



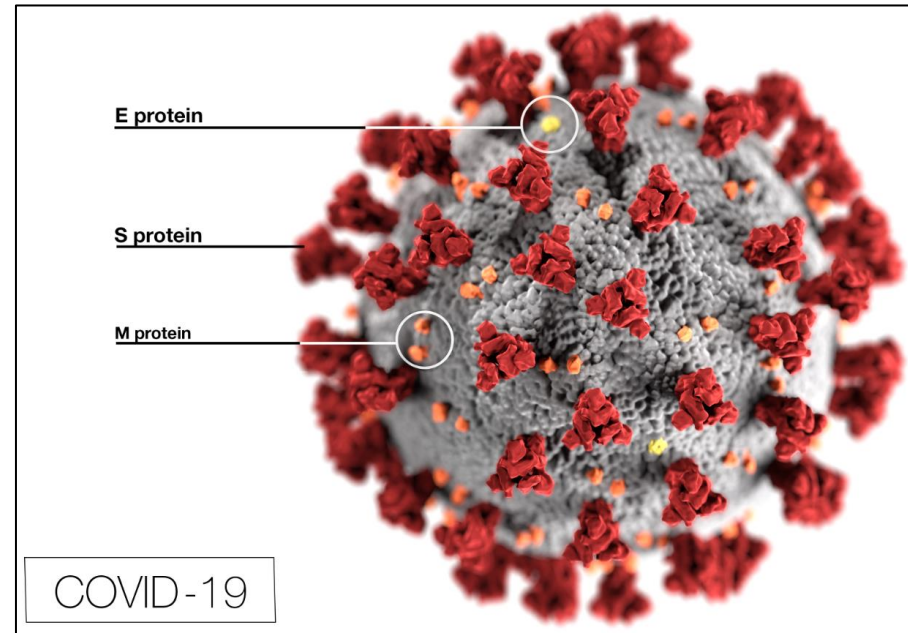
SPATIALLY EXAMINING COVID-19

PAUL CLEARY, MAY 5, 2020

Agenda

Spatially Examining COVID-19

- Timeline in Illinois and Indiana
- Current distribution of the virus
- Population Density
- Spatially Clustered?
- How is it spreading?
- Forecasting the peak



Indiana COVID-19 Timeline

March 6; First case in IN

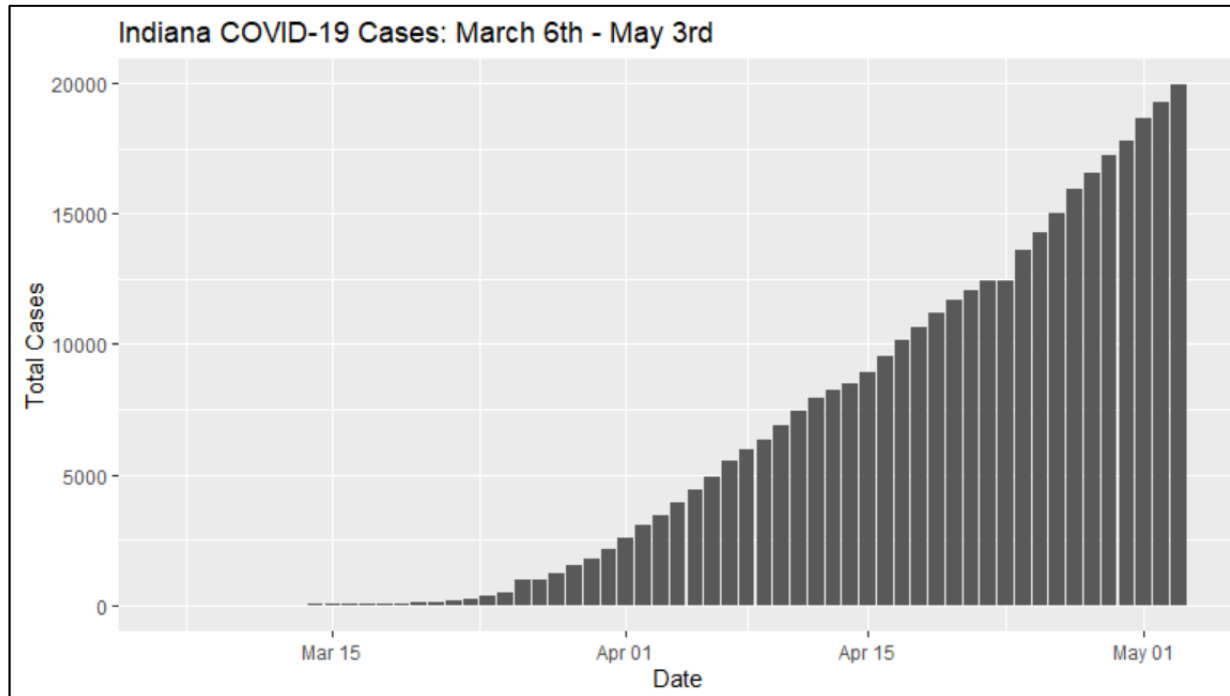
March 16: Initial Business Closure

March 24: Non-Essential Services Closed

March 12; Mass Gatherings Restricted

March 19: Schools Closed

March 25: Statewide Stay at Home Order



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Illinois COVID-19 Timeline

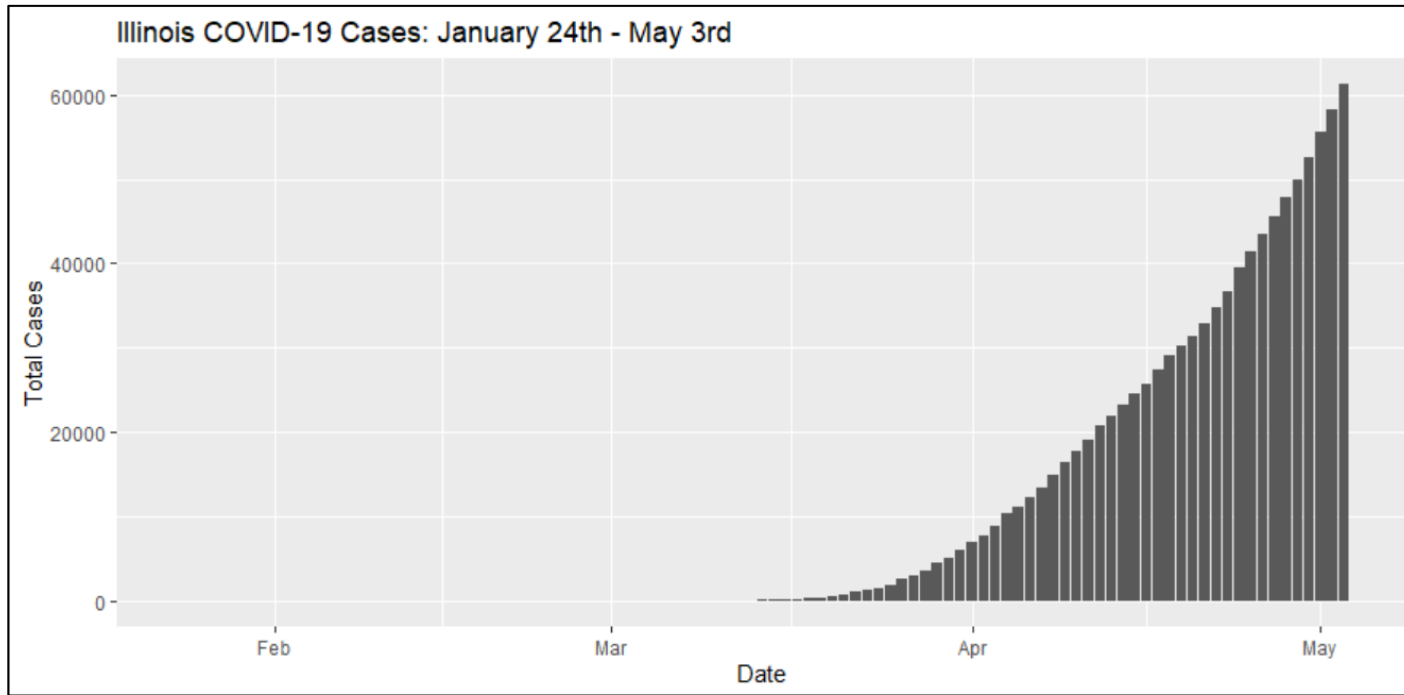
January 24; First case in IL

March 15: Bars and Restaurants closed

March 21: Statewide Stay at Home Order & Non-Essential Business closed

March 13; Schools Closed

March 16: No Mass Gatherings > 50



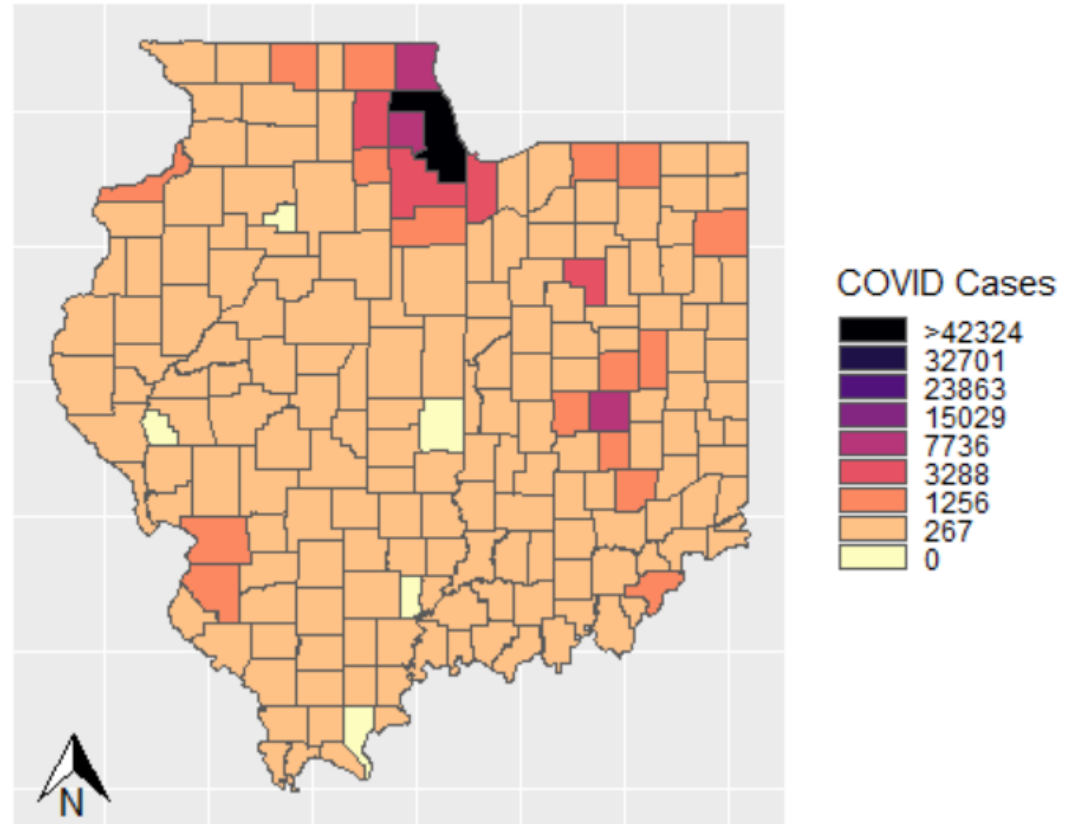
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COVID-19 Cases by County

- Chicago and Indianapolis regions are the most impacted
- Both have major airports that may have served as the seed locations.
- Is population density a factor?
- How does it spread?

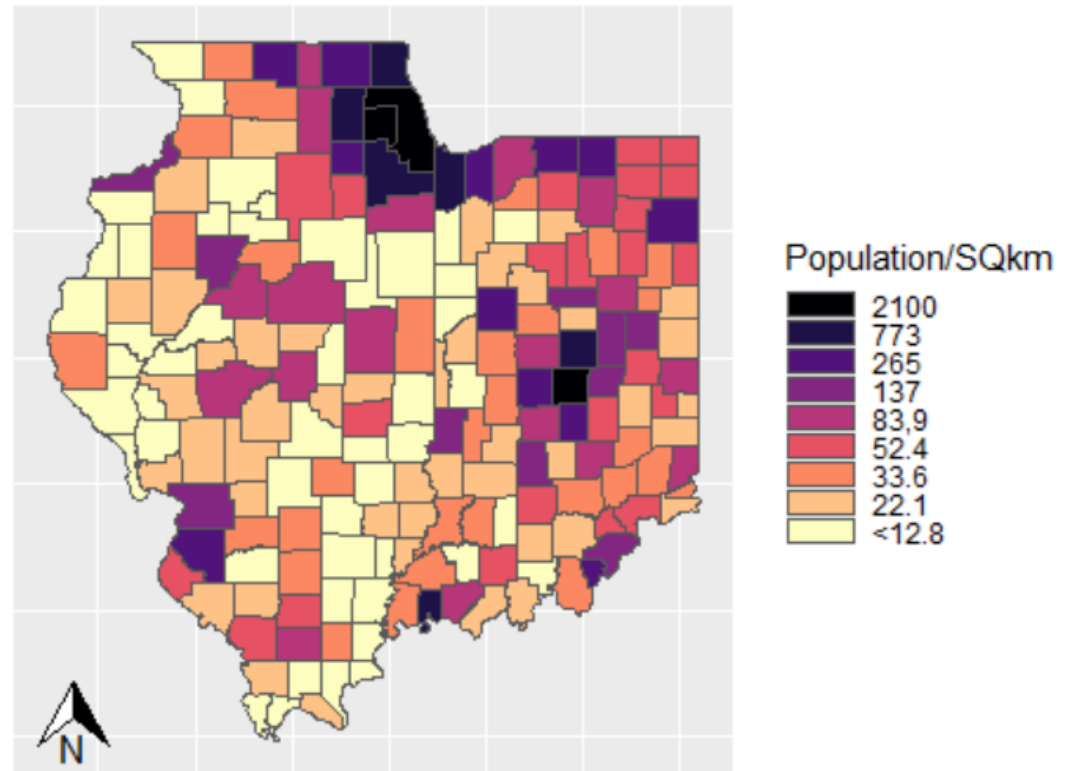
COVID cases in Illinois and Indiana as of 03 May 2020



Population Density

- Chicago and Indianapolis are clearly the most densely populated areas across both states.
- Is there spatial clustering of both population density and COVID-19?
- If so, is there an apparent connection?

Population Density of Illinois and Indiana

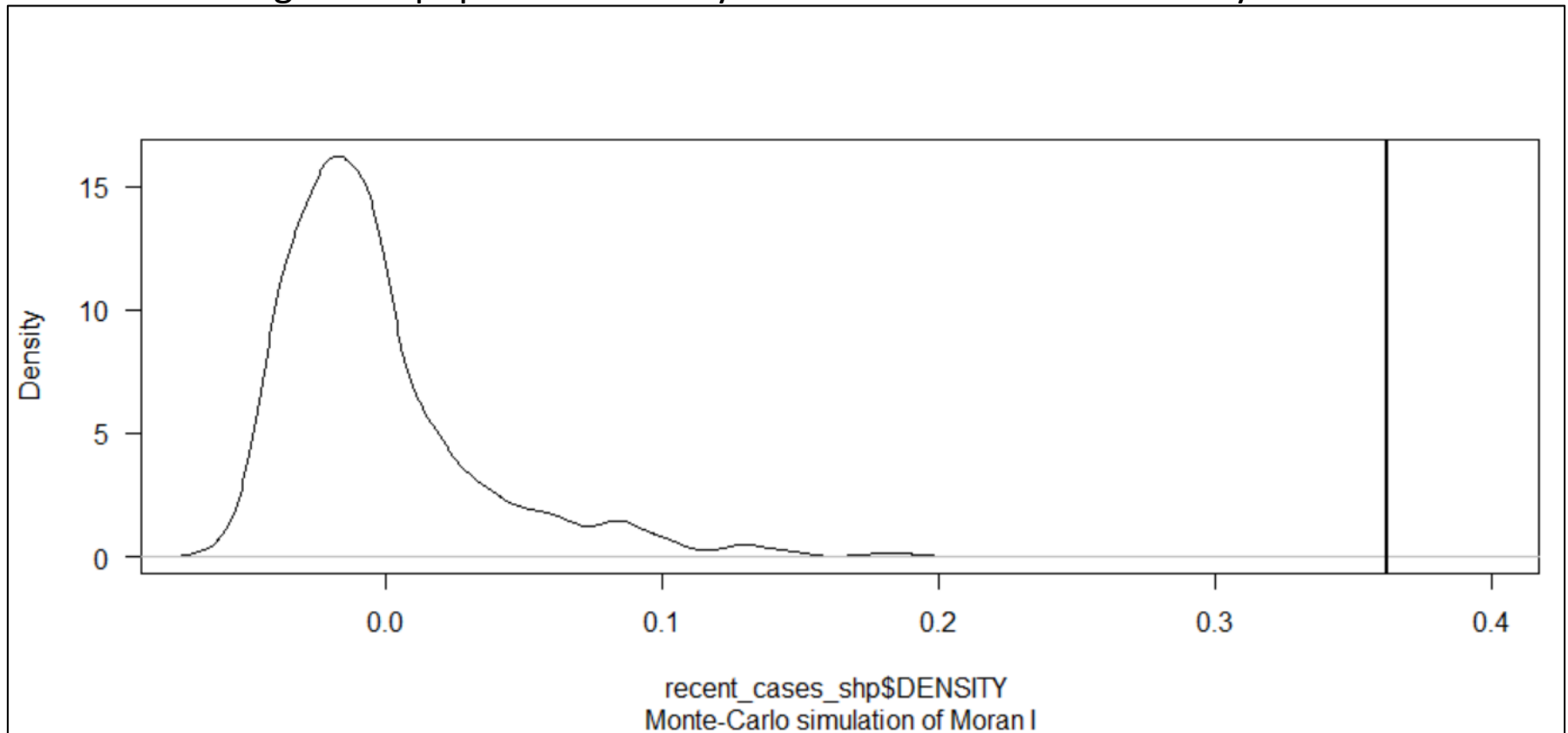


Population Density Spatial Autocorrelation

Moran's I Results:

Moran's I statistic = 0.3620 P-value = 0.001667

Confirms clustering of the population density when measured at the county level.



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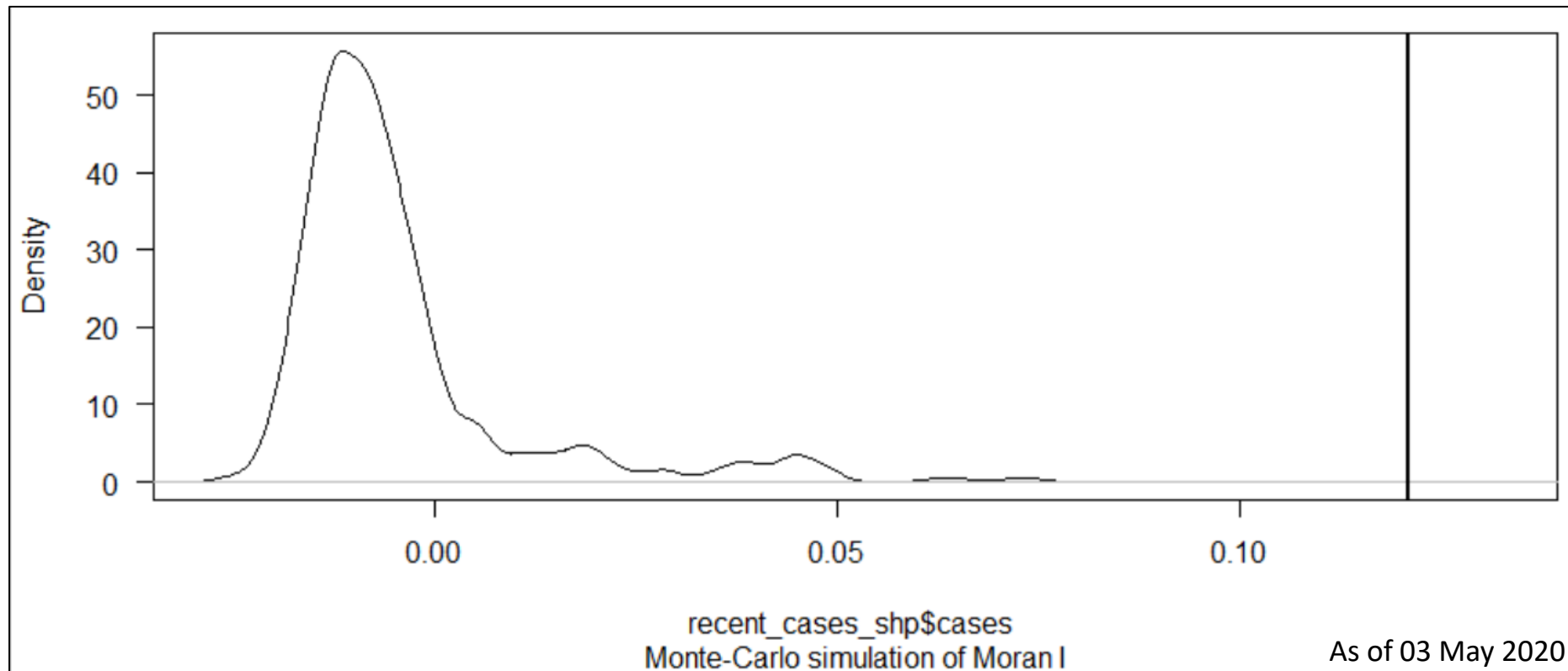
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COVID-19 Cases Spatial Autocorrelation

Moran's I Results:

Moran's I statistic = 0.12093 P-value = 0.001667

Confirms clustering of COVID-19 cases when measured at the county level.

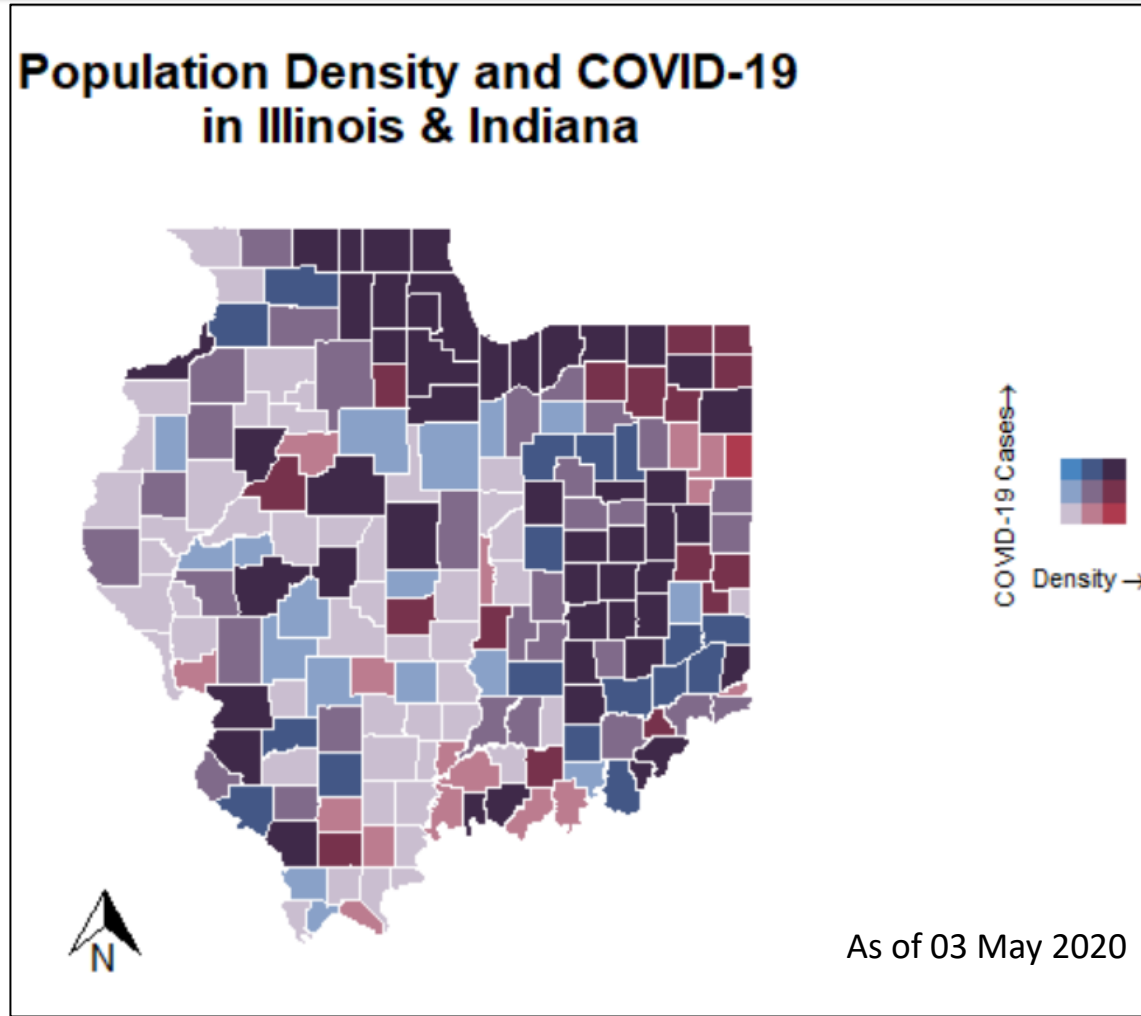


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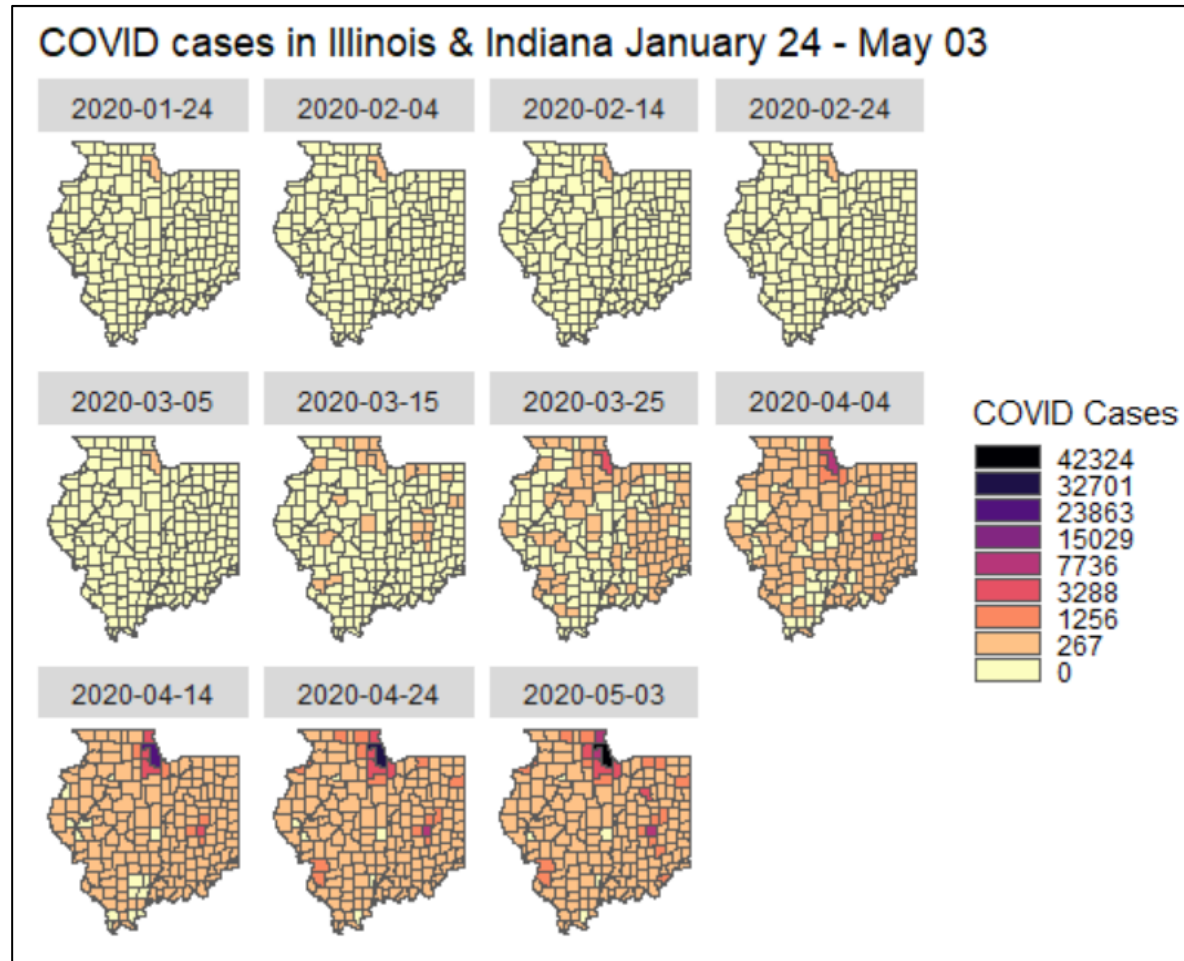
Bivariate Map

- Bivariate map displaying the interaction of the population density and cases of COVID-19 in each county of Illinois and Indiana.
- Uses a 3x3 grid to display nine classes of interaction.
- The color in the bottom left of the grid represents a county with a low population density and few cases of COVID-19
- The color in the upper right of the grid is for counties with a population density and many cases of COVID-19.



Growth of COVID-19 across Illinois & Indiana

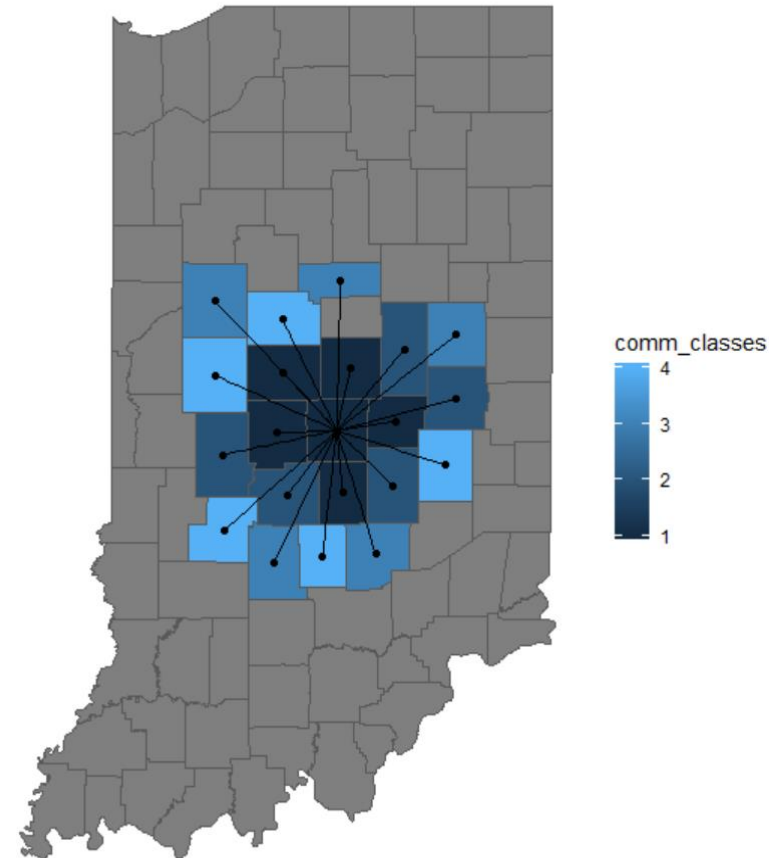
- Appears to emanate from Chicago and Indianapolis
- Potentially due to the presence of airports and international travelers
- Role of commuters in spreading it to the surrounding communities?



Indianapolis Commuters

- The 20 counties with the most daily commuters to Indianapolis, Indiana (Marion Co)
- 190,715 daily commuters from these 20 counties to Indianapolis
- Commuters are a likely method of transmission to the outlying counties of Indiana

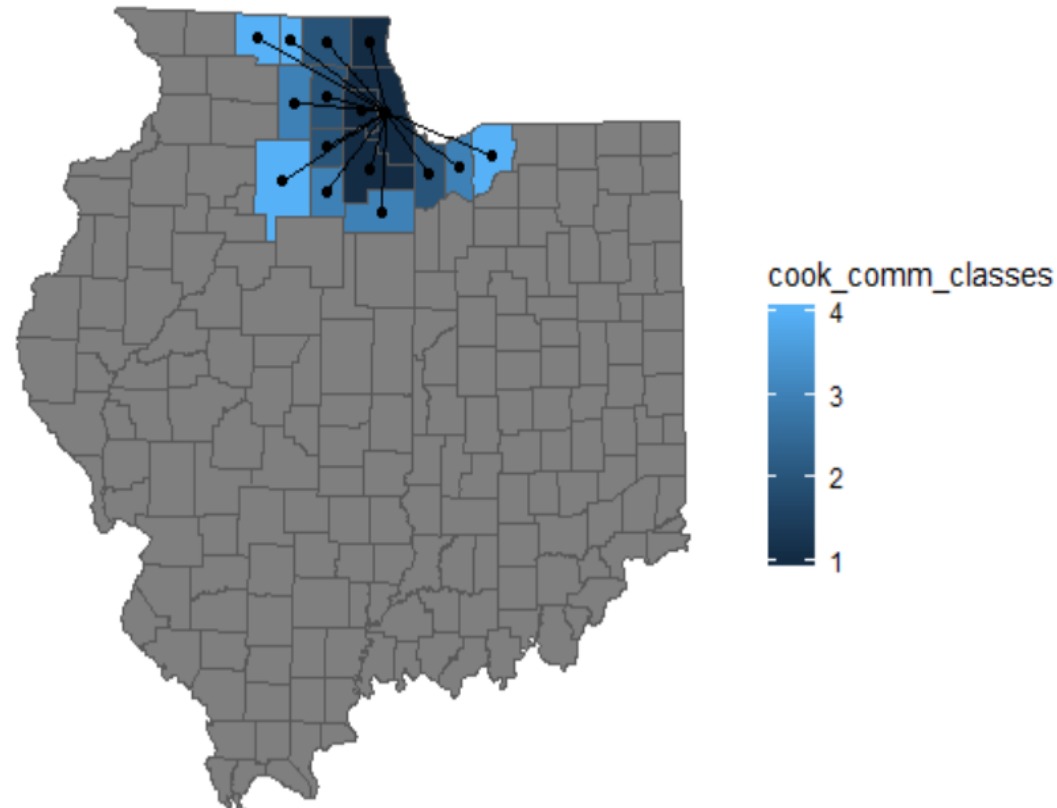
Top 20 Counties with Commuters to Indianapolis (Marion Co)



Chicago Commuters

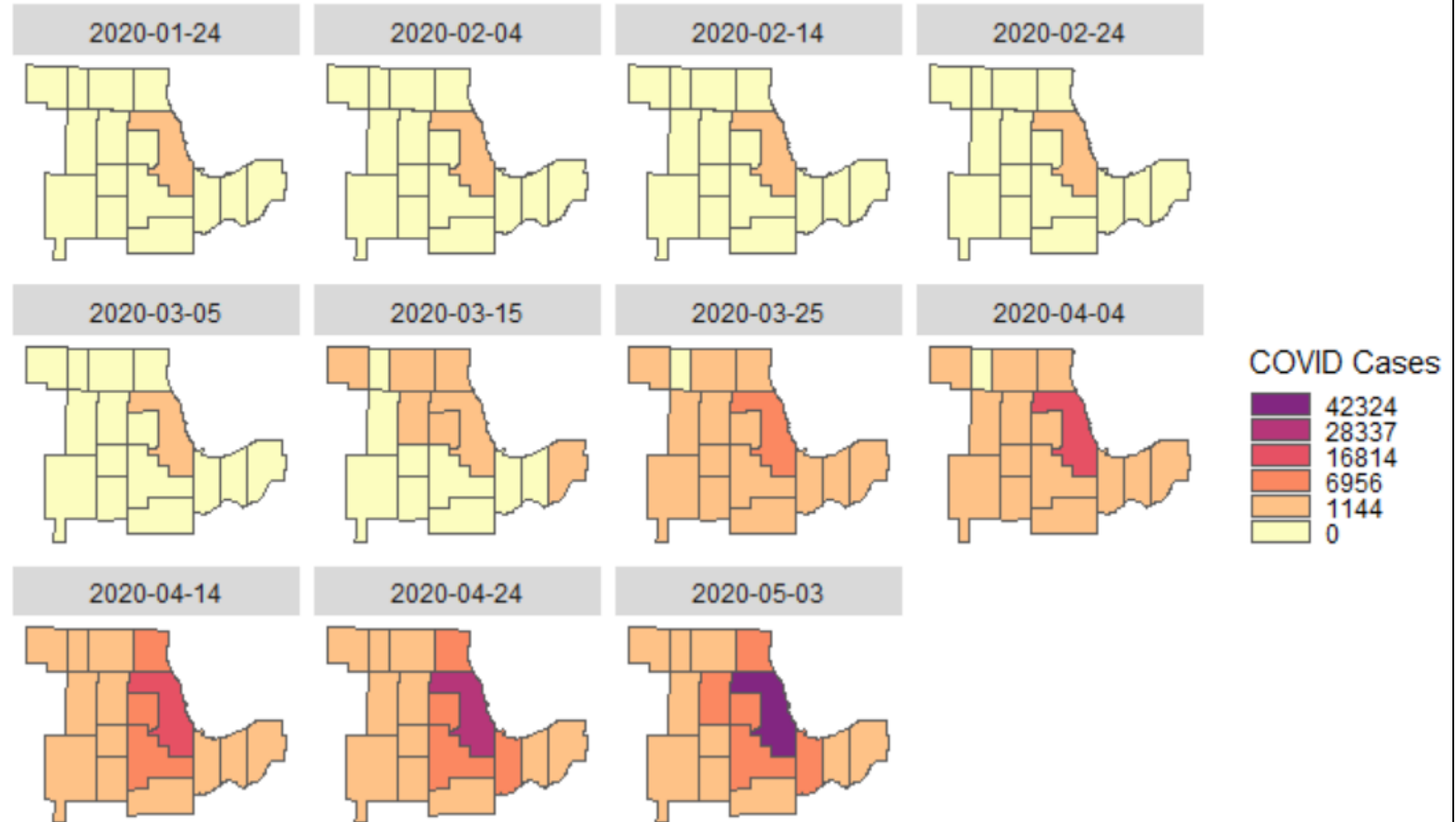
- The top 16 counties with the most daily commuters to Chicago
- 449,978 daily commuters from these counties to Chicago
- Commuters from Indiana
 - Lake Co = 42,490
 - Porter Co = 5,149
 - Laporte Co = 1,022
 - Total = 48,661
- Two major airports
 - O'Hare: busiest in the Midwest

Top 16 Counties with Commuters to Chicago (Cook Co)



Spread of COVID-19 in Chicago Metro

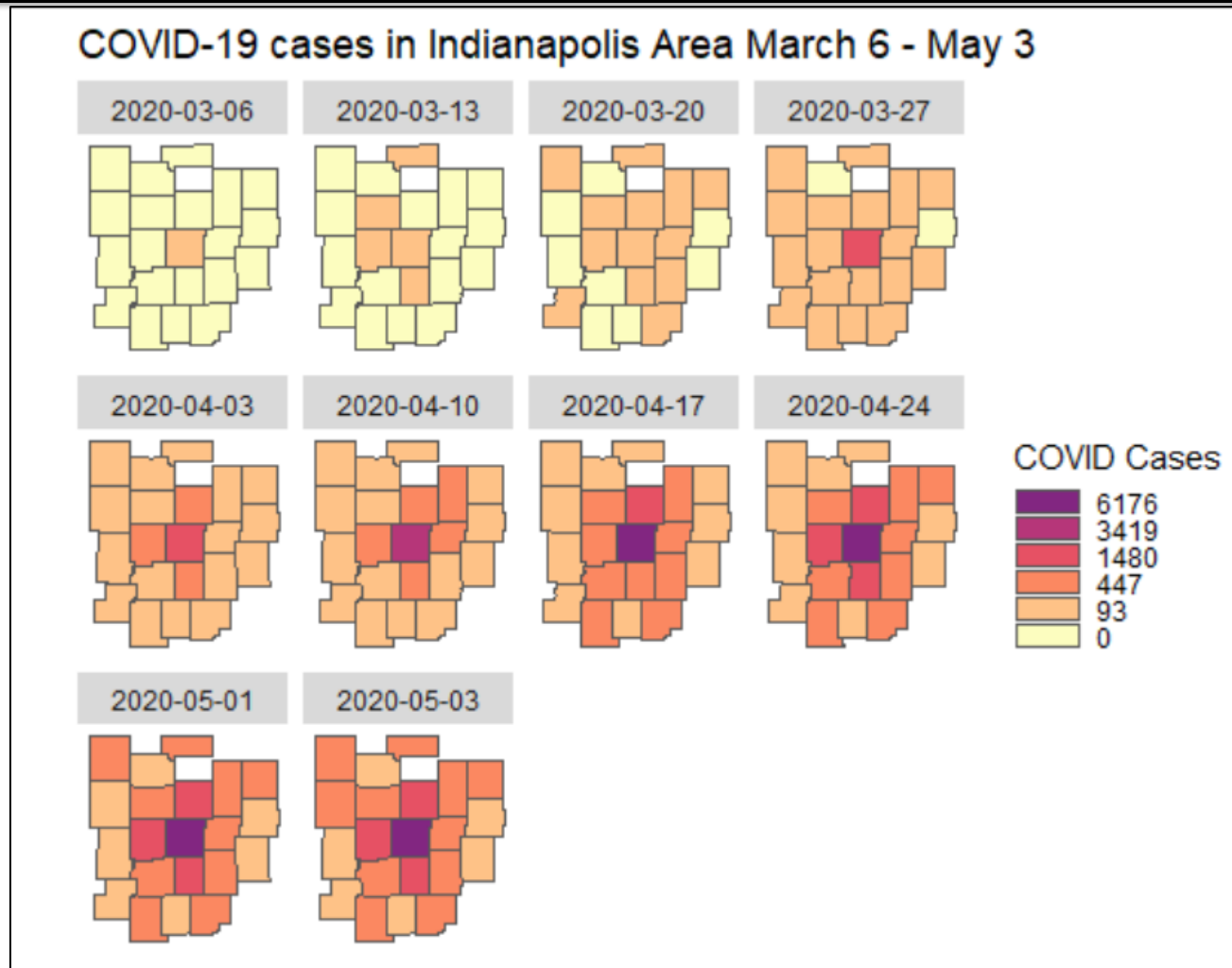
COVID-19 cases Chicago Area January 24 - May 3



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Spread of COVID-19 in Indianapolis Metro

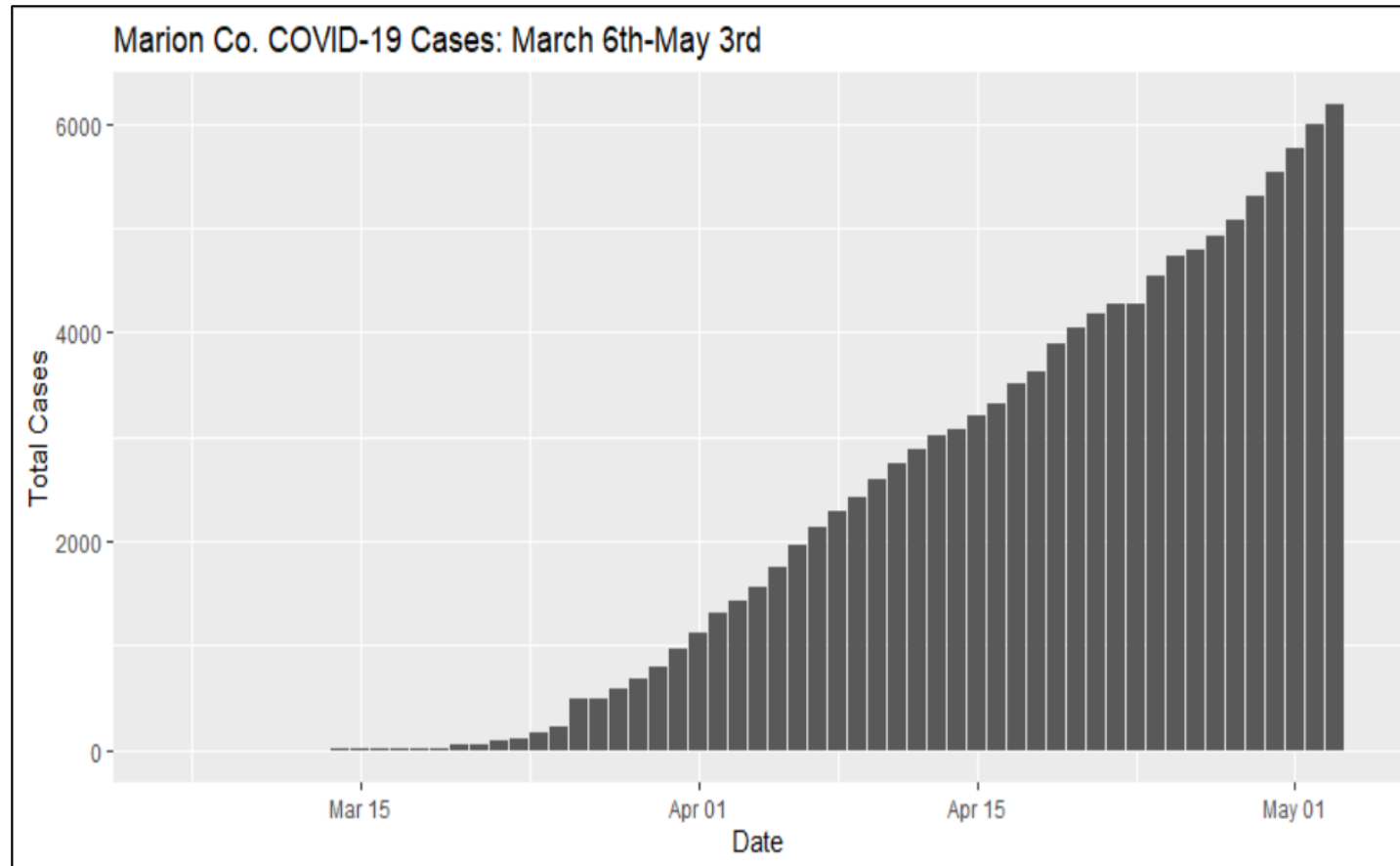


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Predicting the Peak

- Implemented an epidemiological predictive model in R to forecast the peak date of COVID-19 in each county.
- Basic SIR model; Kermack–McKendrick theory introduced in 1927
- Model source code is from GitHub
- Deterministic Model that is dependent on the cumulative number of cases and population

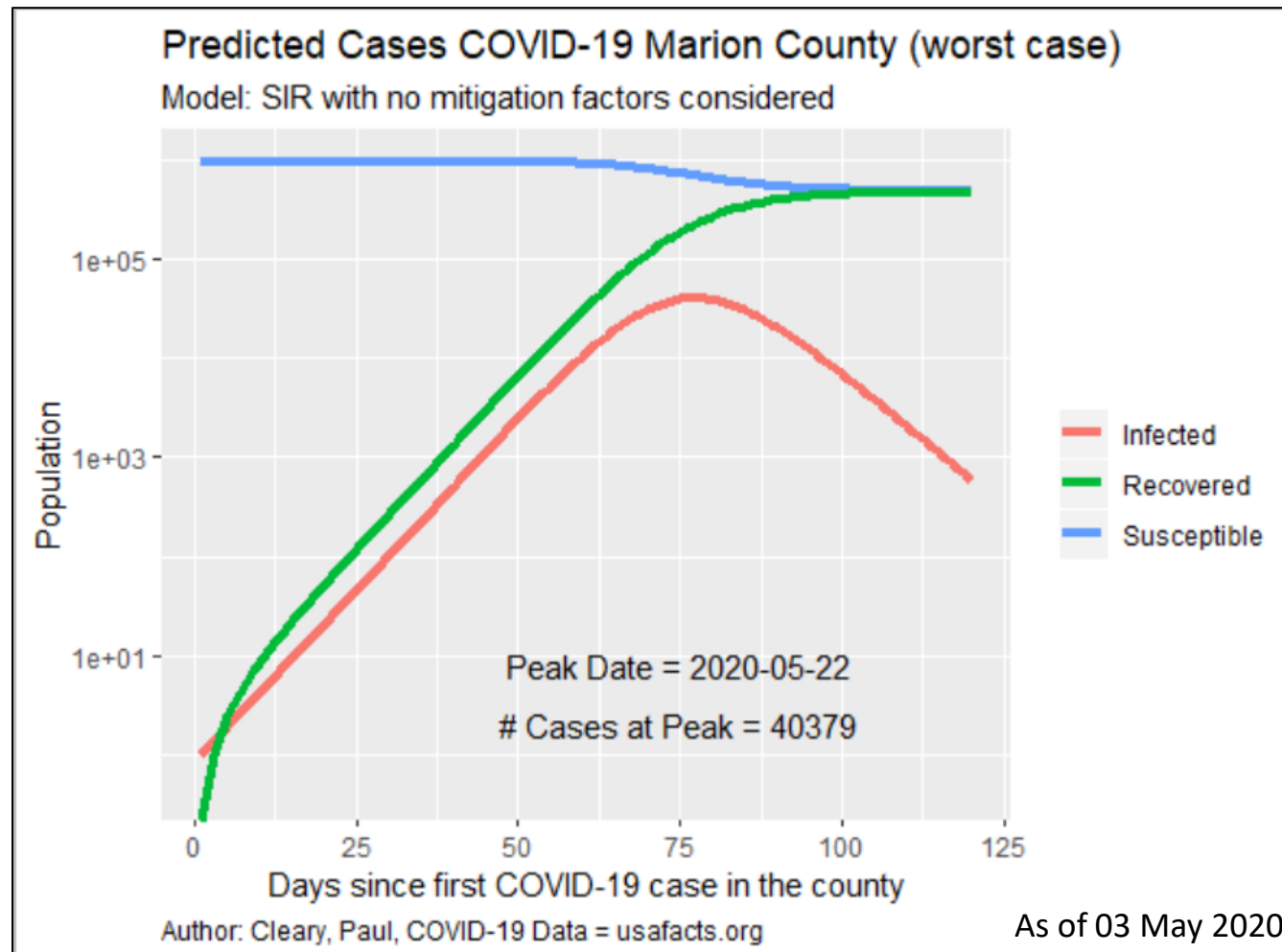


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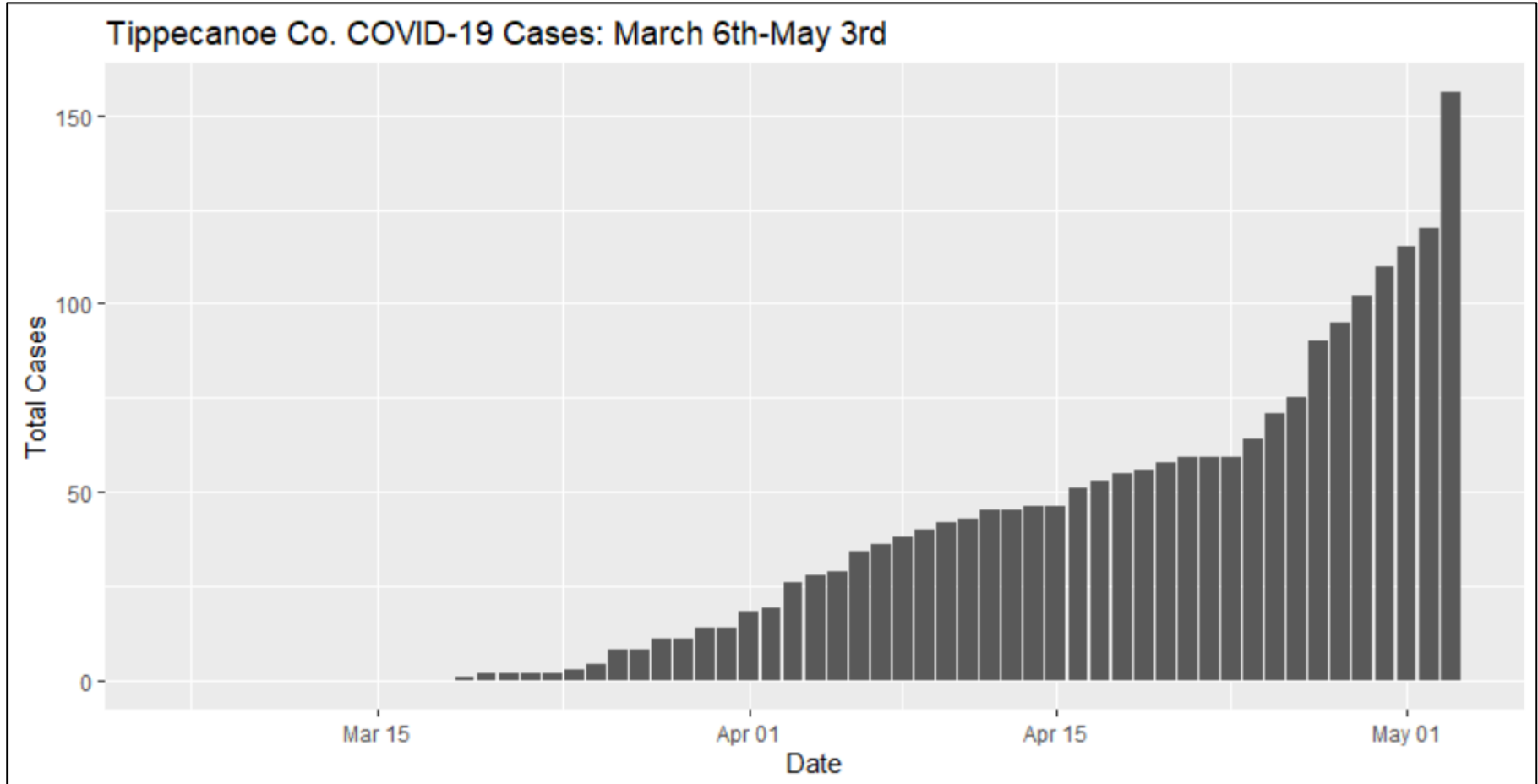
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Predicting the Peak Marion Co

- From April 17 to May 3 the model has shifted the peak date from May 08 to May 22
- The predicted # of cases has dropped from 63,098 to 40,379



Predicting the Peak Tippecanoe Co

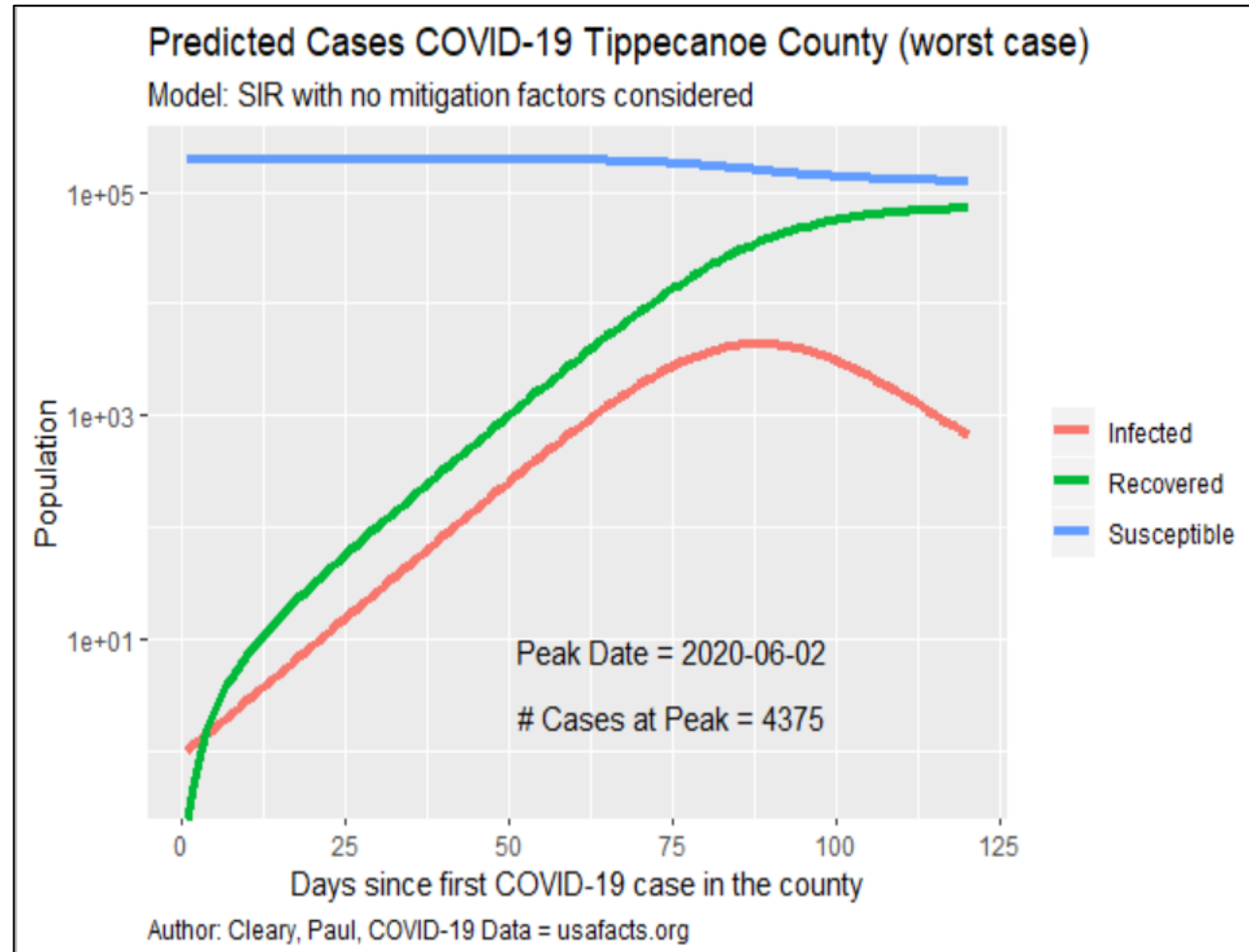


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Predicting the Peak Tippecanoe Co

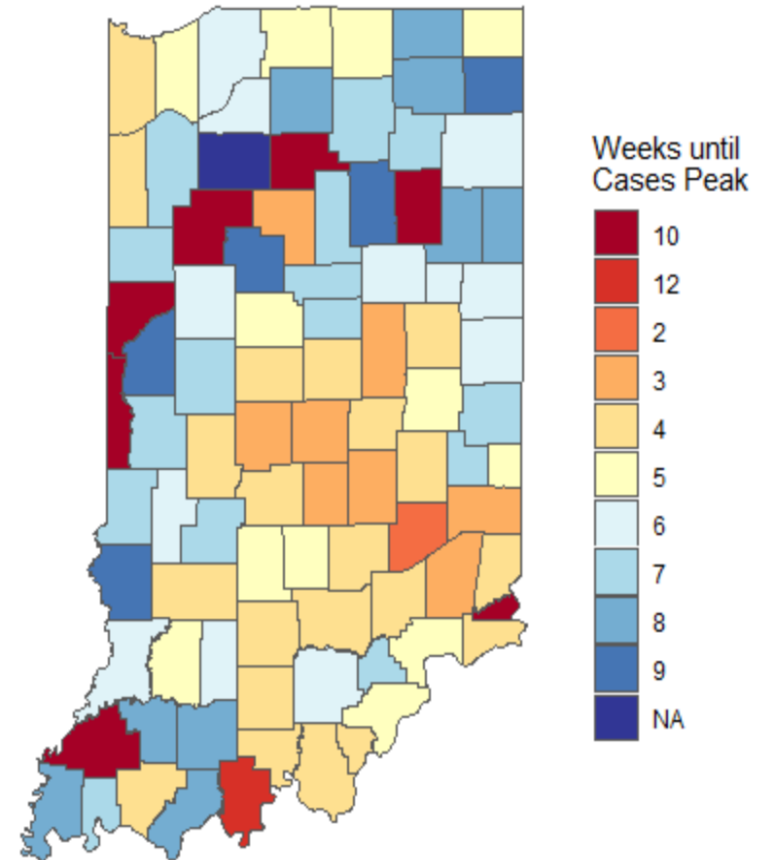
- From April 17 to May 3 the model has shifted the peak date from May 16 to June 02
- The predicted # of cases has dropped from 7,121 to 4,375
- Noticed it is susceptible to sudden spikes in cases



Predicting the COVID-19 Peak

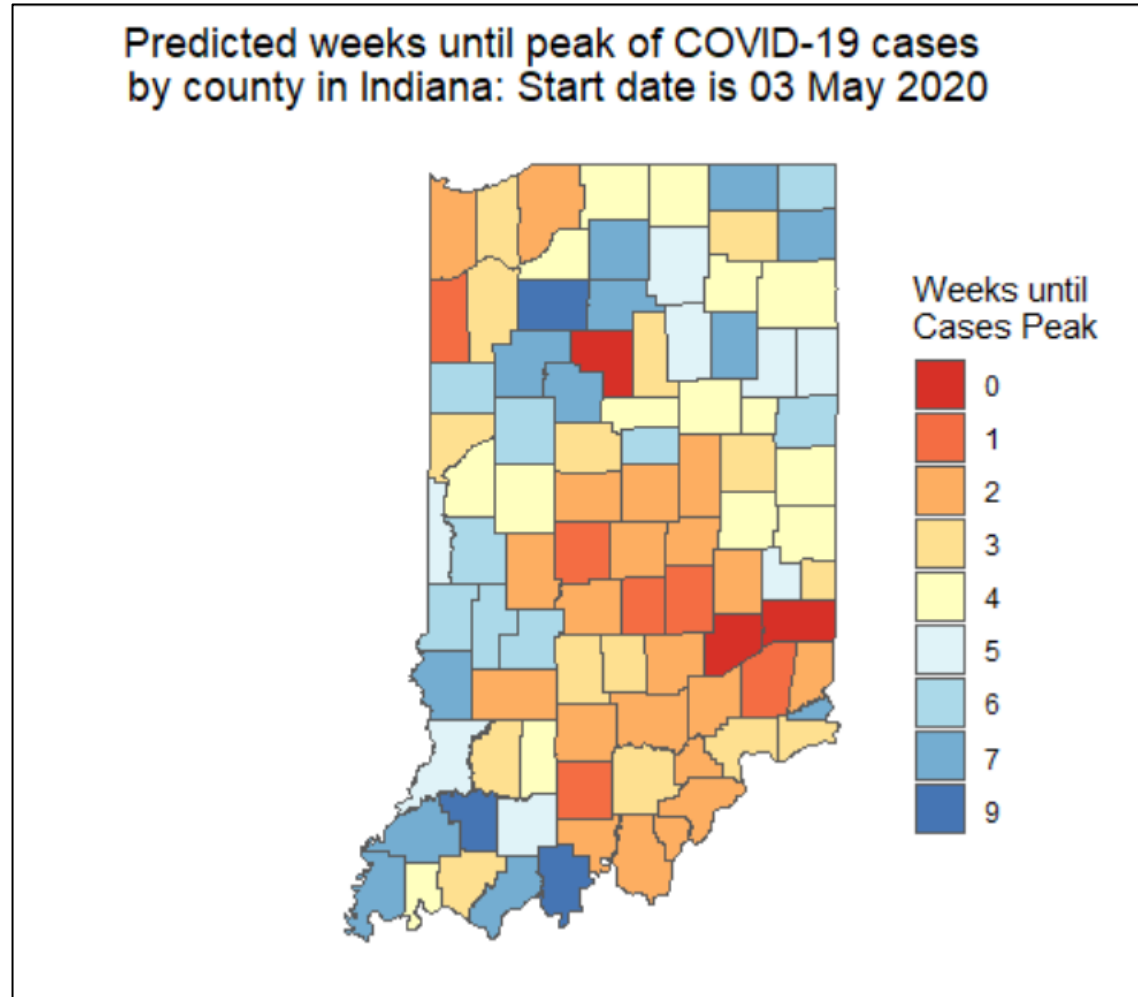
- Used the predicted peak date to develop a week by week forecast for the state
- Intended to help in forecasting where medical assistance may be required

Predicted weeks until peak of COVID-19 cases
by county in Indiana: Start date is 23 April 2020



Predicting the COVID-19 Peak

- The expected peak date of peak cases continues to move right on the calendar
- This may be a result of social distancing and other efforts to slow the spread and 'flatten the curve'



Conclusion

- COVID-19 is clustered in higher density areas
- Initial method of transmission was via air travel
- Regional method of transmission is likely commuters and the workplace
- Local growth of the virus continues to increase
- The predicted date of peak continues to push to the right
 - Possibly a result of social distancing
- Predicted number of cases is declining

COVID cases in Illinois and Indiana as of 03 May 2020

