Near real-time reporting of incidence and prevalence for Porcine Epidemic Diarrhea Virus (PEDV) and Porcine DeltaCoronaVirus (PDCoV) in Ontario swine herds

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- Background
- Objectives
- Data Source, Processing, Analysis
- Ongoing Work
- Conclusion

Background

- PEDV and PDCoV emerged in North America in May 2013
- A year later, an estimated 7M had succumbed to PEDV

- In Canada, PEDV and PDCoV emerged in January 2014 - most cases were detected in Ontario

- Introduced via imported spray-dried porcine plasma (feed) contaminated with PEDV
- By July 2014, only 62 cases had been reported in Ontario and the outbreak was largely under control

Background

- With the success of PEDV and PDCoV elimination programs at the herd level, there is now interest at eliminating both pathogens from the Ontario swine industry
- As such, monitoring incidence and prevalence at the provincial level is of high importance
- Emphasis is on providing data analysis and information to relevant stakeholders in near-real time

Objectives

- Design approaches for efficient estimation of PEDV and PDCoV incidence and prevalence from existing sources

- Provide a weekly report with:

  - the number of new cases

  - the number and proportion of sites in a specific PEDV or PDCoV infection status in a given week

Data Source

- Data source: database for the Ontario Swine Health Advisory Board's disease control program (DCP), known as ARC&E (**A**rea **R**egional **C**ontrol and **E**limination)

- Provides herd unique identifiers, herd type, date of herd enrollment into the database, PEDV and PDCoV status of individual premises, and the date that individual premises changed their PEDV and PDCoV status

Data Processing

- Connection to the database established through ODBC (**O**pen **D**atabase **C**onnectivity **P**rotocol)
- Data imported into R using the RODBC package
- Extracted the possible values for a herd's infection status

Data Processing

TO STATUS

FROM STATUS	Presumed Positive	Confirmed Positive	Presumed Negative	Confirmed Negative
Not Available	*positive*	*positive*	-	-
Presumed Positive	-	-	*negative*	*negative*
Confirmed Positive	-	-	*negative*	*negative*
Presumed Negative	*positive*	*positive*	-	-
Confirmed Negative	*positive*	*positive*	-	-

Output was used to calculate:

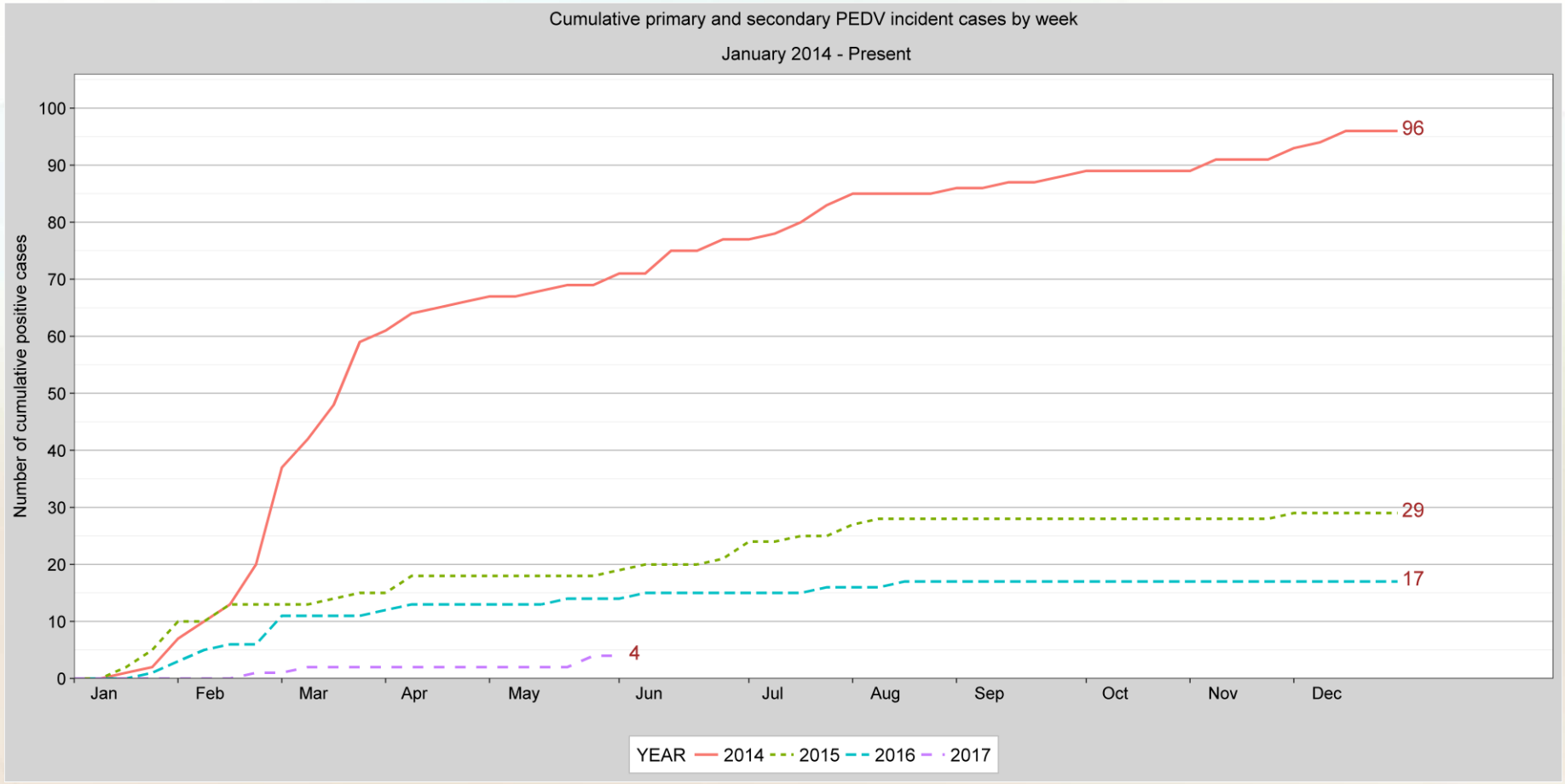
- Weekly number of herds with specific infection status
- Weekly number of new positive and negative herds
- Yearly incidence and prevalence

Data Analysis

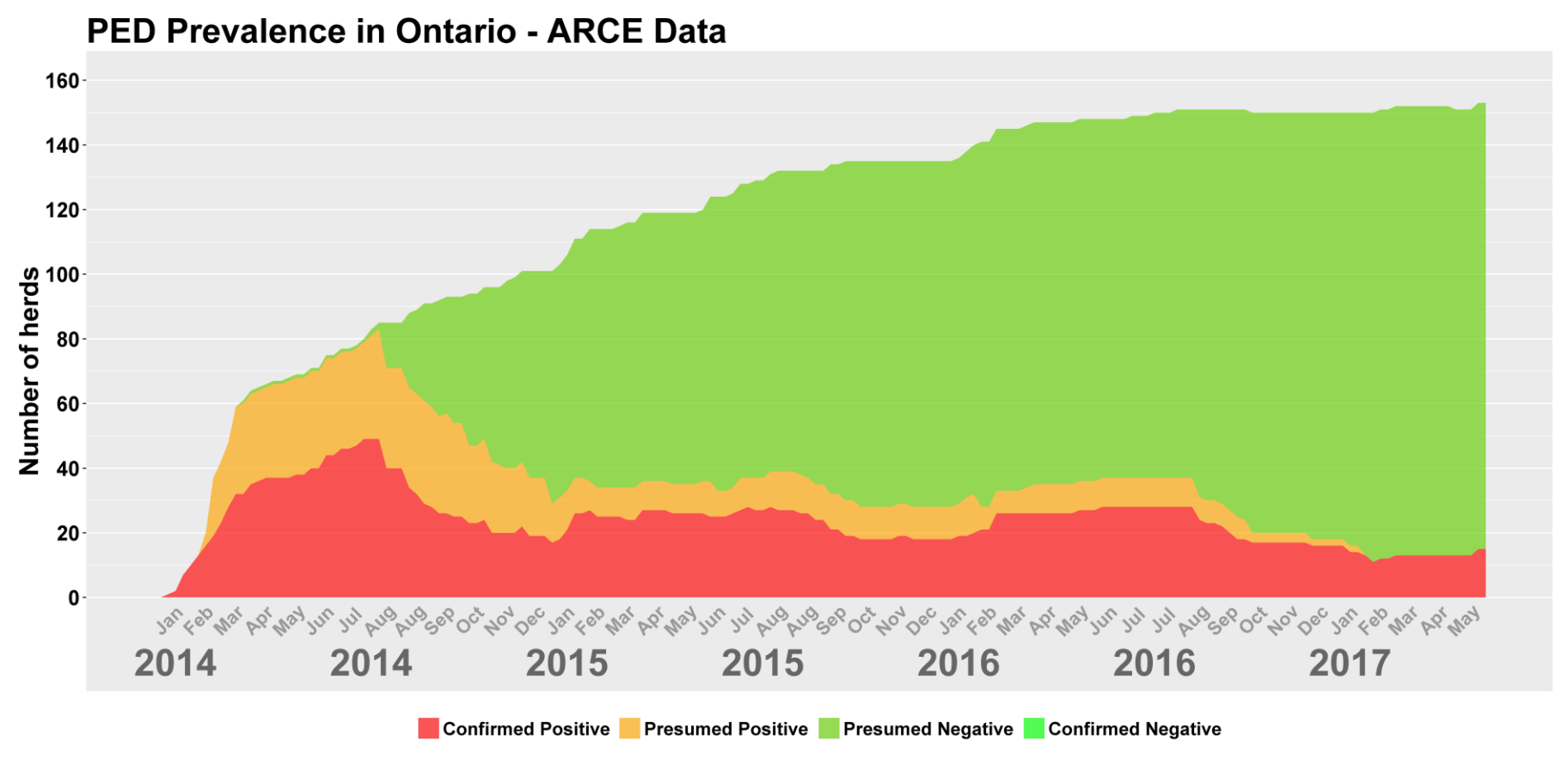
Estimated incidence risk and prevalence of PEDV and PDCoV in Ontario swine herds between 2014 and 2016

Year	Cumulative n of new cases	Incidence (%)	Number of cases at year-end	Prevalence (%)
Porcine Epidemic Diarrhea Virus				
2014	96	13.7	37	4.5
2015	29	3.0	28	2.3
2016	17	1.4	18	1.4
Porcine DeltaCoronaVirus				
2014	8	1.1	4	0.5
2015	3	0.3	2	0.2
2016	1	0.1	2	0.2

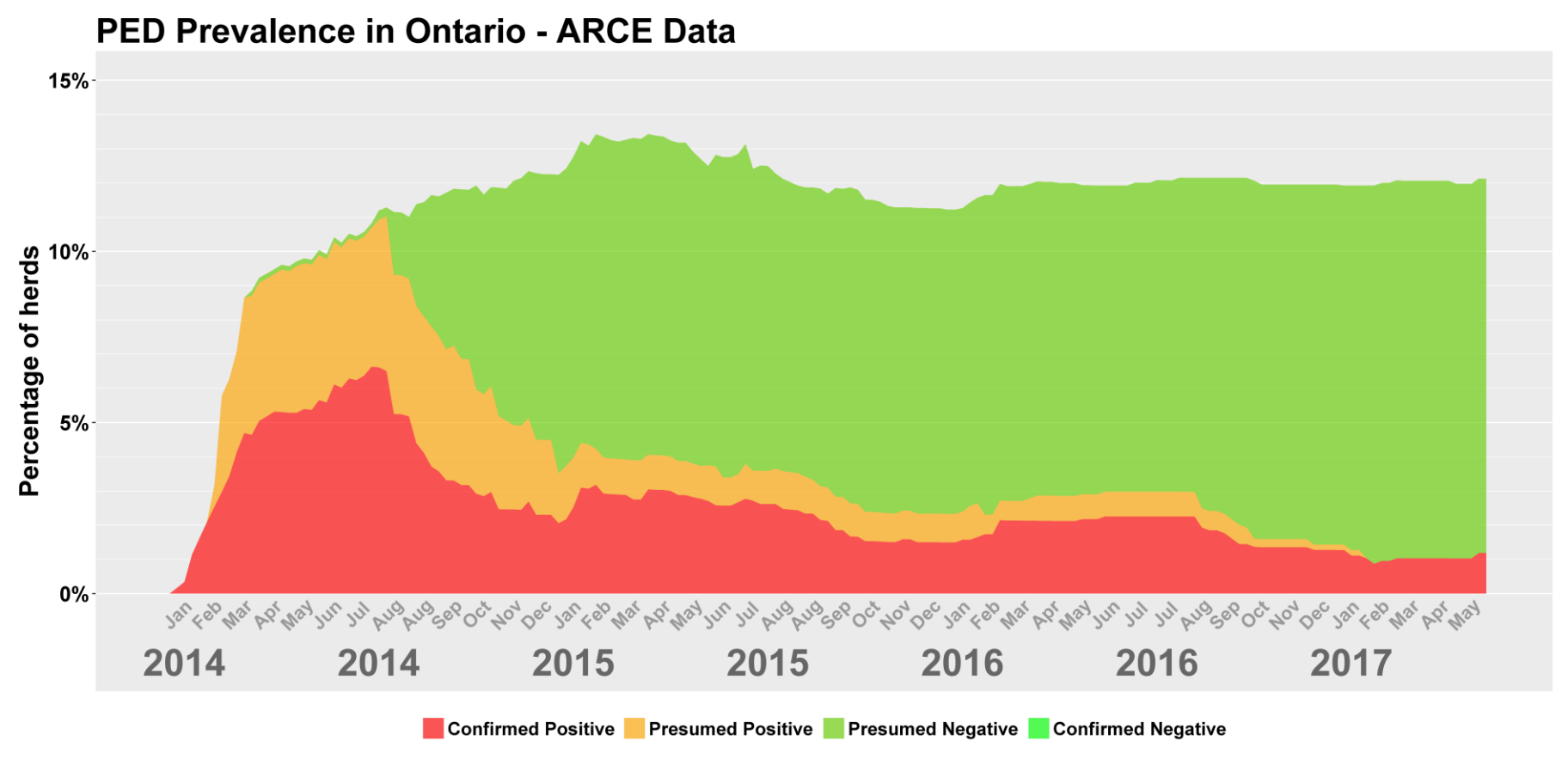
PEDV Cumulative Incidence



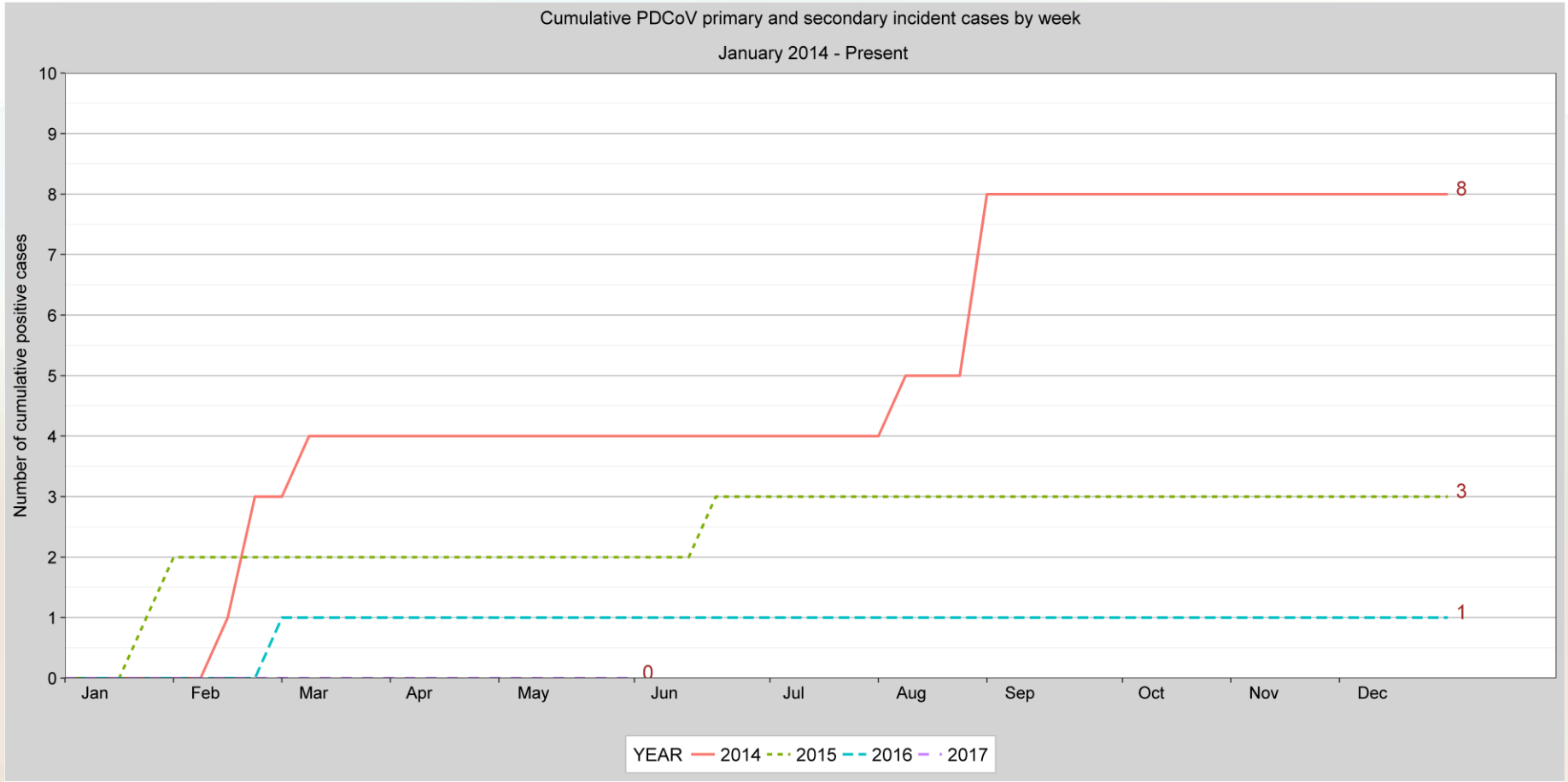
PEDV Prevalence



PEDV Prevalence (proportion)



PDCoV Cumulative Incidence



PEDV/PDCoV Dynamic Plots

PEDV Cumulative Incidence Plot (PEDV Cumulative Incidence Plot.html)

PEDV Prevalence Plot (PEDV Prevalence Plot.html)

PEDV Prevalence Plot (proportion) (PEDV Prevalence Plot (proportion).html)

PDCoV Cumulative Incidence Plot (PDCoV Cumulative Incidence Plot.html)

PDCoV Prevalence Plot (PDCoV Prevalence Plot.html)

PDCoV Prevalence Plot (proportion) (PDCoV Prevalence Plot (proportion).html)

Ongoing Work

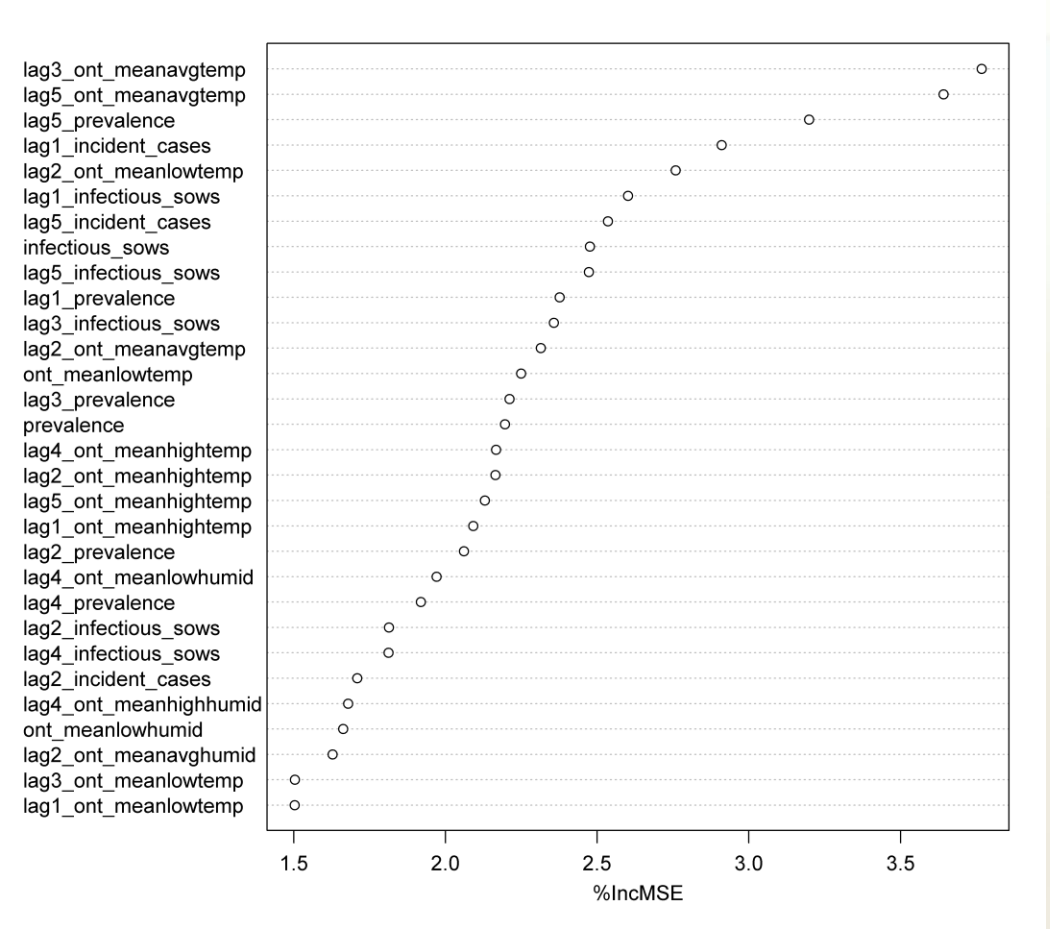
- Forecasting
  - Predict new incident cases by including environmental factors:
    - Temperature
    - Humidity
    - Precipitation
  - Identify Ontario counties with highest pig counts - http://www.omafra.gov.on.ca/english/stats/livestock/ctypigs14.htm
  - Perth, Middlesex, Huron, and Wellington counties

Ongoing Work

- Temperature, humidity, and precipitation for all 4 counties obtained from Weather Underground – www.wunderground.com
- Averaged values to obtain temperature, humidity, and precipitation values representative of Ontario
- Random Forest model:
  - Response variable = weekly incident cases
  - Independent variables = weekly prevalence, number of infectious sows, high temp, average temp, low temp, high humidity, average humidity, low humidity, precipitation
  - Independent variable lags: weekly values for the prior 5 weeks beginning 2014-01-05

Ongoing Work

Variable importance for random forest model with all co-variates (top 30 co-variates listed)



Ongoing Work

- Per the variable importance measures, temperature plays a crucial role in the number of incident cases (10 out of the 30 variables are temperature-related)

- Looking at the top 3 variables:
  - The average temperature at 3 and 5 weeks prior, in addition to the prevalence 5 weeks prior, are factors to consider in PEDV incidence

Conclusion

- In summary, simple descriptive statistics from a DCP database can be generated and analyzed in near real-time to provide:
  - Yearly measures of disease frequency (incidence and prevalence)
  - Weekly incidence and prevalence
  - Static and dynamic plots for weekly reports
  - Variables which can be inserted into a model for forecasting purposes

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