Comparison of bird migration In the US between peak migration in September and migration in November

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Abstract

Birdcast migration data was used to analyze migration data between September and November. The differences between the two months demonstrate the effects of temperature on migration traffic/ migration timing. Taking data from September 22 – 28, and November 9 – 15, average active radars were counted for each night and the two weeks were compared using a 2 sample t-test. The results showed that migration in the September week was significantly (p=0.000201) higher than the November week, which shows how important temperature is as a factor in determining the timing and traffic of migration.

Introduction

Migration is the response of birds to a change in seasonality and environmental periodicity (Berthold, 2001). This periodic response is affected by a variety of environmental factors such as nutrient or mating availability, predation risks, or weather changes. Studies indicated that bird migration was a widespread response even during the last ice age, adapting to the different patterns of seasonality, highlighting the plasticity of the bird migration system (Somveille, 2020). Over the last few decades, average atmospheric temperatures have increased by several degrees, with the 10 warmest years on record all occurring since 1998 (NOAA 2019). This has a significant impact on the ecology of many species including birds. Birds have been forced to adapt to the drastic climate changes which have affected temperature patterns (higher fluctuations and higher than normal temperatures), wintering sites, breeding locations, and many other aspects of their phenology. According to the Conservation of Migratory Species of Wild Animals (CMS), 84% of bird species face some threat from climate change, and many extinctions have been predicted with anthropogenic causes (Robinson, 2005). These threats have been documented in all taxa. Southern species such as Egrets have changed wintering areas in certain populations, reducing their migration distances, and changing breeding grounds. Migration barriers are also growing with increased desertification and reduced vegetation. Climate change will have important effects on biodiversity and the establishment of invasive and alien species. Populations that have not adjusted to the changing conditions have suffered significant losses due to lack of resource availability. By virtue of the complexity of a migratory bird's lifestyle, they have been used as a model for studying climate change.

The primary goal of this experiment was to determine the difference in migration between September (peak migration) and November (lower migration). To do this, Birdcast data was used to compare migration activity between the two months. Birdcast is an online project aimed at raising public awareness about the sensitivity of bird populations and predict and monitor bird migrations using weather radars. Birdcast turns weather radar data into the numbers and flight directions of birds, creating a live migration map (Birdcast, 2020). Considering September has the greatest change in seasonality and historical migration patterns, I predict that migration will be significantly higher in September, and will drop in November.

Methods

Data collection

Birdcast archives migration data from the US weather surveillance radar network between sunset to sunrise relative to the Eastern time zone. Data is available from 2018/03/20 and is updated daily. I collected Data from September 22-29 2020, and November 2 – 9 2020. The data counted was the average number of active radars that detected migration movement. The species detected are mainly nocturnal migrators, which composes a large portion of bird species.

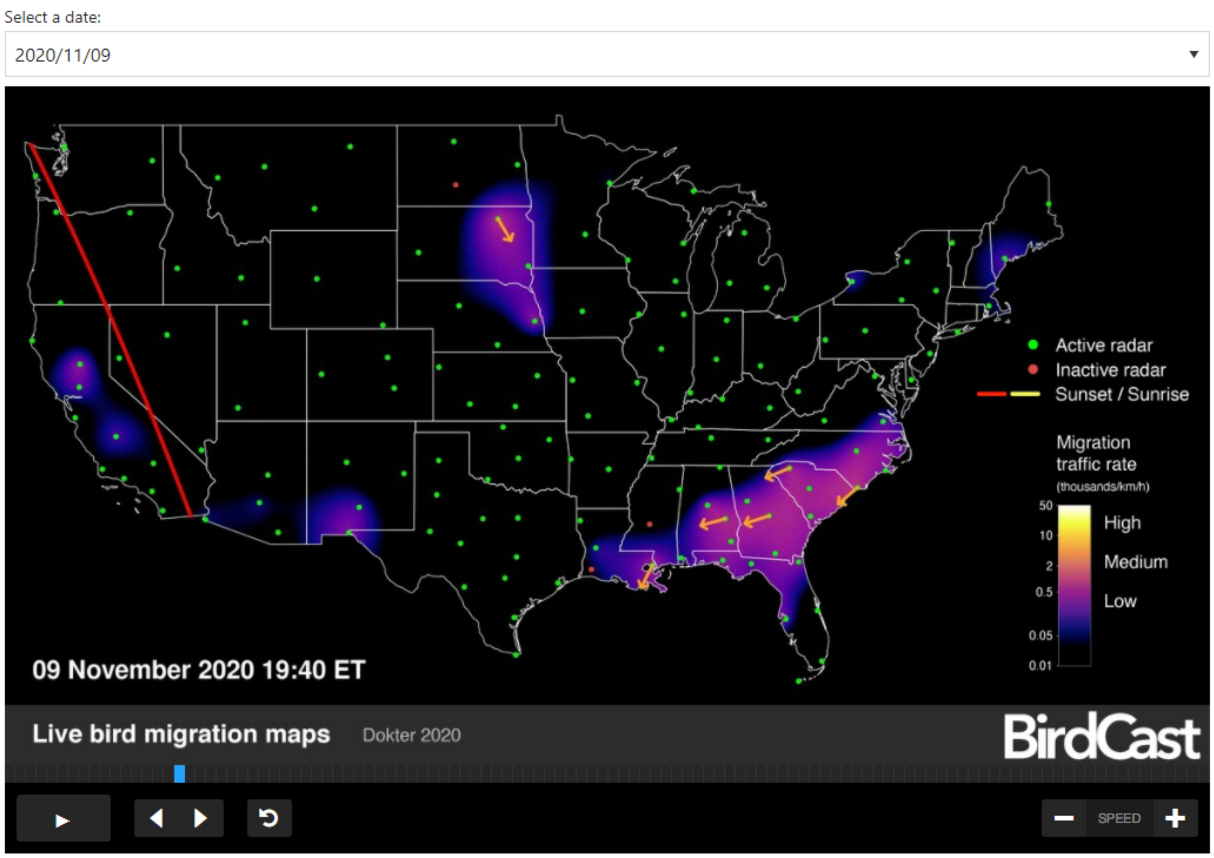

Figure 1. Birdcast Live Bird Migration Map for November 9, 2020.

As shown in Figure 1, radar data is collected every 10 minutes from sunset to sunrise. Active radars are shown in green, and when it encounters bird migration traffic, an arrow showing the migration direction is shown. Each day's information was calculated into an average number of active radars that collected migration information, and data was collected for 1 week in each month of interest.

Data Analysis

The collected data shown in Figure 2 was compared using a 2 sample t-test, where the means of the data collected in September were compared to the data collected in November.

Results

September	Average Active Radars	November	Average Active Radars
22	65	9	5
23	49	10	22
24	38	11	33
25	35	12	35
26	46	13	23
27	51	14	16
28	55	15	21

Figure 2. Average number of Active Radars collecting Migration Data from September 22-28, and November 9-15 2020.

H_0: $\mu_{Sept} = \mu_{Nov}$

H_A: $\mu_{Sept} > \mu_{Nov}$

T-value Calculation

s2p = ((df1/(df1 + df2)) * s21) + ((df2/(df2 + df2)) * s22) = ((6/12) * 103.29) + ((6/12) * 102.81) = 103.05

s2M1 = s2p/N1 = 103.05/7 = 14.72

s2M2 = s2p/N2 = 103.05/7 = 14.72

t = (M1 - M2)/√(s2M1 + s2M2) = 26.29/√29.44 = 4.84

p = 0.000201

There was much higher variation in migration data for the November data set compared to the September data set. Active radars are also not evenly distributed throughout the country and some radars collect data much more often than others.

Discussion

The p-value was <0.05 and therefore I reject the null hypothesis, and the mean September migration data set was significantly higher than the November data set. Assuming Radar data is proportional to migration activity of nocturnal birds, this implies that migration traffic is significantly higher in September compared to November.

Birdcast Data

Weather radars emit radio waves from an antenna which strike nearby objects in the atmosphere. Once an emitted wave hits an object, energy is emitted in several directions, some of which is directed back towards the radar. Based on the movement of the returning wave, the object's size, distance, and direction of movement can be analyzed. All modern weather radars are doppler radars which take advantage of the Doppler effect to determine precipitation (Figure 3)

Doppler radar sends the energy in pules and listens for any returned signal.

Figure 3. A weather radar emits a radio wave and waits for a return wave to determine the object. (https://www.weather.gov/jetstream/how)

Dual polarization waves give another dimension of data, which allows radars and ornithologists to detect the movement of birds, and distinguish other weather data from migration data. While there have been advancements in radar technology, radar data must still be analyzed using algorithms. Errors in analysis include information from aircraft, meteorological objects such as rain, hail or clouds, as well as ground clutter, which may skew the data for bird migration.

The next generation radar system (NEXRAD) has 143 radar sites in the continental US, however they are not evenly distributed. Due to topographical features (mountains and hard to reach areas), some areas are uncovered by radars. Algorithms must compensate for this as well as other limitations for radar differences (US Department of Commerce, 2019)

September vs November Temperature and Seasonality Differences

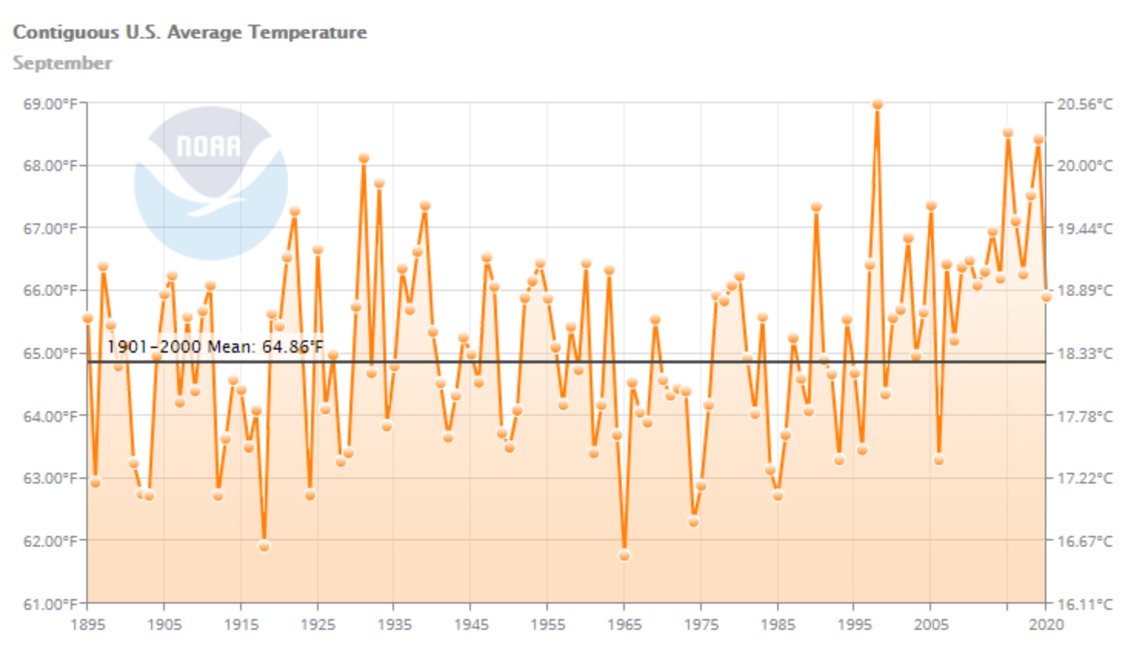

Figure 4. Average Temperature in September for the Contiguous US.

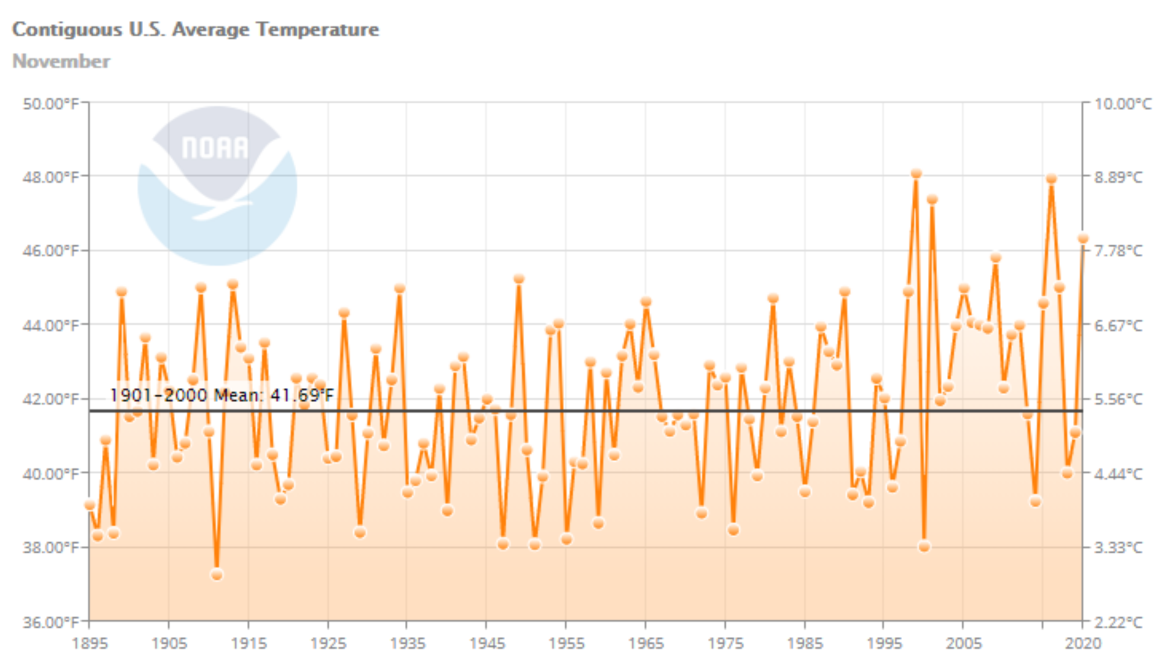

Figure 5. Average Temperature in November for the Contiguous US.

Figures 4 and 5 show the upward trend in average temperatures for both September and November over the last hundred years, with average temperatures in September higher than temperatures in November. In the US for 2020, the average temperature in September was 66 degrees F, while in November, it was 41.2 degrees F (NOAA, 2020).

Historical Migration Patterns

Most studies agree that migration will respond to temperature change or climate indices which include several climate factors (temperature, precipitation, wind, etc). While some species may follow endogenous rhythms or other ecological factors such as breeding habitats and feeding regimes, temperature is significantly correlated with migration timings, with several species migrating earlier in warmer years (Miller-Rushing, 2008).

Conclusion

There is a significant decrease in bird migration in the continental US in November compared to September. Migration often occurs throughout August to December, and seasonality play a large role in determining migration patterns. The decrease in bird migration demonstrates that temperature changes are also a significant factor and that climate changes will have large impact on the global bird migration system.

Citations

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