The Great Dismal Swamp: Impacts on bird populations from 1983 to present.

By, Karlie Pritchard

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INTRODUCTION: Internship project with U.S Fish and Wildlife Services, MARI and ODU

Old Dominion University, Mitigation and Adaptation Research Institute (MARI) and U.S Fish and Wildlife Services (U.S.F.W.S) developed the Conservation Leadership minor. Upon completion of the minor each student must participate in an internship with U.S.F.W.S creating their own unique project with the key elements of conservation leadership.

My internship took place at The Great Dismal Swamp National Wildlife Refuge. The Great Dismal Swamp is home to an extraordinary type of ecosystem, consisting of more than 112,000 acres of forests and marshlands, providing habitat for 210 identified bird species (U.S Fish and Wildlife Service, 2012). My project consisted of analysis of raw data taken at the bird-banding station at the refuge. The data was taken from years 1983 to 2016. The outcome goal was to compare changes in select bird species population over time, comparing them to climatic events, and water levels on the refuge. With the help of Don Schwab the former biologist at the refuge, I selected 10 species: Carolina Wren, Common Yellowthroat, Eastern Towhee, Hooded Warbler, Louisiana Waterthrush, Ovenbird, Prairie Warbler, Prothonotary Warbler, Swainson's Warbler, and the Wood thrush. These 10 species are low to ground nesters. The data was simplified between the months of April-August (breeding season for the selected species).

As an indicator species, birds indicate overall health of an ecosystem and how well it is functioning through population trends (Hill, 2017). Extreme weather events, such as prolonged frozen spells, droughts, hurricanes and increased precipitation can have

significant effects on bird populations, including long-term effects on whole cohorts (Stenseth *et al*. 2002).

The projections provided by the IPCC state that the average global temperature will rise by 0.2°C per decade. If the temperature rises 3.5 °C by 2100, this may result in 600-900 bird species extinctions (Şekercioğlu et al., pg.1-18, 2012). By identifying trends in bird populations at The Great Dismal Swamp, we can better assess the ecosystem as a whole.

DATA ANALYSIS:

I. Bird populations of selected species from years 1983-2016

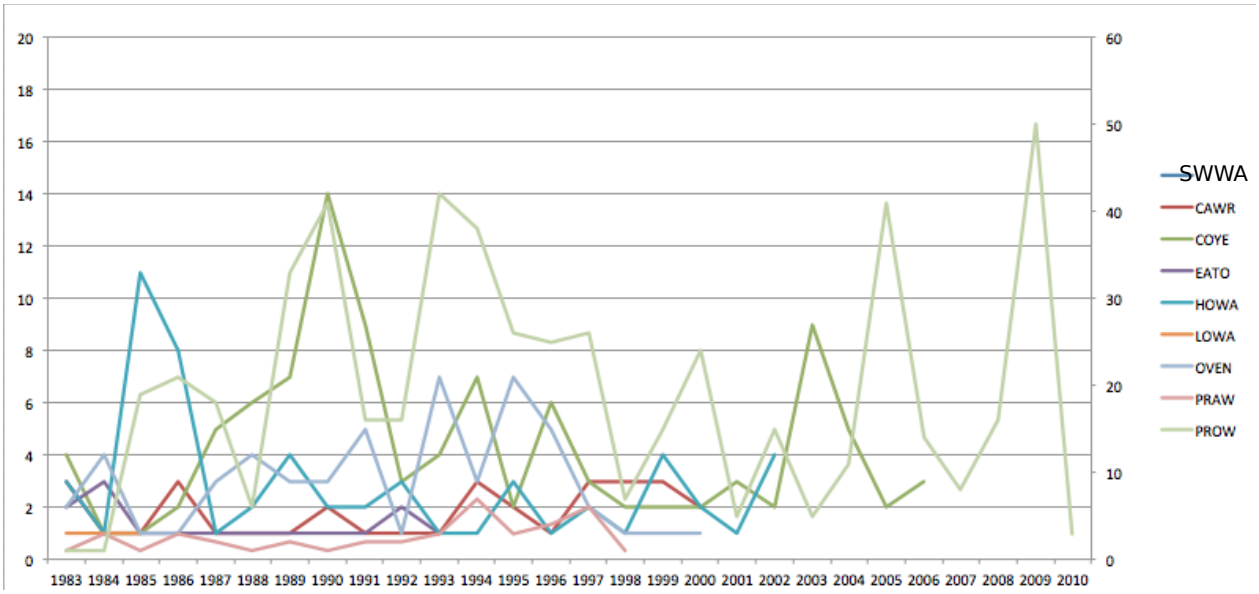


Figure 1. Cumulative chart of bird species (Prothonotary Warbler; right axis)

The figure above shows the population trends of the selected species by their productivity rate. Overall trends show peaks in the mid 1990's, declines in the early 2000's and a decrease in the sightings of many species after 2000. The Prothonotary Warbler is the light green line with the axis on the right as there is an overall larger

population of the Prothonotary warbler on the refuge. After simplifying the raw data in an Excel document a new tab was created for each species individually. In each species tab, data was further simplified to find the productivity rate of each individual species. Adult females to hatchlings measure the productivity rate. Adult females are coded as a 5 for sex and 1,5,6, or 7 for age and hatchlings male or female age code 2 (male sex code: 4). Productivity rate is the number of young produced per adult female each year; the probability of a young bird surviving to its first breeding season, and the probability that a surviving adult will return to the refuge nest site to breed the following year (NPS, 2017).

II. Temperature at The Great Dismal Swamp (1989-2016)

Effects of heat waves and cold spells on bird populations can negatively impact birds that have limited temperature variation as well as birds having low basal metabolic rates. Bird species may experience a series of physiological events due to heat waves and other climatic events (Şekercioğlu et al., pg.1-18, 2012). The figures below created via xmACIS a program recommended by Eric Seymour, (service hydrologist with the National Weather Service), show the maximum and minimum temperatures recorded in the selected months (April-August) during the past 37 years. The data shows an average for highs and lows in temperature in area since 1980, and does not suggest an overall rise in temperature from the selected years prior.

Figures 2 and 3

Minimum 4-Month Mean Min Temperature for Norfolk Area, VA (ThreadEx)

Click column heading to sort ascending, click again to sort descending.

Rank	Value	Dates	Missing Days
1	64.2	1997-05-01 through 1997-08-31	0
2	64.6	1992-05-01 through 1992-08-31	0
3	65.2	1983-05-01 through 1983-08-31	0
4	66.0	1996-05-01 through 1996-08-31	0
5	66.0	1982-05-01 through 1982-08-31	0
6	66.2	1988-05-01 through 1988-08-31	0
7	66.2	1984-05-01 through 1984-08-31	0
8	66.2	1981-05-01 through 1981-08-31	0
9	66.3	1985-05-01 through 1985-08-31	0
10	66.3	1980-05-01 through 1980-08-31	0
Period of record: 1980-01-01 to 2017-09-11			

Maximum 4-Month Mean Max Temperature for Norfolk Area, VA (ThreadEx)

Click column heading to sort ascending, click again to sort descending.

Rank	Value	Dates	Missing Days
1	86.7	2010-05-01 through 2010-08-31	0
2	86.2	2011-05-01 through 2011-08-31	0
3	86.0	1991-05-01 through 1991-08-31	0
4	85.9	1993-05-01 through 1993-08-31	0
5	85.6	1987-05-01 through 1987-08-31	0
6	85.4	1980-05-01 through 1980-08-31	0
7	85.1	1995-05-01 through 1995-08-31	0
8	84.9	1994-05-01 through 1994-08-31	0
9	84.7	2015-05-01 through 2015-08-31	0
10	84.5	2017-05-01 through 2017-08-31	0
Period of record: 1980-01-01 to 2017-09-11			

III. Extreme weather events at The Great Dismal Swamp (1989-2016)

"Global climate change is expected to result in an increased incidence of extreme weather events, such as heat waves, cold snaps, and droughts. When these events occur during the late spring and early summer, the peak breeding season for many birds in the United States, they can have detrimental effects on the reproductive success of many bird species." (Henschell, 2017).

The image created below via Microsoft Excel shows the significant hurricanes that occurred in the area at or in close proximity to the refuge from years 1979 to 2012.

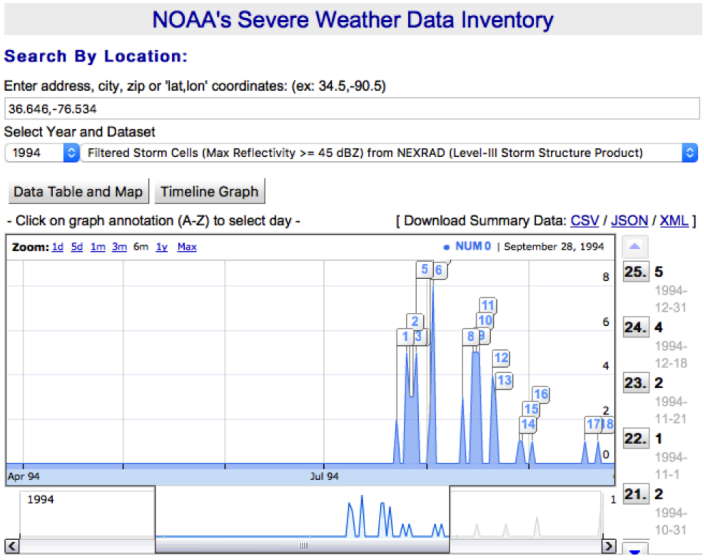
YEAR	DATE	NAME
1979	5-Sep	David
1985	25-Jul	Bob
1985	27-Sep	Gloria
1986	17-Aug	Charley
1996	7/12/13	Bertha
1996	9/5/06	Fran
1997	24-Jul	Danny
1998	27-Aug	Bonnie
1999	9/4/05	Dennis
1999	9/15/16	Floyd
2003	18-Sep	Isabel
2004	3-Aug	Alex
2004	14-Aug	Charley
2004	29-Aug	Gaston
2004	8-Sep	Frances
2004	17-Sep	Ivan
2004	28-Sep	Jeanne
2006	1-Sep	Earnesto
2009	11-Nov	Ida
2011	8/26/28	Irene
2011	8/8/09	Lee
2012	26-Oct	Sandy

Figure 4.

The hurricanes highlighted are the storms with more severe impacts in the area including, tornados, lightning strikes, extreme wind, or rain. Hurricanes can have severe impacts on the refuge as well as its bird population. In 2003 hurricane Isabel destroyed 90% of the 3,600-acre stand and flattened 80% of the refuges purest cedar stands, home to many bird species (Virginia Places, 2017). These disturbances can cause changes in vegetation and impacts on food chains causing direct impact to the population of bird species in the refuge.

With help from Eric Seymour, a service hydrologist with the National Weather Service, I was able to locate the Severe Weather Inventory Data tool provided by NOAA (https://www.ncdc.noaa.gov/swdi/#TileSearch). By searching specific years that included recorded hurricanes and other storm cells at the coordinates of the bird banding station at

the refuge, graphs were created to see extreme weather events / storm cells.



NOAA's Severe Weather Data Inventory

Search By Location:

Enter address, city, zip or 'lat,lon' coordinates: (ex: 34.5,-90.5)

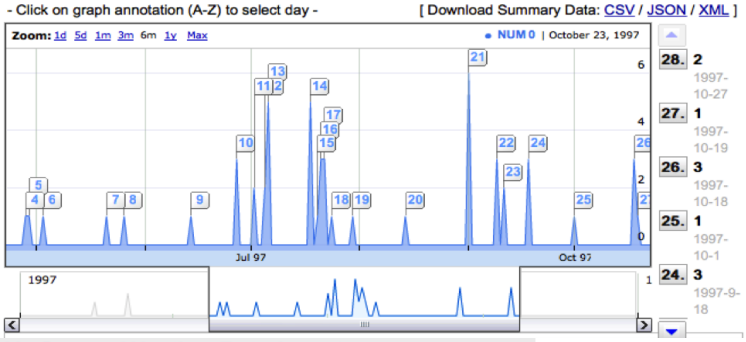
36.636,-76.545

Select Year and Dataset

1997 | Filtered Storm Cells (Max Reflectivity >= 45 dBZ) from NEXRAD (Level-III Storm Structure Product)

Data Table and Map | Timeline Graph

- Click on graph annotation (A-Z) to select day - [Download Summary Data: CSV / JSON / XML]



28. 2 1997-10-27
27. 1 1997-10-19
26. 3 1997-10-18
25. 1 1997-10-1
24. 3 1997-9-18

NOAA's Severe Weather Data Inventory

Search By Location:

Enter address, city, zip or 'lat,lon' coordinates: (ex: 34.5,-90.5)

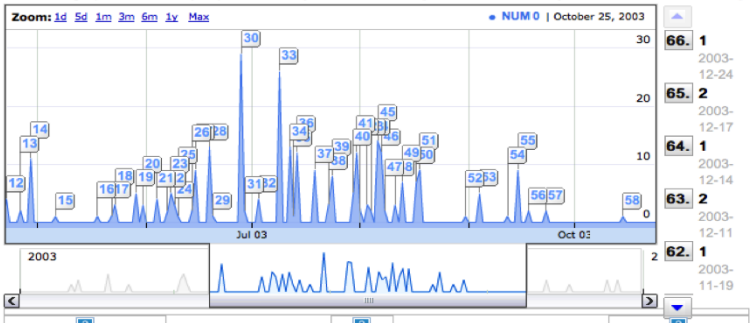
36.646,-76.534

Select Year and Dataset

2003 | Filtered Storm Cells (Max Reflectivity >= 45 dBZ) from NEXRAD (Level-III Storm Structure Product)

Data Table and Map | Timeline Graph

- Click on graph annotation (A-Z) to select day - [Download Summary Data: CSV / JSON / XML]



66. 1 2003-12-24
65. 2 2003-12-17
64. 1 2003-12-14
63. 2 2003-12-11
62. 1 2003-11-19

NOAA's Severe Weather Data Inventory

Search By Location:

Enter address, city, zip or 'lat,lon' coordinates: (ex: 34.5,-90.5)

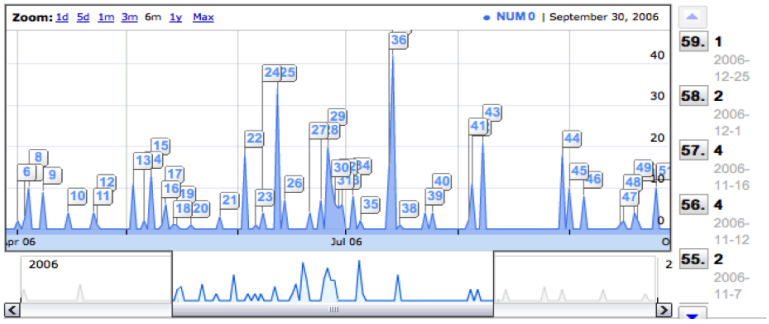
36.646,-76.534

Select Year and Dataset

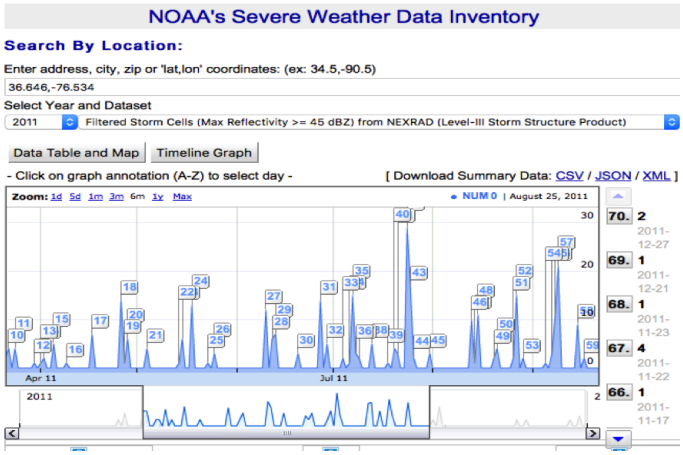
2006 | Filtered Storm Cells (Max Reflectivity >= 45 dBZ) from NEXRAD (Level-III Storm Structure Product)

Data Table and Map | Timeline Graph

- Click on graph annotation (A-Z) to select day - [Download Summary Data: CSV / JSON / XML]



59. 1 2006-12-25
58. 2 2006-12-1
57. 4 2006-11-16
56. 4 2006-11-12
55. 2 2006-11-7



Figures 5-9

The figures above show filtered storm cells at 36.646-76.534. The first figure is data from the year 1994, (first available year of data by NOAA) and the following figures show years 1997, 2003, 2006 and 2011. Each figure shows months April-October, the months significant to the collected data as well as hurricane season in Virginia. The changes observed from years 94' to 2011 show that there have been an increase in storm cells over time. As the years progressed the cells showed higher and more frequent cell systems. An increase in storms has impacted the Great Dismal Swamp by decreasing suitable and preferred trees and other habitat preferences for ground nesting birds. The impact on ground to low nesting birds nesting sites cause water inundation and foraging areas will be changed by the timing and abundance of food supplies and other resources.

IV. Management practices at The Great Dismal Swamp (1989-2016)

Hydrological practices are used to manage water levels at the refuge. The graphs below were created via Microsoft Excel using data collected by Fred Wurster and Don Schwab from years 1998-present at the Refuge. 2003 shows a peak in precipitation, due

to hurricane Isabel. An additional peak in 2004 is conclusive with the multiple hurricanes. The graph shows the time period before 2003 to have generally lower water levels, during this time the population for these bird species were at a higher rate, dropping after significant hurricanes and fires, and then increasing again after the water levels decreased.

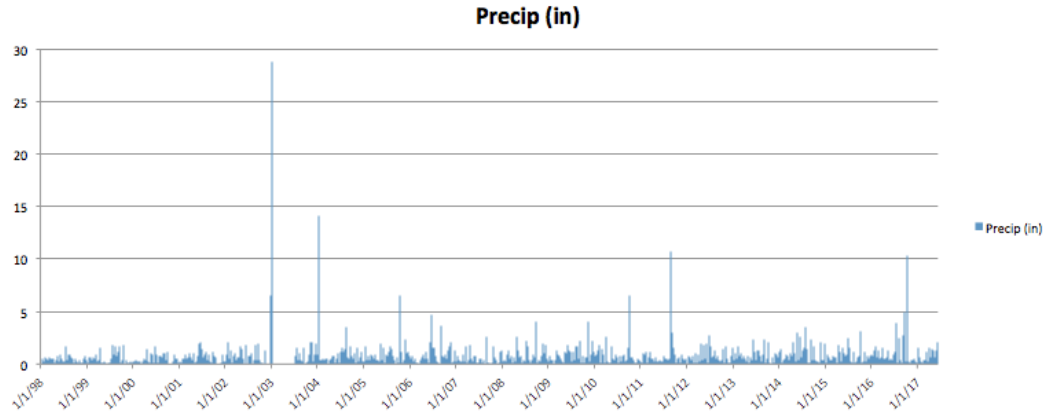


Figure 10.

HAZARDS OF BIRD POPULATIONS IN RELATION TO DATA ANALYSIS:

I. Climatic events

As shown from the data there is a decline in population in the year 2003 and 2004, significant to the impact of hurricane Isabel. 2003 and 2004 were a common low for the selected species of birds on the refuge. During this nesting season, water levels were at a peak on the refuge, at an average of 28.75 inches. The data analysis also shows impact in relation to drought, between the years 2007-2011 there was little annual rain fall in the area, this created an increase in bird populations around the bird-banding site

due to better nesting conditions. During this time period some species were affected by large wildfires occurring in other areas of the refuge.

II. Management practices

Although prescribed burns are helpful for regenerating a healthy ecosystem, wildfires can greatly affect bird populations. Studies by Olivia Sanderfoot, show that birds can be affected when a healthy bird is able to flee a fire it can suffer greatly from the effects of smoke inhalation due to the unique way that birds breath air “Unlike mammals, birds inhale oxygen, exchange it for carbon dioxide, and exhale the byproducts all in one breath; they don’t have to contract or expand their lungs repeatedly. The unique technique allows them to breathe and oxygenate at a rapid rate, which is optimal for flight.”(Shivni, 2017). After the large fire in 2008 near Corapeake ditch and 2011 near Lake Drummond, certain species showed resilience like adult Carolina Wrens, Common Yellowthroats, Hooded Warblers, Prairie Warblers and Prothonotary Warblers, while the remaining species declined. The Hydrological practices around the bird-banding site were minimal, as shown from the data provided by the refuge hydrologist. With little management for the water levels in the area of the bird-banding site, this allows the ground nesters to nest in that location when other areas of the swamp are much wetter.

VULNERABILITIES OF BIRD SPECIES IN RELATION TO DATA

CONCLUSIONS:

I. Nesting site locations

The selected species are low to ground nesters. For example, the Ovenbird builds a domed nest with a small opening on constructed of grasses, leaves and bark. The Ovenbird also constructs its nest on ground where cover is sparse. (Ovenbird. Audubon

2017). The ground nesters on the refuge have proven stable over the years in regards to little changes in hydrological practices around the bird banding station of the refuge. Measures may have to be taken in order to insure that the area is not inundated with water causing the low and ground nesters to search for a new location to nest.

II. Habitat specificities

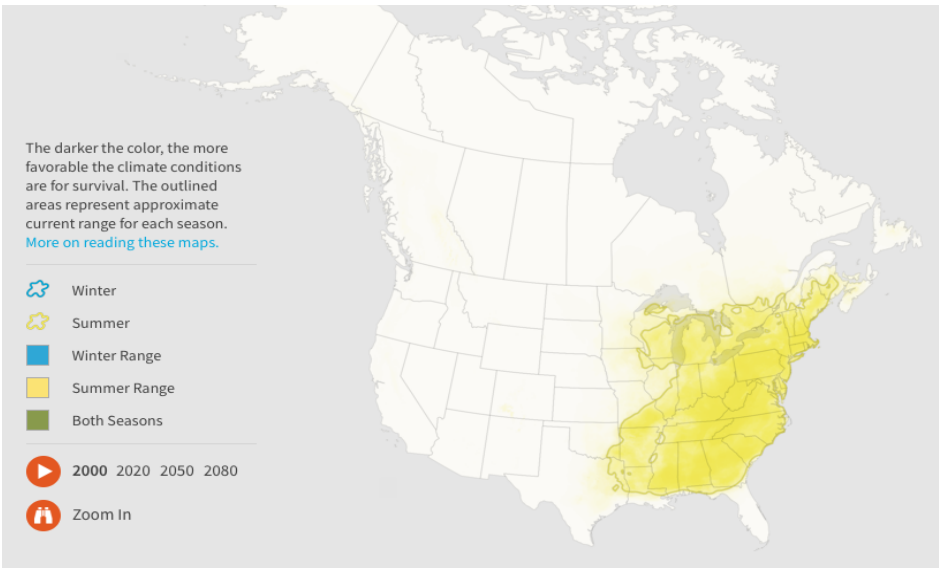
The selected species prefer habitat specifications that include damp forested areas with tall trees and low shrubs during there breeding seasons, the selected species are partial to swamps in the southern United States. The species are also migratory birds that prefer Wintering in the tropical lowland woods and mangrove swamps.

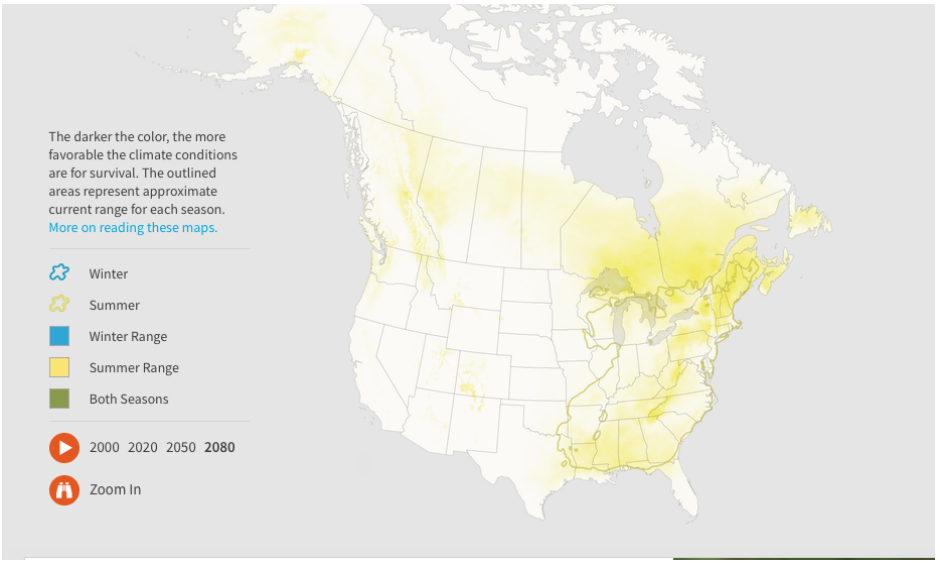
III. Biological limitations

Scientists from the Museum of Vertebrate Zoology have studied as global temperature rise phenology changes; birds are migrating and breeding earlier in order to keep their chicks from overheating in compensation to global warming. (Furuya, 2017). Jacob Socolar, an ecologist at the University of Connecticut observed more than 47,000 nests through Project NestWatch, (led by the Cornell Lab of Ornithology) studying the rate of nesting success and failure for 100-plus species around the continent. The collection of data confirmed his hypothesis: “Birds nesting in the cooler fringes of their typical range fledged more chicks as temperatures increased, while birds nesting in the warmer fringes lost more fledglings”(Furuya, 2017). Decrease in available water, insects and heat stress is all factors that can impact the physiology of birds on the refuge.

FORESIGHT FOR BIRD SPECIES POPULATION AT THE GREAT DISMAL SWAMP

For many of the selected species of birds that reside at the Great Dismal Swamp, their range will shift north over time. The Audubon society predicts that by 2080 the Ovenbird, (one of the 10 selected species) current range will have shifted north almost entirely into Canada, meaning their population will be scarce at the refuge (Ovenbird, Audubon, 2017). Audubon's projection for the Wood Thrush states "climate models project an 82 percent loss of current summer range by 2080" (Wood Thrush, Audubon, 2017). The figures below show the range and distribution for the Wood Thrush in the year 2000 compared to the range and distribution in 2080. Projections also show that only 18% of the current range is stable.


The darker the color, the more favorable the climate conditions are for survival. The outlined areas represent approximate current range for each season.
More on reading these maps.
Winter
Summer
Winter Range
Summer Range
Both Seasons
2000 2020 2050 2080
Zoom In


The darker the color, the more favorable the climate conditions are for survival. The outlined areas represent approximate current range for each season.
More on reading these maps.
Winter
Summer
Winter Range
Summer Range
Both Seasons
2000 2020 2050 2080
Zoom In

Figures 11 and 12: Future range for the Wood Thrush.

IN RELATION TO DATA CONCLUSION AND FUTURE PROJECTIONS:

I. Temperature

The data conclusion for temperature rise at the refuge from 1983 to present did not show a significant rise. As The Great Dismal Swamp is leaving the Holocene and entering the Anthropocene, we will see an increase in temperature by as much as 3.5 °C by 2100. These temperature increases may impact Migratory birds that could experience phonological miscuing if cues used to time departure from wintering habitats do not change sufficiently to allow them to arrive earlier at a spring/breading habitat (Berthold, 1990).

As stated by the Audubon society, we may see the migration of these species further north during their breeding season. During many species wintering season an increase in birds relocating to habitats further north over time will be apparent as well.

II. Climatic events

The most significant conclusion found in the data analysis was the impact of increasing climatic events, such as, hurricanes, high precipitation levels, and drought. Increasing extreme events in turn will affect populations by reducing severely and an increase in their frequency could potentially affect the viability of populations in the long term. With projections in relation to the data analysis and climate change the species predicted to further decline include, Eastern Towhee, Louisiana Waterthrush and the Common Yellowthroat, and the Hooded Warbler. These species along with the reaming species may look for more suitable habitat further inland in the future to avoid some of the impacts.

II. Management practices

Management practices at the refuge that should be considered for future projections include hydrology practices. The selected species of birds have habitat specifications that require them to nest low, as well as near water, but too much water in their habitat can create issues that will cause the birds to look for a new, more suitable nesting site. We know that these species of birds like the area around the banding site, as this is where data was collected. The refuge does not do much in terms of hydrological practices in the area around the banding site currently, or in the past. By keeping the area around the bird-banding site generally drier or at a lower water level than other areas of the refuge for ground nesting birds the population will be more stable. The habitat specifications include areas near water but should not be too wet to provide nesting sites.

OPTIONS FOR BIRD SPECIES AT THE GREAT DISMAL SWAMP:

Short term options to stabilize or increase bird populations at the Great Dismal Swamp include mitigation practices such as water management in the area to insure the habitat is not to dry nor too wet for the species…

Creating artificial low nesting boxes given the event that the area in which the birds prefer is too wet to ensure that the birds whom are ready to nest when arriving have a place to go. Increasing active management, for example citizen science, such as the bird counts done at the refuge is an option that should continue in potential sites in other areas of the refuge. Communal events that appeal to birders and others interested in conservation may peak the awareness of those who are interested in mitigating the impact of climate change on our native birds. Through community events sharing information on planting native plants that birds at the refuge prefer in “your own backyard” would be beneficial. If there is an occurrence where the swamp’s water table is too high for these

birds to breed, local backyards or parks may serve as natural corridors for these species as they may potentially migrate to other areas.

Other options may include a hands off approach, letting these species migrate north naturally will indeed lessen the population at the refuge, but may increase habitat for birds native to more southern or subtropical parts of the united states that are migrating north as well.

RECOMMENDATIONS FOR BIRD SPECIES POPULATION:

In conclusion to the data I have analyzed, my recommendations include education and awareness to the public about the danger our native birds are facing, as well as public events to inform locals of the issue. Spreading awareness of natural corridors to help bird's migration a smoother process. Working with other national wildlife refuges and state parks that may follow the projected migration routes provided by the Audubon Society to monitor and mitigate the migration of these species as well as new species that we may begin to see in the Great Dismal Swamps future. Rewetting the swamp as needed is a practice that is necessary for the refuge, although, keeping the area around the bird-banding station generally drier may mitigate the decline in population. The area will most likely stay as wet as it needs to without management given the increase in precipitation and an overall rise in water tables in the future. Unless there is an extreme drought in the future that causes the area to become dangerously dry and at risk of wildfire then this area should continue to have little to no rewetting as there are other areas of the refuge that are inundated with water and not as suitable for these particular species. Another suggestion for thought would be looking into the specific flora in wintering habitats that declining species are partial to. Finding certain plants that may do well in hotter, wetter places

during winter months may be considered for the refuge in the future. As we may see certain trees and plants declining, the ecosystem will start to change and become one that can be found in areas further south, it is possible to make this transition smoother to accommodate for the bird species that reside in the refuge. This option should be carefully considered, as there are risks of invasive species. In the future, preparing for a hurricane by creating a number of artificial nests may be beneficial to accommodate ground nesters if the area is significantly impacted by a storm surge. Using mist nets in other areas of the swamp would be very beneficial to determine if there are other sites that the species may start to prefer, therefore we can better learn what is needed to mitigate for these species.

Overall, continuing to monitor the refuges bird populations by misting and citizen science will be the most beneficial way to understand how the populations will continue to change over time.

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