An Analysis of the Ranges of Invasive Bird Species Across New Jersey

Abstract

In New Jersey, invasive bird species include the mute swan, house sparrow, house finch, European starling, and brown-headed cowbird. As of 2022, all these species are widespread and terrestrial besides the mute swan, which is emerging and freshwater. For all of these birds, there has been a drastic downturn in the number of sightings between 2021 and 2022. The average percent decrease between all the different invasive bird species analyzed from 2021 to 2022 is 76.79%. However, it is odd that none of the species investigated have data collected before 2021 besides the brown-headed cowbird. One may consider that the total number of active bird watchers may have decreased between 2021 and 2022, but this is not the case: there are 97,000 more "eBirders" in 2022 than in 2021. It may also be considered that the downturn in sightings is most likely due to efforts to control the populations of these invasive bird species. However, although the New Jersey government has pursued many options for reducing the populations of invasive bird species that are humane and efficient, none have been very effective. Most likely, the steep downturn in sightings is due to avian influenza, a disease that has been found in wild New Jersey birds since 2022. However, although the invasive species' population downturn is beneficial, this disease also affects native birds, which is problematic.

Introduction

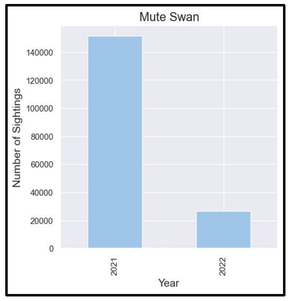
An invasive species is a non-native organism in an ecosystem that causes economic and/or environmental harm (Burgos-Rodríguez & Burgiel, 2019). Invasive species are one of the most significant threats to ecosystems, human health, animal health, plant health, infrastructure, food production, military readiness, the economy, and cultural resources (**Figure 2**) (Burgos-Rodríguez & Burgiel, 2019). Due to these extensive impacts, most governments attempt to prevent invasive species from being introduced, established, and spread (Burgos-Rodríguez & Burgiel, 2019). Furthermore, most governments will try to rid ecosystems of invasive species through many eradication and control methods (Burgos-Rodríguez & Burgiel, 2019).

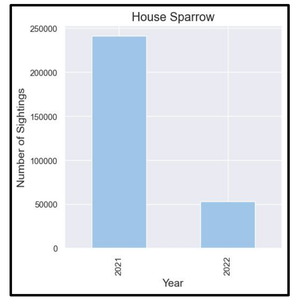
In New Jersey, invasive bird species include the mute swan (*Cygnus olor*), house sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), European starling (*Sturnus vulgaris*), and brown-headed cowbird (*Molothrus ater*) ("2022 Invasive Species List," 2022). As of 2022, all these species are widespread and terrestrial besides the mute swan (*Cygnus olor*), which is emerging and freshwater ("2022 Invasive Species List," 2022). The New Jersey Invasive Species Strike Team (NJISST) Threat Code for the mute swan (*Cygnus olor*) is high, house sparrow (*Passer domesticus*) is mild, house finch (*Carpodacus mexicanus*) is mild, European starling (*Sturnus vulgaris*) is moderate, and brown-headed cowbird (*Molothrus ater*) is high ("2022 Invasive Species List," 2022). None of these species have an Early Detection of and Rapid Response Action Code besides the mute swan (*Cygnus olor*), whose code is one ("2022 Invasive Species List," 2022).

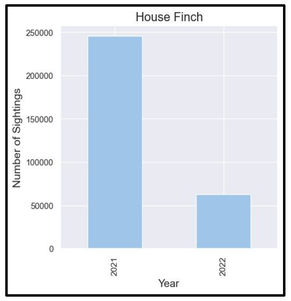
Methodology

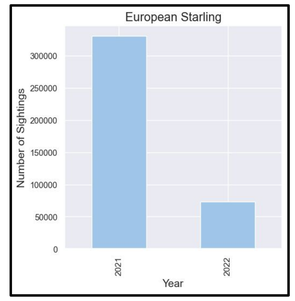
1. Download House Finch eBird data for each species in New Jersey (*Use EBird Data and Tools*, n.d.).
2. Analyze each of these bird's files in Python using pandas, seaborn, and Matplotlib (**Figure 1**):
   a. Read the bird's comma-separated values file into a data frame.
   b. Create a new column consisting of the year the bird was observed.
   c. Remove rows that were observed in 2023.
   d. Create new comma-separated values files for each year the bird was observed.
   e. Create a bar plot that compares the number of sightings of the bird each year.
3. Create a new ArcGIS Pro file.
4. Create a new map for each year and each bird.
5. Download New Jersey County Boundaries shapefile (NJ OGIS, 2022).
6. Analyze the eBird data for each year and each bird in ArcGIS Pro (**Figure 3**):
   a. Insert New Jersey County Boundaries shapefile into a map in the file.
   b. Use the Dissolve Boundaries tool on the New Jersey County Boundaries layer to make an outline of New Jersey.
   c. Insert the bird's comma-separated values file for the year being analyzed.
   d. Run Display XY Data on the table.
   e. Edit the symbology on the layer created and make it a heat map.

Objective: To create map profiles of the ranges and sightings of invasive birds in New Jersey.









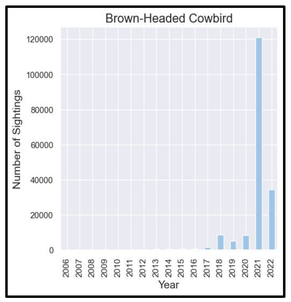


Figure 1: Five graphs were created using the Python programming language and the pandas, seaborn, and Matplotlib Python packages. Pandas is a powerful, fast, and flexible data manipulation and analysis tool (*Pandas*, n.d.). Seaborn and Matplotlib are dynamic data visualization tools (*Matplotlib: Visualization with Python*, n.d.). Seaborn is built on Matplotlib and includes many additional features (*Seaborn: Statistical Data Visualization*, n.d.). The graphs created show the number of sightings of each bird reported in New Jersey in the given year (*Use EBird Data and Tools*, n.d.). All the birds other than the brown-headed cowbird do not have data before 2021. There were 151,377 sightings of the mute swan (*Cygnus olor*) in 2021 and only 26,589 in 2022. There were 240,997 sightings of the house sparrow (*Passer domesticus*) in 2021 and only 53,170 in 2022. There were 245,356 sightings of the house finch (*Carpodacus mexicanus*) in 2021 and only 62,831 in 2022. There were 330,538 sightings of the European starling (*Sturnus vulgaris*) in 2021 and only 73,212 in 2022. From 2006 to 2022, the brown-headed cowbird (*Molothrus ater*) had sightings as follows: 10 in 2006, 4 in 2007, 89 in 2008, 98 in 2009, 94 in 2010, 204 in 2011, 305 in 2012, 709 in 2013, 789 in 2014, 829 in 2015, 877 in 2016, 1,701 in 2017, 8,866 in 2018, 5,094 in 2019, 8,538 in 2020, 120,874 in 2021, and 34,612 in 2022. It is clear that for all of these birds, there has been a drastic downturn in the number of sightings between 2021 and 2022. However, it is odd that none of the species analyzed have data collected before 2021 besides the brown-headed cowbird (*Molothrus ater*). To the right of each graph is an image of the bird being analyzed. Each of these birds is different in appearance, which makes sense as none of them share a family (Schoch et al., 2020). The first taxonomic rank that all these birds share is their infraclass, *Neognathae* (Schoch et al., 2020).

Discussion

In conclusion, over the past two years, the number of sightings of invasive bird species in New Jersey has drastically decreased. In particular, the average percent decrease between all the different invasive bird species analyzed from 2021 to 2022 is 76.79%. However, it is unclear why there has been such a drastic downturn in the sightings of these bird species. One may consider that the total number of active eBird users or bird watchers may have decreased between 2021 and 2022, but this is not the case. In 2021, more than 723,000 active "eBirders" submitted over 192 million bird observations (Team eBird, 2021). In comparison, in 2022, more than 820,000 active "eBirders" submitted over 225 million bird observations (Team eBird, 2023). The idea that there were fewer eBird users or bird watchers in 2022 than in 2021 is unfounded.

Another possible reason for this downturn in sightings is the many options for reducing the populations of invasive bird species in New Jersey that the New Jersey Invasive Species Council has pursued (Clef, 2009). All of the techniques the government attempts to use are humane and efficient (Clef, 2009). In particular, there have been many efforts to control the mute swan (*Cygnus olor*) population in New Jersey by making it a game bird (Clef, 2009). However, these efforts have not succeeded (*Waterfowl and Migratory Birds in New Jersey*, 2023). Despite this, it is possible that some hunters knowledgeable of the status of the mute swan (*Cygnus olor*) as invasive still kill the bird when they see it. Incidents like this could occur with other invasive birds as well. Although the mute swan (*Cygnus olor*) is not a game bird, there are still occasions where they are euthanized in New Jersey (Zoppo, 2021).

Most likely, the steep downturn in sightings is due to highly pathogenic avian influenza (HPAI) (*Frequently Asked Questions: Highly Pathogenic Avian Influenza (HPAI)*, n.d.). This disease, H5N1, has been sighted in wild New Jersey birds since February 2022 (*Frequently Asked Questions: Highly Pathogenic Avian Influenza (HPAI)*, n.d.). However, although the population downturn of these invasive species is beneficial, this disease also affects native birds which is problematic.

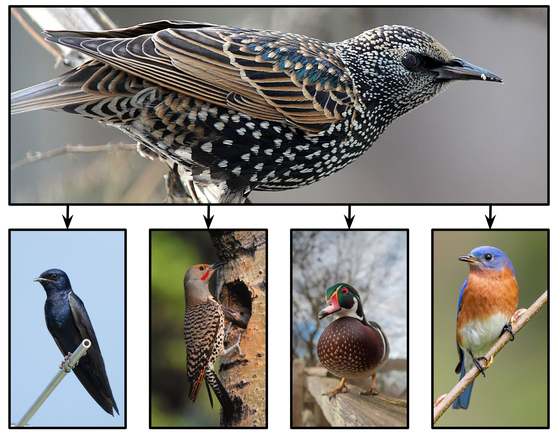


Figure 2: The European starling (*Sturnus vulgaris*) pictured at the top is an invasive species that take over the nesting sights of many native songbirds all across the United States of America (*European Starling (Sturnus Vulgaris)*, n.d.). In New Jersey, the birds affected include purple martins (*Progne subis*), northern flickers (*Colaptes auratus*), wood ducks (*Aix sponsa*), and Eastern bluebirds (*Sialia sialis*) (*European Starling (Sturnus Vulgaris)*, n.d.). These species are pictured at the bottom, respectively. European starlings (*Sturnus vulgaris*) also eat and contaminate livestock feed (*European Starling (Sturnus Vulgaris)*, n.d.).

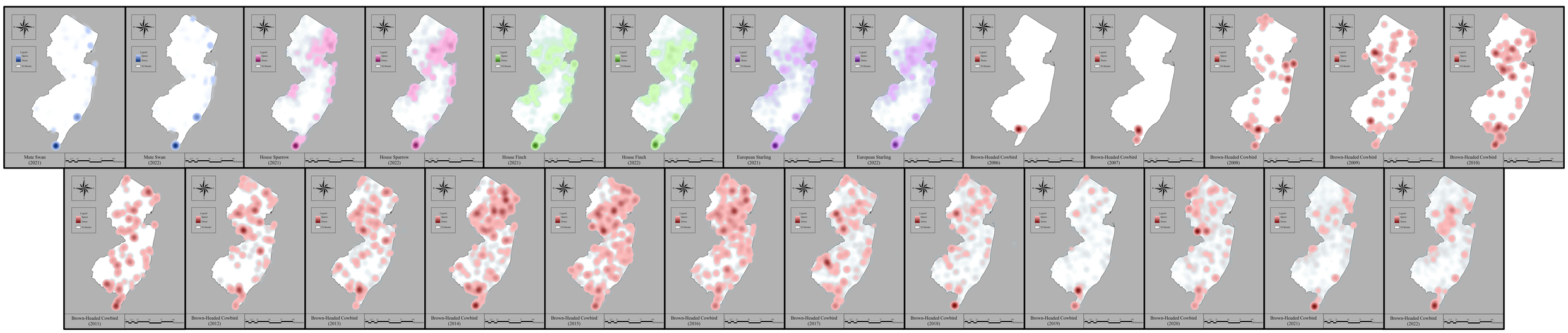


Figure 3: Twenty-five maps were created using the ArcGIS Pro application. ArcGIS Pro is a mapping software that allows users to create data visualizations, perform advanced analyses, and conduct authoritative data maintenance in numerous dimensions (two, three, or four) (*ArcGIS Pro*, n.d.). Each graph focused on a specific year of observation for an individual invasive bird species present in New Jersey. Only two maps were needed for four invasive bird species, one for 2021 and another for 2022. These four species are the mute swan (*Cygnus olor*), house sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), and European starling (*Sturnus vulgaris*). On the contrary, seventeen maps were needed for the brown-headed cowbird (*Molothrus ater*). These maps covered all of the years from 2006 to 2022. The first year of observation of the house sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), and European starling (*Sturnus vulgaris*) already showed an extensive range of the species in New Jersey. This is odd, as it would make more sense for the sightings to increase steadily. Differently, the mute swan (*Cygnus olor*) and brown-headed cowbird (*Molothrus ater*) began with a small range that expanded over time. However, although the extent of the brown-headed cowbird (*Molothrus ater*) has become widespread, the mute swan (*Cygnus olor*) is still quite limited. Regardless, this makes sense as all of these species besides the mute swan (*Cygnus olor*) are currently considered widespread ("2022 Invasive Species List," 2022). Unlike the other species, the mute swan (*Cygnus olor*) is still in the process of Early Detection of and Rapid Response ("2022 Invasive Species List," 2022). Interestingly, many bird sightings for all species are in Cape May County, indicating that this is a prime location for bird watchers, which is supported by the fact that Cape May County is a migratory haven for birds that attracts bird watchers (*Birding, Nature & Wildlife*, n.d.).