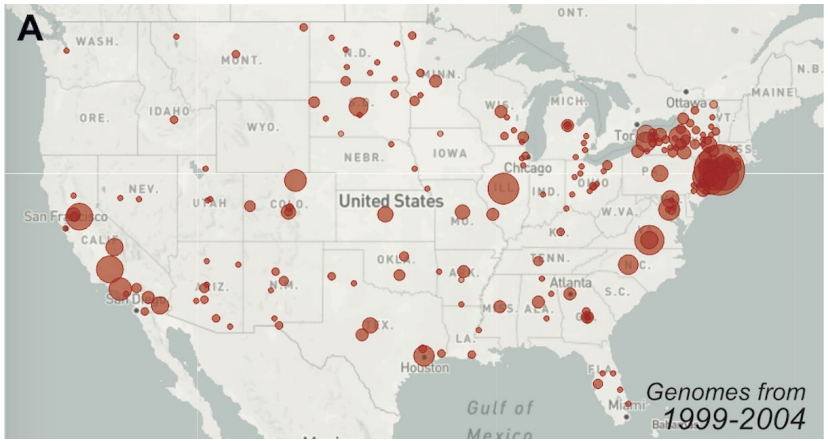
- Fever
- Headache
- Body ache
- Vomiting
- Diarrhea
- Skin rash
- Fatigue

West Nile Fever

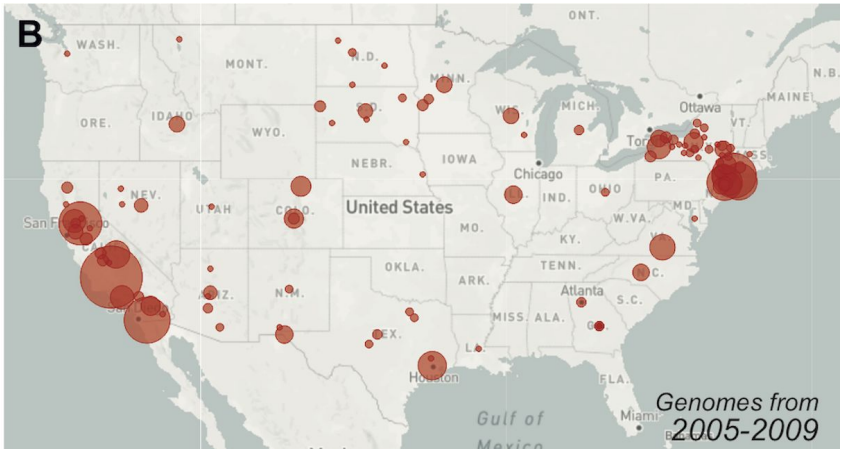
However, some may lead to severe neurological infections which may lead to encephalitis or meningitis, which may eventually lead to permanent neurological damage or even death.

Need for Prediction

728 available WNV genomes from 37 states from 1999 to 2004



789 WNV genomes from 22 from 2005 to 2009



Reference: https://journals.plos.org/plospathogens/article?id=10.1371/journal.ppat.1008042

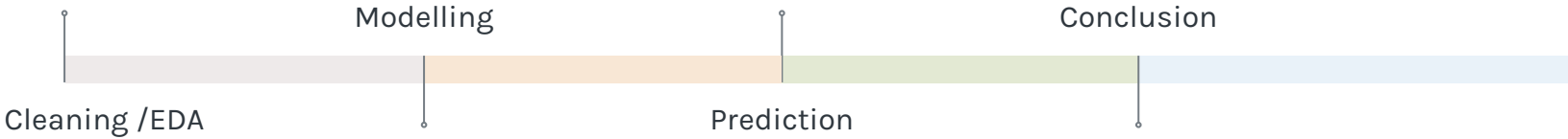
Our process is easy

Exploring the data

After cleaning and scaling, the data is visualised through graphs to identify visual trends or patterns.

Making the predictions

The best performing model is used to predict on our testing dataset (which will then be submitted for validation on Kaggle).



Finding the best model

Multiple models are chosen and trained on in order to find the best performer based on the ROC (Receiver operating characteristic) AUC score.

Identifying key takeaways

Use the modelling features to understand the importance of each feature and to identify the model's strengths and weaknesses.

Data

Mosquito Trap data for 2007, 2009, 2011 and 2013.

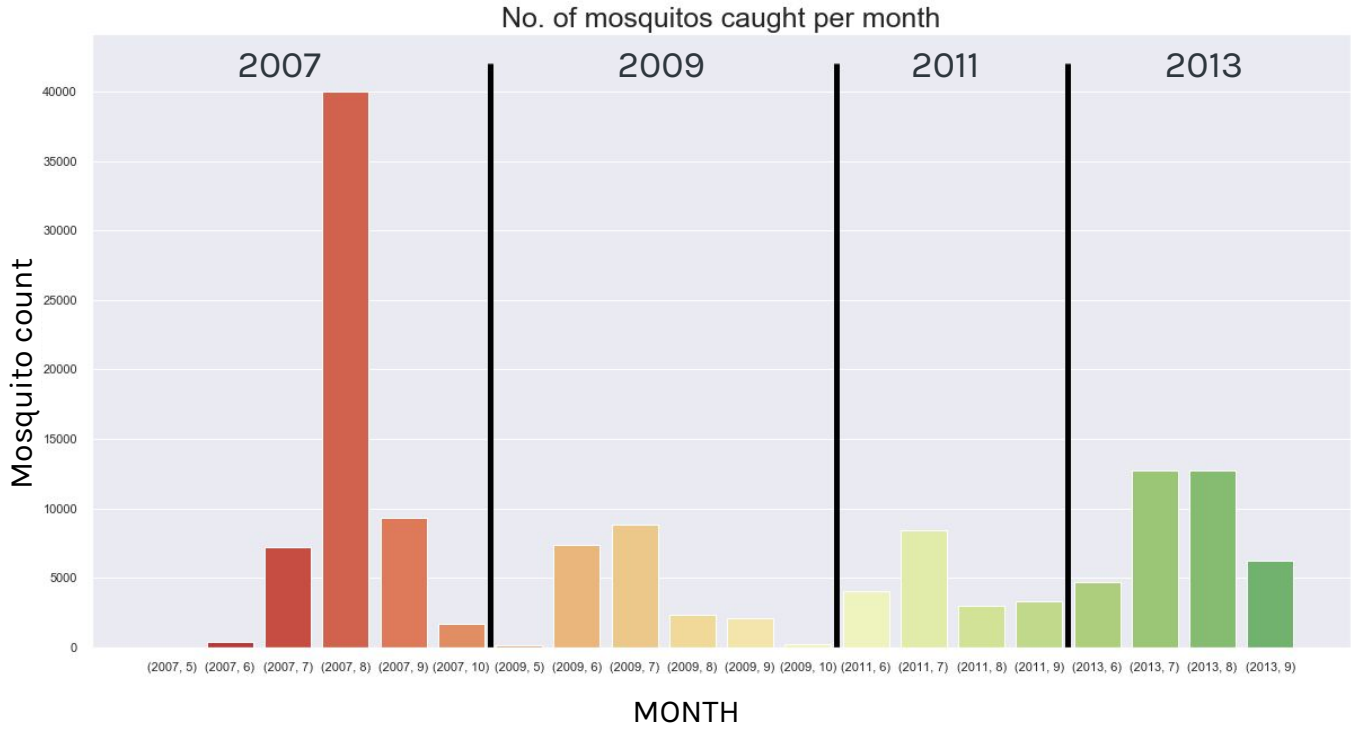
- ❏ Trap location
- ❏ Date
- ❏ Number of mosquitos
- ❏ Species of mosquitos
- ❏ Presence of West Nile Virus

Spraying data for 2011 and 2013

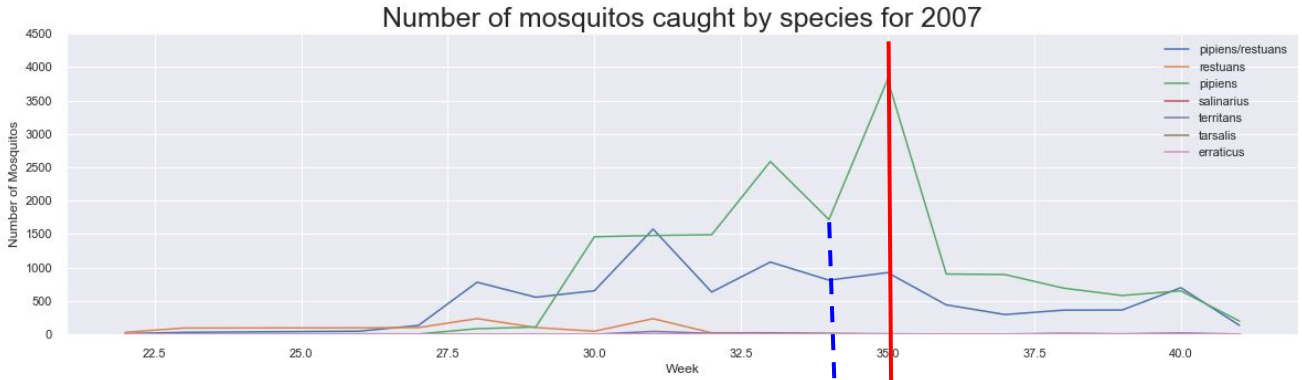
- ❏ Date
- ❏ Time
- ❏ Location of spray

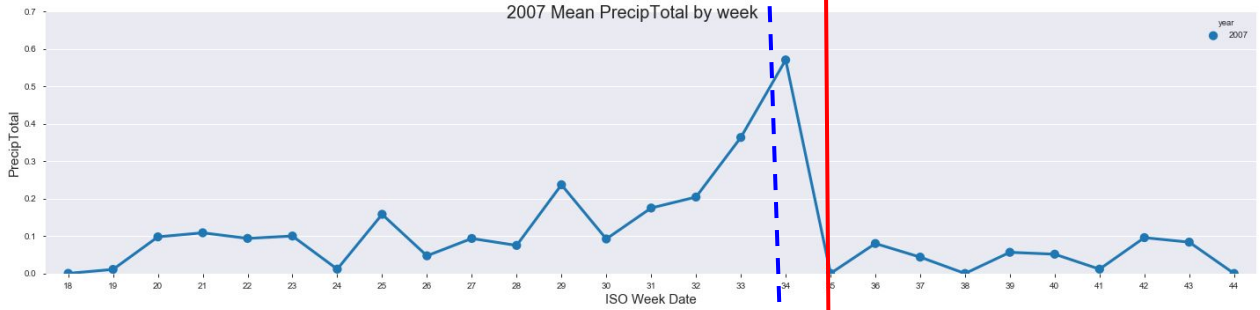
Weather station data from 2007 to 2014

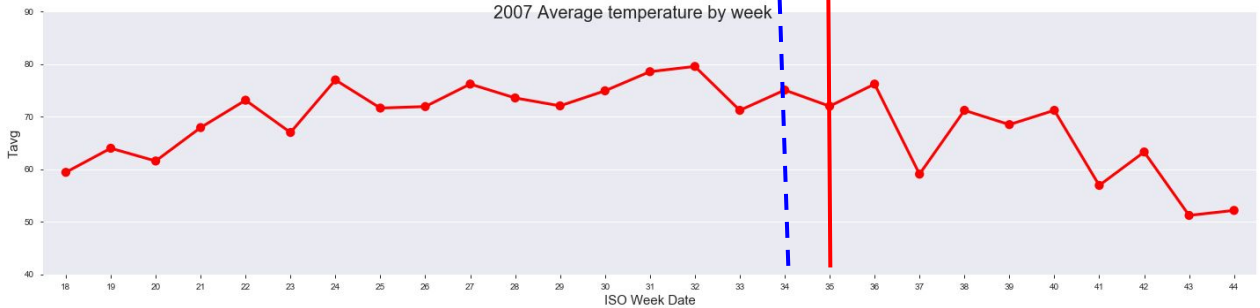
- ❏ Chicago O'Hare International Airport
- ❏ Chicago Midway International Airport


No. of mosquitos caught per month
2007
2009
2011
2013
Mosquito count
40000
35000
30000
25000
20000
15000
10000
5000
0
(2007, 5)
(2007, 6)
(2007, 7)
(2007, 8)
(2007, 9)
(2007, 10)
(2009, 5)
(2009, 6)
(2009, 7)
(2009, 8)
(2009, 9)
(2009, 10)
(2011, 6)
(2011, 7)
(2011, 8)
(2011, 9)
(2013, 6)
(2013, 7)
(2013, 8)
(2013, 9)
MONTH

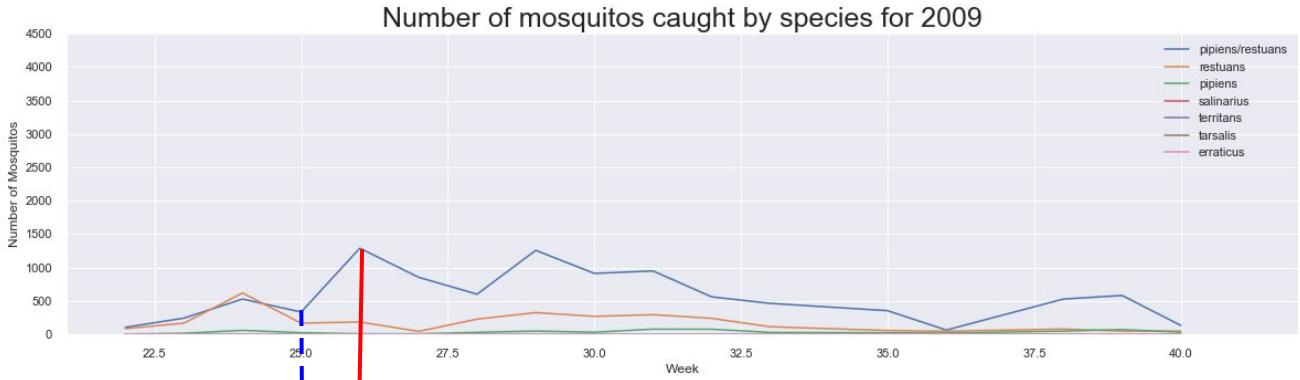
2007


Number of mosquitos caught by species for 2007
Number of Mosquitos
Week
pipiens/restuans
restuans
pipiens
salinarius
territans
tarsalis
erraticus


2007 Mean PrecipTotal by week
PrecipTotal
ISO Week Date
year
2007


2007 Average temperature by week
Tavg
ISO Week Date

2009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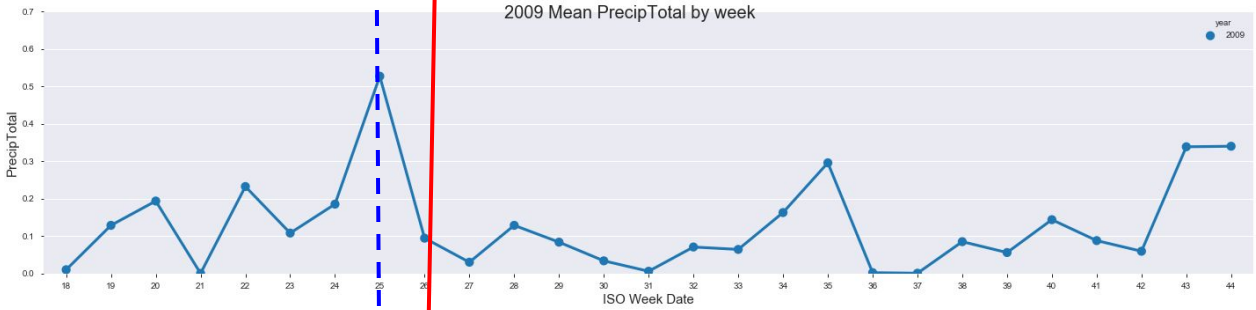
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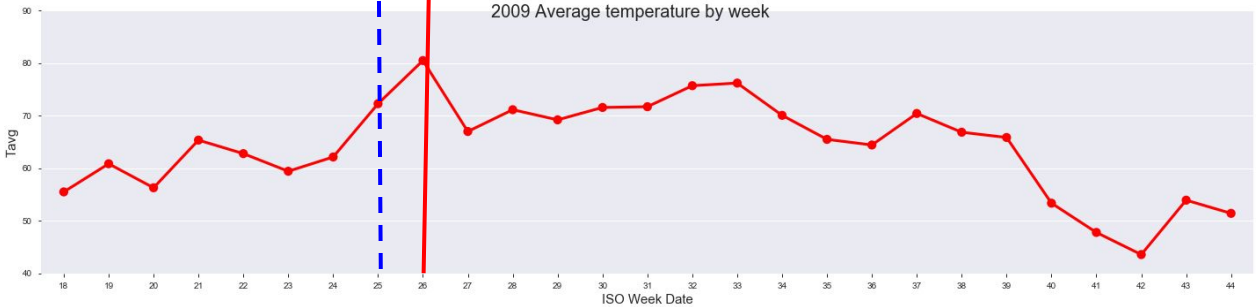
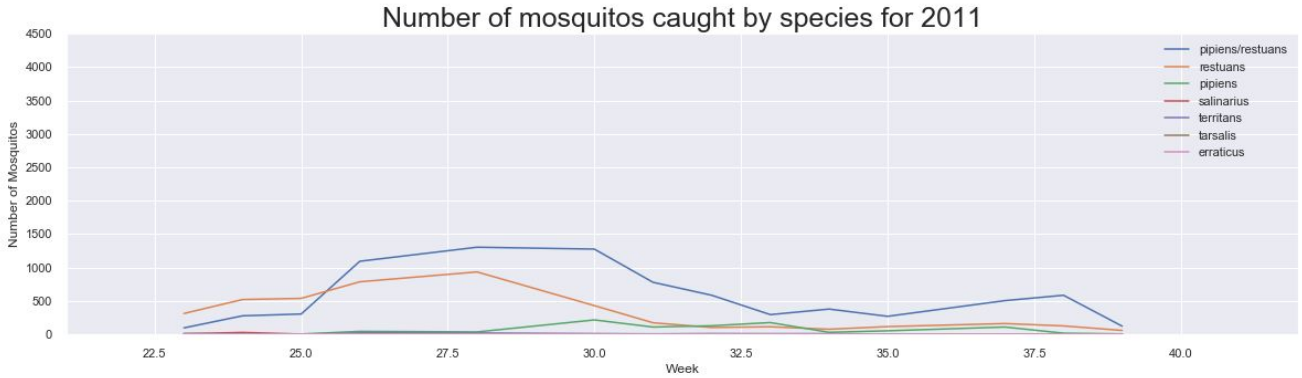

2009 Average temperature by week
Tavg
ISO Week Date

2011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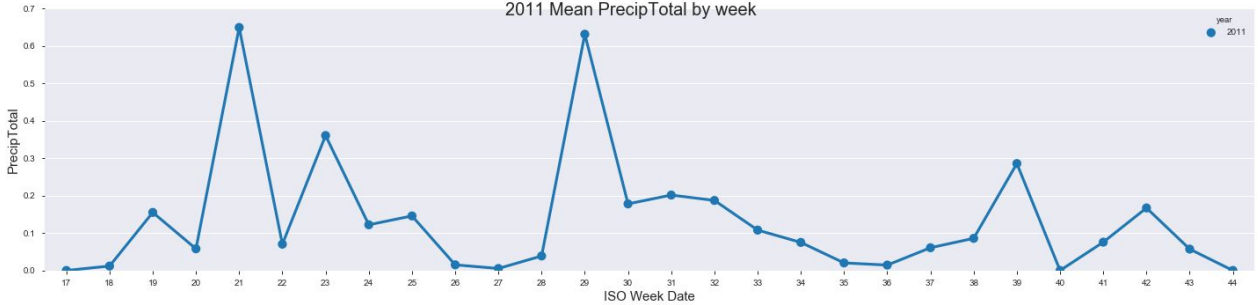
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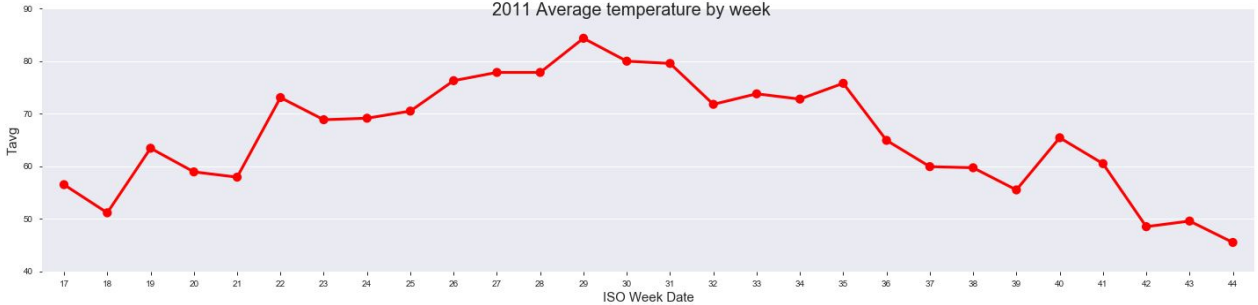
2011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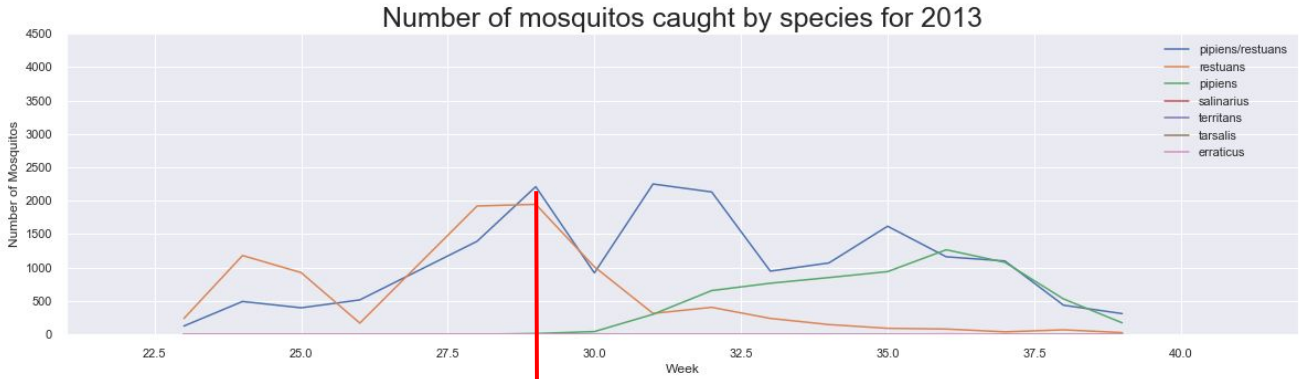
Tavg
ISO Week Date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Number of Mosquitos
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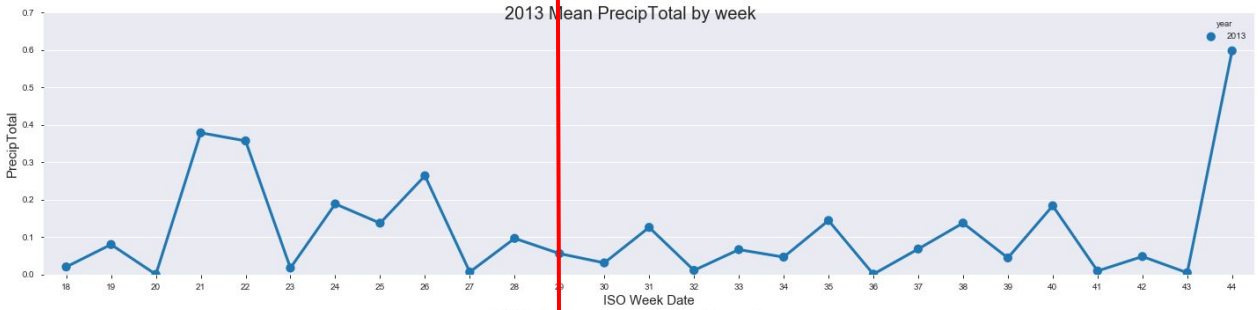
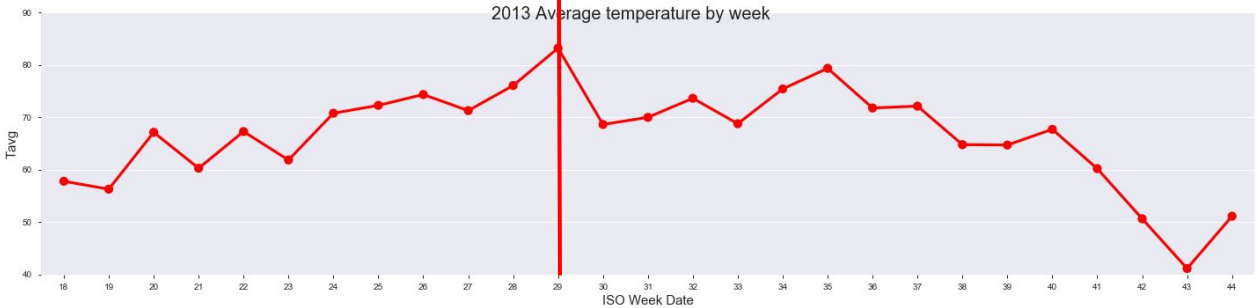

2013 Mean PrecipTotal by week
PrecipTotal
ISO Week Date
year
2013


2013 Average temperature by week
Tavg
ISO Week Date

2013

Modelling Process

Models Used

- ❏ Extra Trees
- ❏ Random Forest
- ❏ XGBoost
- ❏ Support Vector Machine (SVM)

	Extra Trees	Random Forest	XGBoost	SVM
ROC-AUC	0.7448	0.7374	0.7242	0.7150
Performance on Unseen Data	0.6869	0.6689	0.6833	0.6424

⚠ Crucial Features

	Feature
1	Culex Restuans
2	July
3	Daylight Hrs(3 days prior)
4	Daylight Hrs(1 days prior)
5	Daylight Hrs
6	June
7	Daylight Hrs(7 days prior)
8	Dew Point
9	Cool
10	Average Temperature

Cost-Benefit Analysis

What is the cost to Chicago from WnV infections every year?

57 WnV cases reported in 2018 in Chicago

	Cost	**Remarks**
Productivity loss from sick days / patient	$21,320	- 2 sick days on average - average of $374 income / day
Hospitalisation & medical charges / patient	$15,000	- assume only 5 cases are serious enough to require hospitalisation - 5 days hospitalisation @ $3,000 / day
Total cost / year	**$97,000**	- for 57 patients

👍 Benefit of Spraying from 2013 data

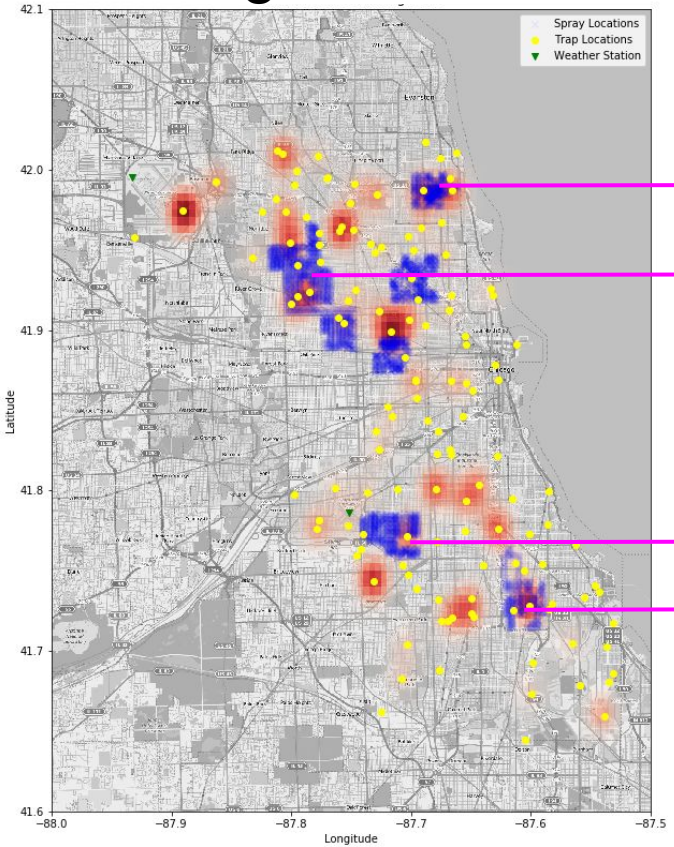
8 spray locations

4 locations experienced **a drop in WnV** in the next month

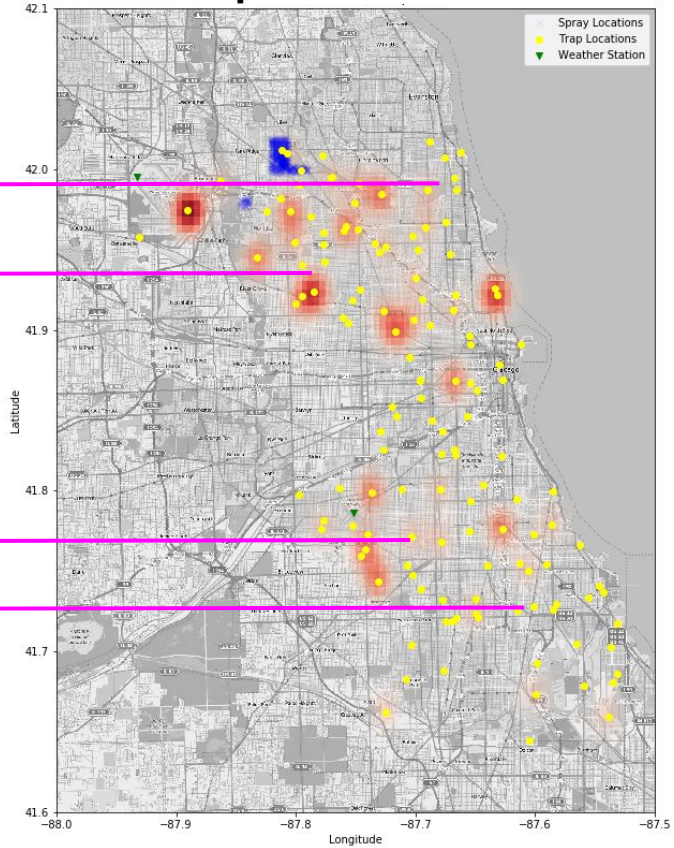
Spraying: 50% effectiveness rate

WNV Presence Heatmap

August 2013



September 2013



Cost of Aerial Spraying per Year

	Quantity	Remarks
Pesticide Cost	$1.30 / acre	- Naled pesticide
Acres to be sprayed	14,980	- assume 1/10 area of Chicago
Cost of 1 plane trip (rental, fuel, manpower)	$9,000	
Total cost of spraying / year	$113,900	-Spray every 3 weeks, from Jun to Sep

	Spray 100%	75%	50%
Total cost of spraying / year	$113,900	**$94,400**	$70,950

< **$97,000 in medical costs**

Conclusions & Recommendation

Our model has a reasonable accuracy of 68% for predicting the presence of the West Nile Virus based on weather features and mosquito trap information.

Our Recommendation - to conduct aerial spraying every *3 weeks on the top 75% hotspots* detected, from June to September each year.

Assuming *50%* effective rate, the spray would optimize government funding and reduce WnV cases by up to 37.5%.

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KEEP
CALM
AND
BE SIGNIFICANT

Good to know

- West Nile Virus (WNV)
- St. Louis Encephalitis (SLE)
- Eastern Equine Encephalitis (EEE)
- La Crosse (LAC)
- Dengue (DEN) locally-acquired and travel-associated
- Chikungunya (CHIK) locally-acquired and travel-associated
- Zika Virus (ZIKA) locally-acquired and travel-associated
- Powassan Virus (a tick-borne disease)