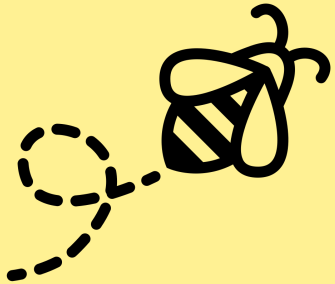


The Future of U.S. Bee Populations

A Time Series Analysis

Group 13: Brendan Hogan, Erin Ospeck, Casey Samagalsky, Celeste Sowell

Outline

- Introduction
- Data
  - Data Set
  - Analysis
- Models
  - Simple Models
  - ARIMA
  - Regression
- Conclusion

Climate and Environment

Bumblebees are dying across North America and Europe as the climate warms, scientists say

The research found a nearly 50 percent decline in the areas occupied by bumblebees in North America.

Declining bee populations pose threat to global food security and nutrition

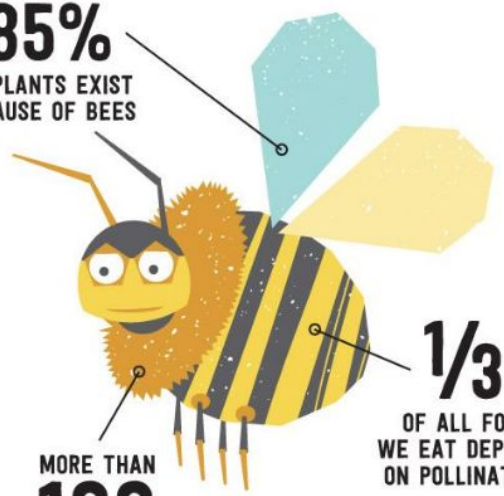
FAO urges countries to step up efforts to protect our crucial allies in fight against hunger, as it observes World Bee Day

Bumblebees are going extinct because of the climate crisis, but there are easy ways to help

By Kristen Rogers, CNN

Updated 4:33 PM ET, Wed March 18, 2020

WHY BEES MATTER



85%
OF PLANTS EXIST BECAUSE OF BEES

1/3
OF ALL FOOD WE EAT DEPENDS ON POLLINATORS

MORE THAN
100
TYPES OF CROPS ARE POLLINATED BY BEES IN THE US—INCLUDING THE CLOVER AND ALFALFA THAT FEED OUR COWS

WFM.COM/POLLINATORS

WHOLE FOODS

Goal

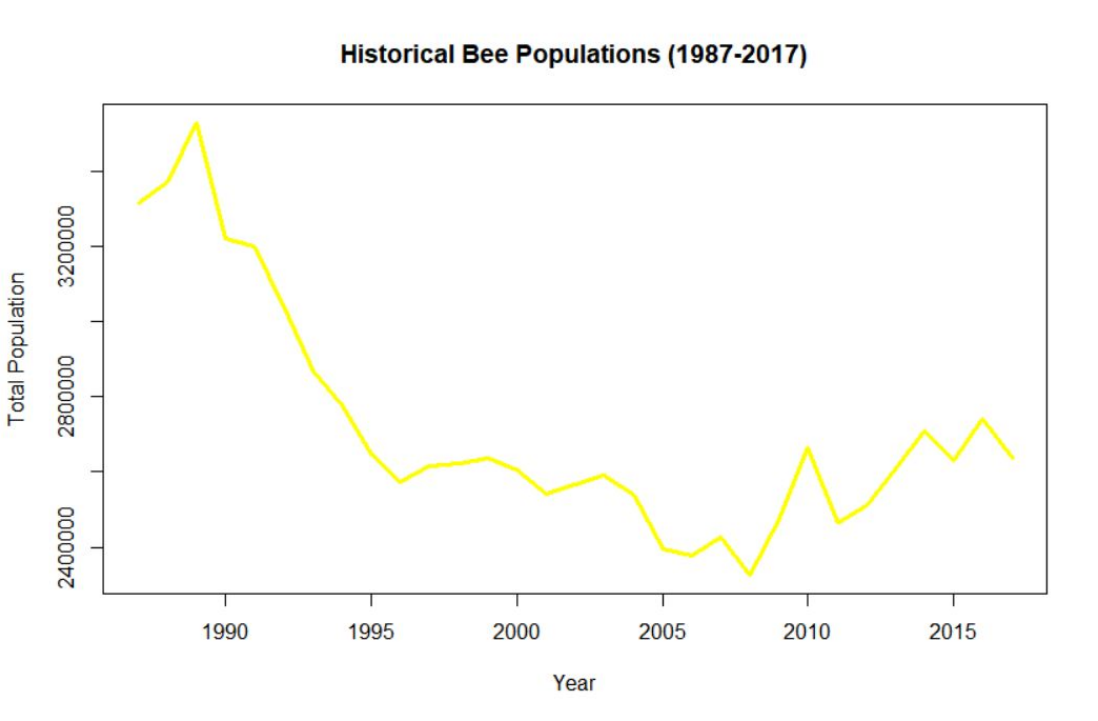
Is the bee population increasing or decreasing in the United States?

Which method works best to forecast this?

Predict: Bee Populations for 2018 and 2019

The Data

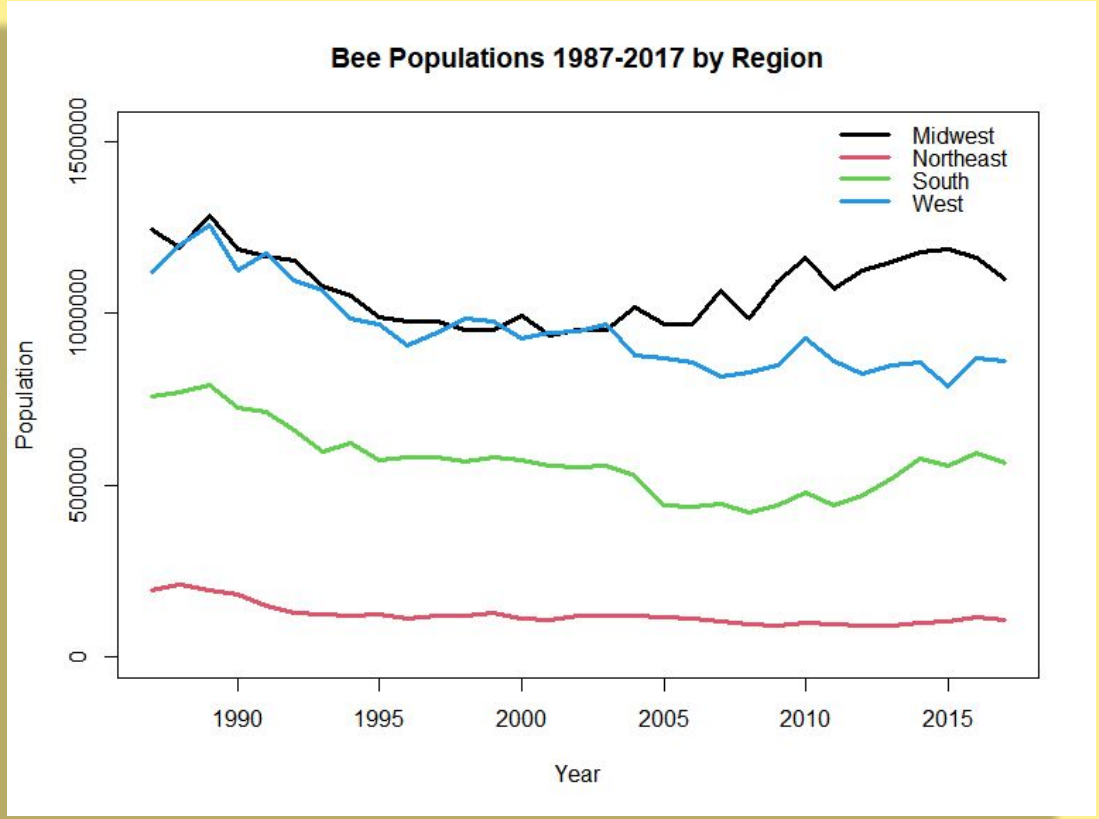
Data Set



- Bee population by state from 1987 to 2017
- Decline from 1990 to 1995

Data from U.S. Department of Agriculture

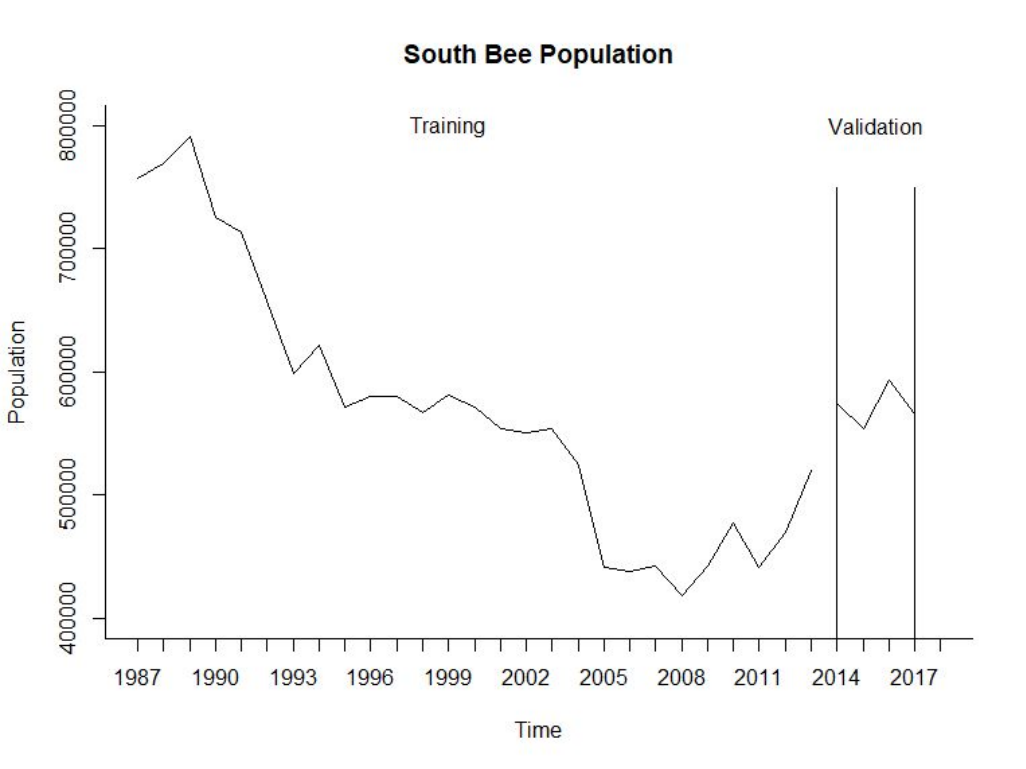
Data Transformation



- Grouped states by regions
  - Midwest
  - Northeast
  - South
  - West
- Aggregated by region

Predictive Models

Simple Methods



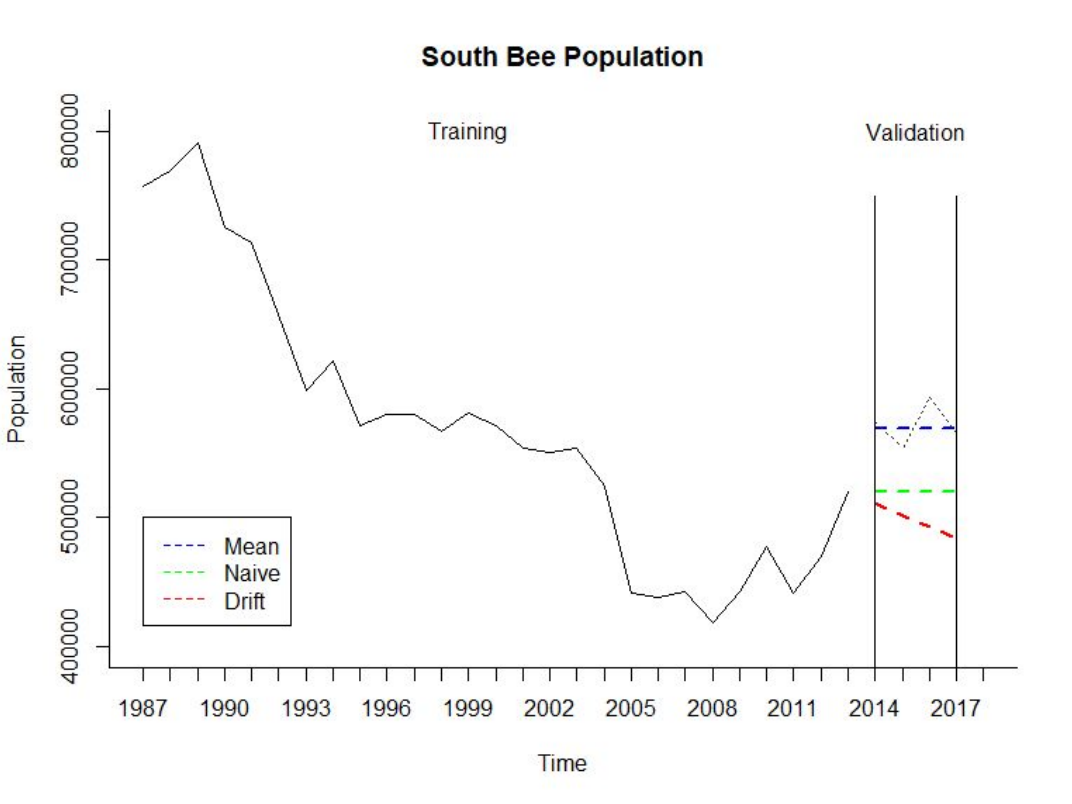
South Region

- Testing Data (1987 - 2014)
- Validation Data (2014 - 2017)

Methods

- Mean
- Naive
- Drift

Simple Methods



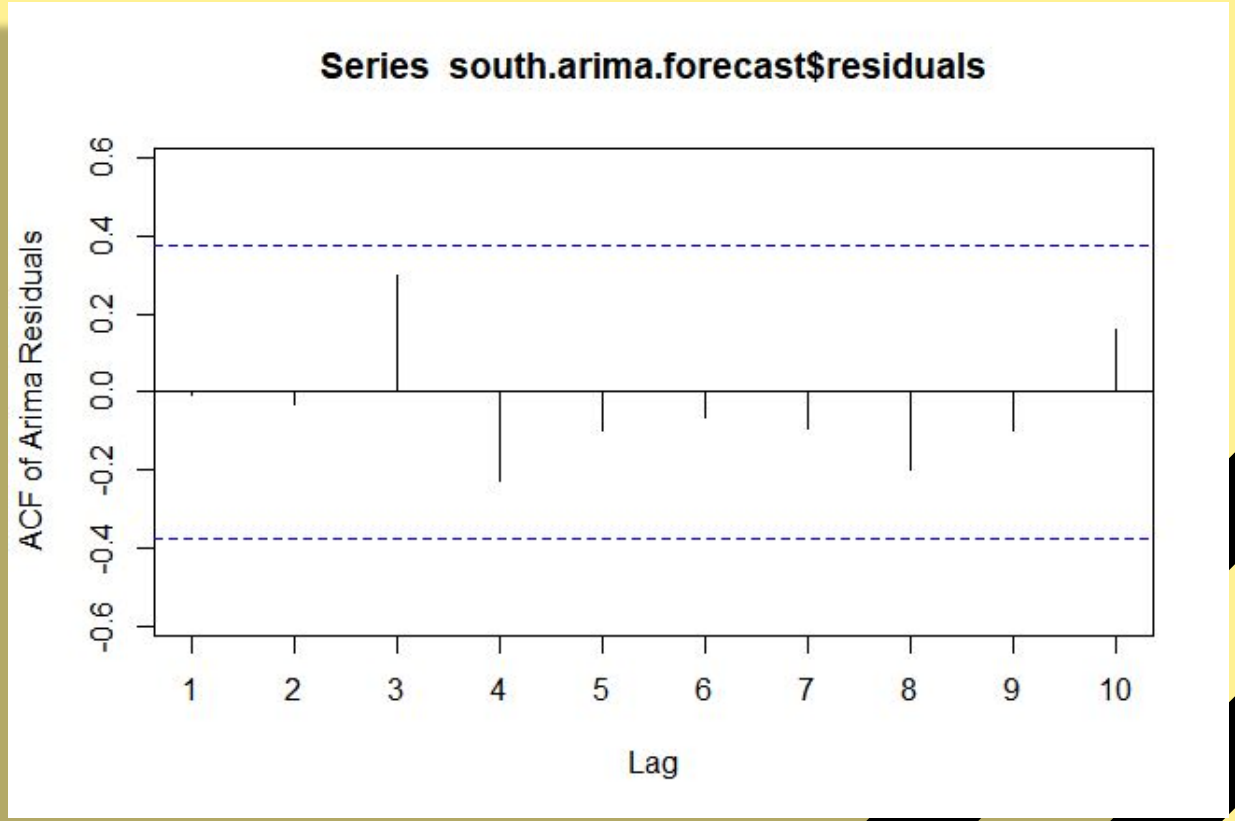
Forecasts

- Mean = 570,000
- Naive = 520,000
- Drift = 520,000 to 490,000

ARIMA

Begun with Southern Region

Autocorrelation Check:



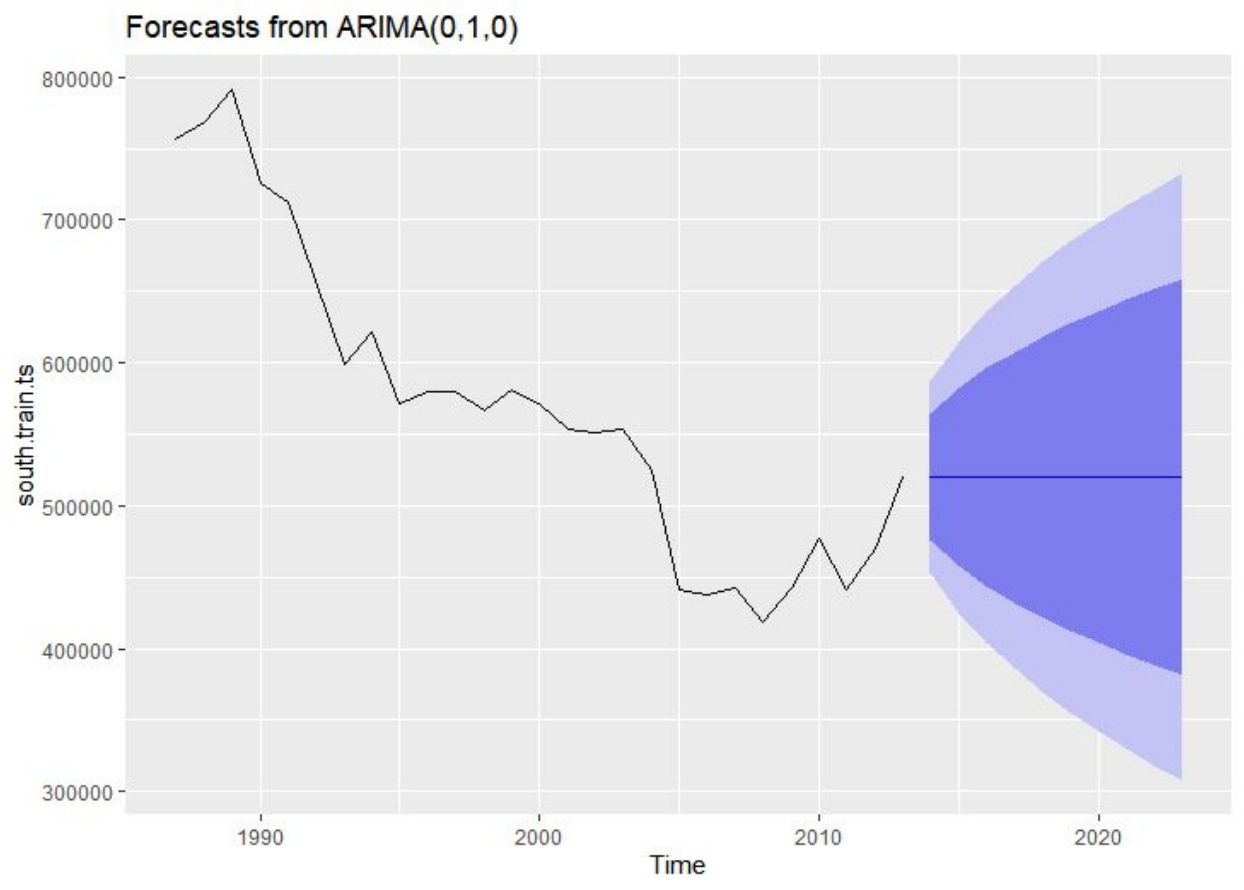
ARIMA

SOUTH

ARIMA(0, 1, 0):
INDICATES THAT OUR MODEL IS A **RANDOM WALK**

- RMSE: 53,911.97

SAME OUTPUT AS **NAIVE MODEL**

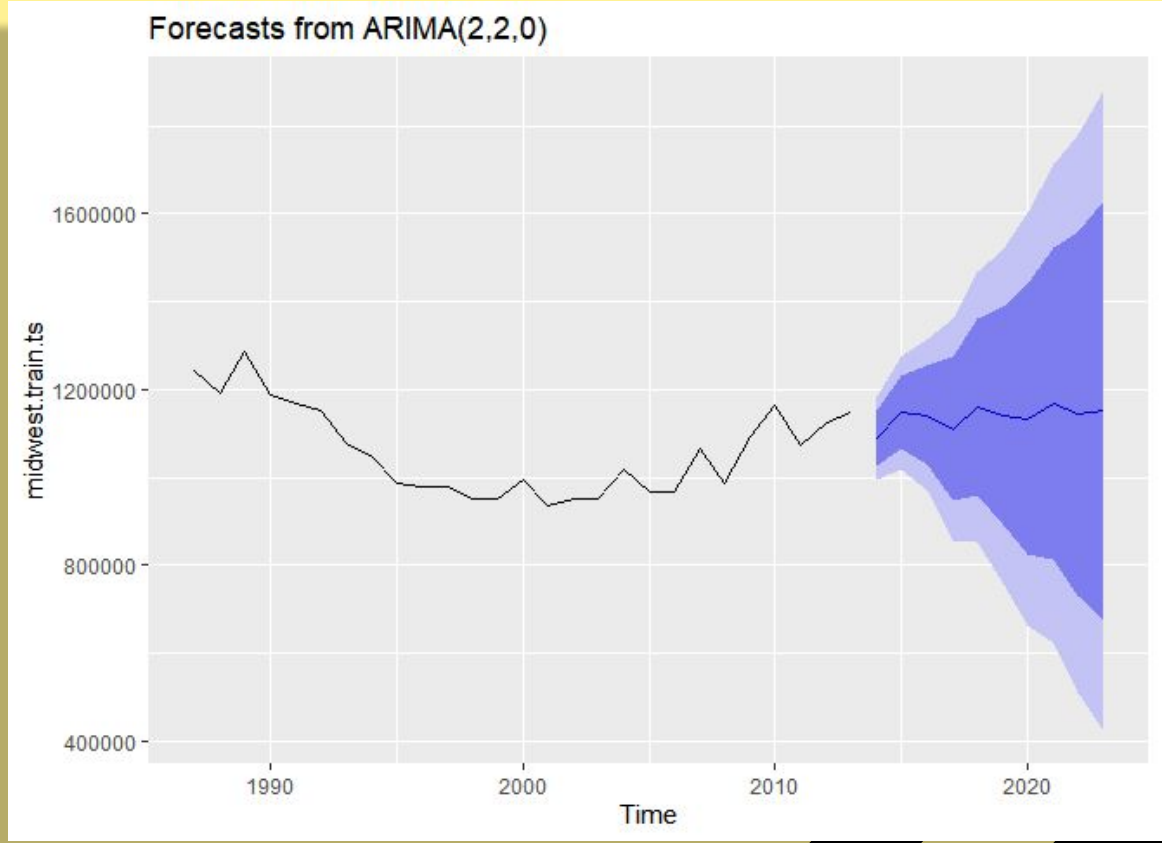


ARIMA

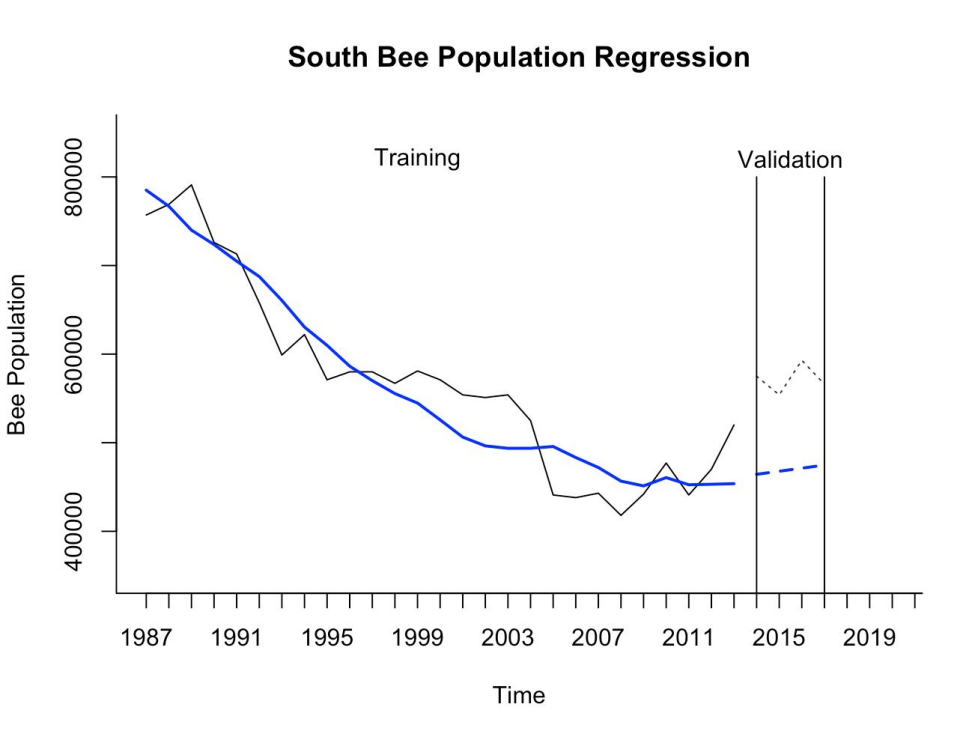
South: Random Walk
West: Random Walk
Northeast: Random walk with drift

Midwest: Not Random

- RMSE: 50,276.43



Regression

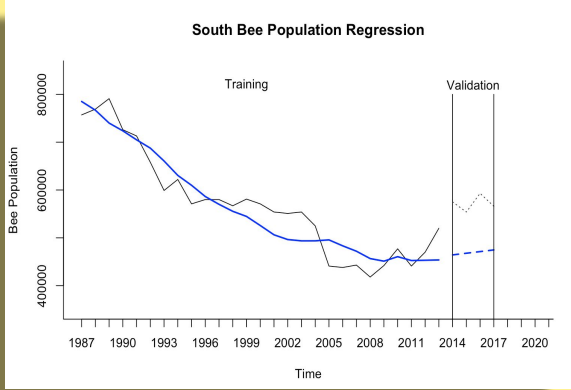


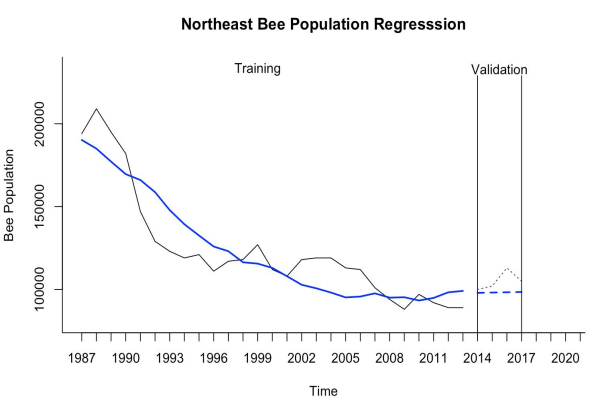
Mean Method

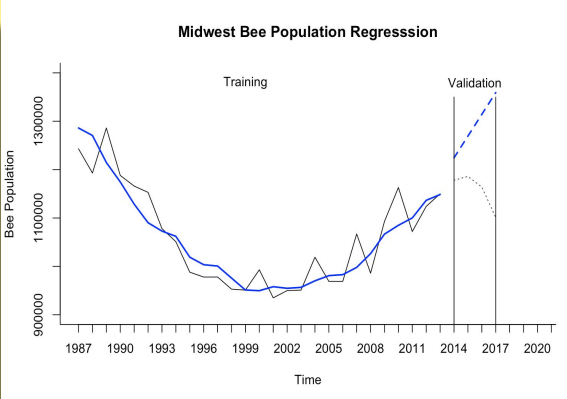
- RMSE = 103,493.93
- MAE = 102,488.58
- MAPE = 17.869

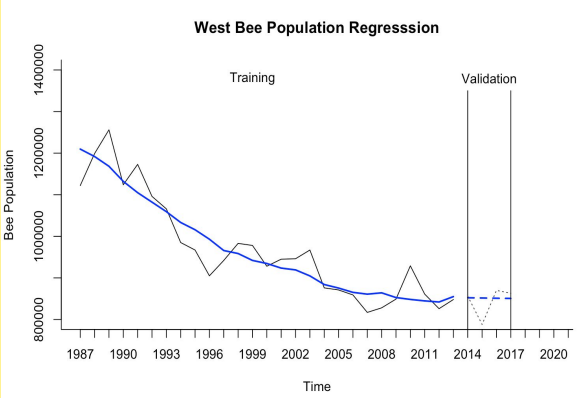
~464,000 to 475,000

REGRESSION


South Bee Population Regression
Training
Validation
Bee Population
400000
600000
800000
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Time


Northeast Bee Population Regresssion
Training
Validation
Bee Population
100000
150000
200000
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Time

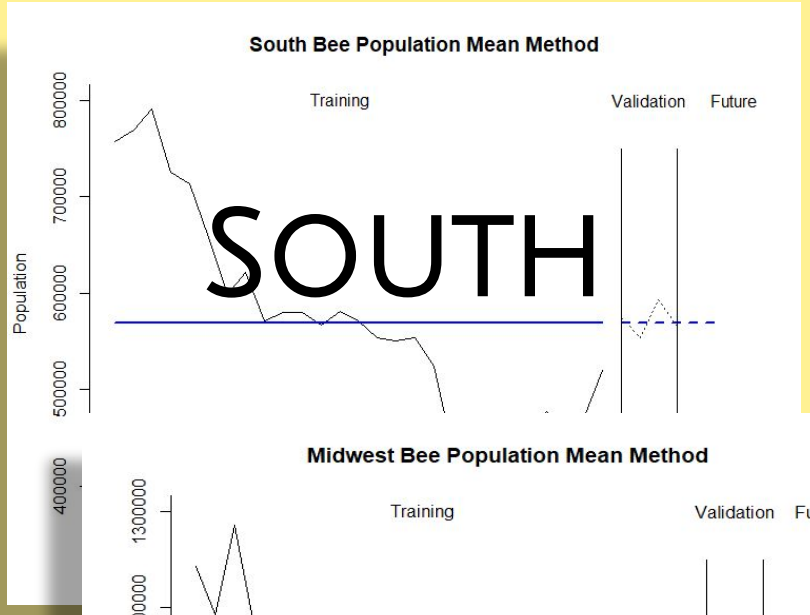

Midwest Bee Population Regresssion
Training
Validation
Bee Population
900000
1100000
1300000
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Time

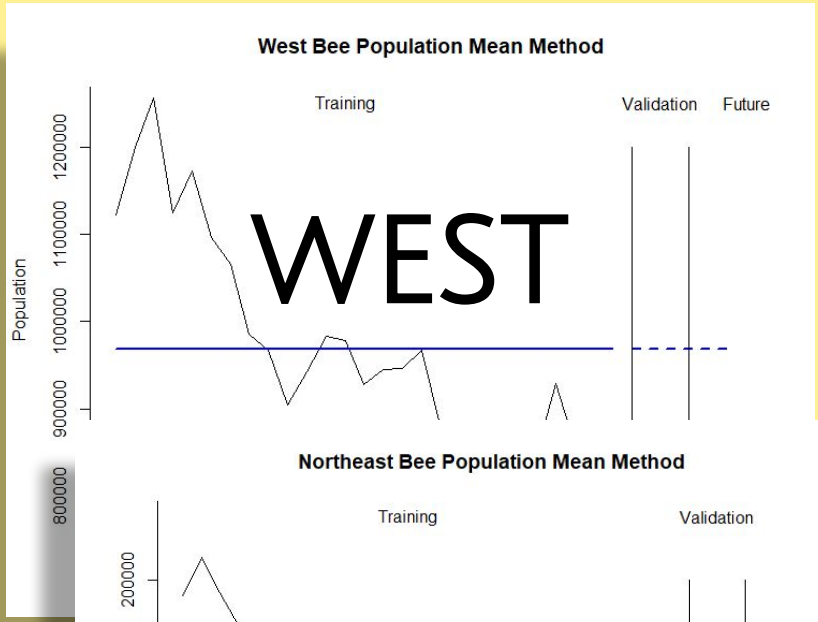

West Bee Population Regresssion
Training
Validation
Bee Population
800000
1000000
1200000
1400000
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Time

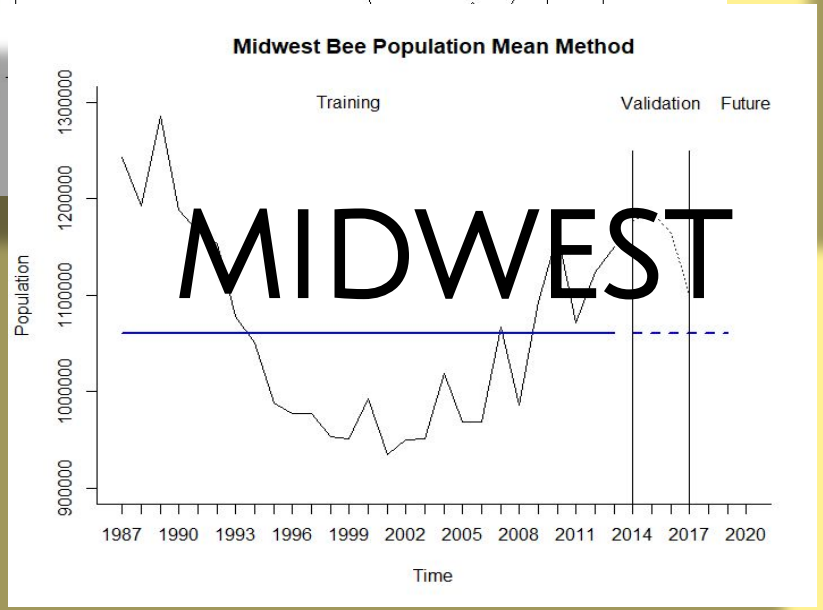
Model Results

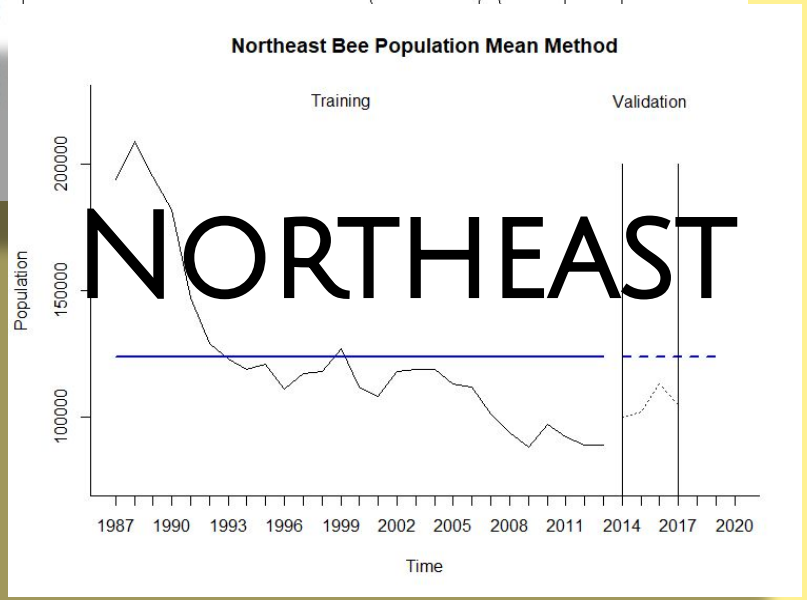
Model Errors

Model	Mean	Naive	Drift	ARIMA (South)	ARIMA (Midwest)	Regression
RMSE	14,574.32	53,911.97	76,987.16	53,911.97	50,276.43	103,493.93
MAPE	2.08	9.03	13.02	9.03	3.41	17.87
MAE	12,000.00	52,000.00	74,788.46	52,000.00	40,045.85	102,488.58


South Bee Population Mean Method
Training
Validation
Future
Population
800000
700000
600000
500000
400000
SOUTH


West Bee Population Mean Method
Training
Validation
Future
Population
1200000
1100000
1000000
900000
800000
WEST


Midwest Bee Population Mean Method
Training
Validation
Future
Population
1300000
1200000
1100000
1000000
900000
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Time
MIDWEST

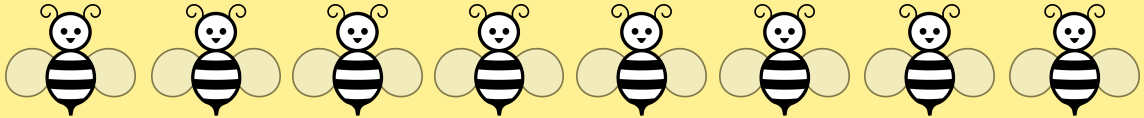

Northeast Bee Population Mean Method
Training
Validation
Population
200000
150000
100000
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Time
NORTHEAST

Forecasts

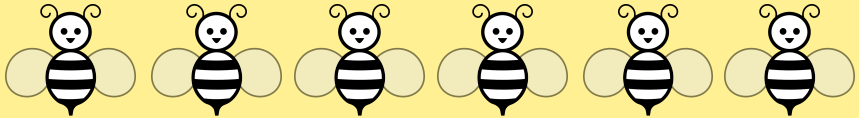
= 100,000 colonies

Midwest

West



South



Northeast

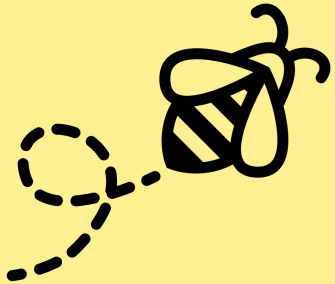
2,671,000 colonies forecasted

Conclusion

Interpretation of Forecasts

Bee populations will remain constant, and this trend is expected to continue through 2018 and 2019

RECOMMENDATION



Thank you!

Questions?

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