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THE EFFECTS CLIMATE VARIABLITY ON AVIFAUNA, ON THE PLATTE RIVER IN NEBRASKA

by

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Under the Supervision of Dr. Mary Bomberger Brown
(or appropriate emphasis/thesis advisor)

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THE EFFECTS CLIMATE VARIABLITY ON AVIFAUNA, ON THE PLATTE RIVER IN NEBRASKA

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University of Nebraska-Lincoln, 2013

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Abstract

This study 1) looked at how weather patterns are predicted to change as a result of global climate change, 2) considered how these changes could affect the survival of Piping Plovers, Interior Least Terns, and Whooping Cranes and 3) considered the importance of managing wildlife in the Great Plains in light of the predicted consequences of global climate change. Correlation (Spearman r_s) tests were completed to compare the abundance of each species of birds and the amount of water flowing in the Platte River. Piping Plovers and Interior Least Terns have a specific amount of water that is not too high or too low, where their survival and reproduction is optimized. Both species rely on the same habitat on the Platte River for survival. The number of Whooping Cranes has been steadily increasing since they were placed on the endangered species list in 1985; they exhibit less reliance on the Platte River than do the plover and tern.

Introduction

Global climate change could be a significant factor explaining why bird populations are being pushed into endangered or other special conservation status (Platte River Recovery Implementation Program, 2012). Anthropogenic, or human caused, changes to environments are also major threats to biodiversity. The combination of the two could have catastrophic consequences for wildlife, in general and birds, in particular. Humans are polluting the atmosphere with carbon dioxide and other greenhouse gases leading to global climate change. On a more local scale, humans are diverting water out of the Platte River for use in row-crop irrigation and municipal usage, which is dramatically affecting the stream flow of the river and impacting the wildlife that depend on the river. A number of bird species of special conservation concern rely on the Platte River for survival, the three species this study focused on are Interior Least Terns (*Sternula antillarum athalassos*), Piping Plovers (*Charadrius melodus*), and Whooping Cranes (*Grus americana*).

Piping Plovers are small, stocky shorebirds that live on open beaches, alkali flats, and sand flats across North America. They feed on freshwater and marine invertebrates they find along the shore (Elliott-Smith and Haig 2004). They breed in three geographical regions, the Atlantic Coast, Northern Great Plains, and the Great Lakes. All of three populations winter on the coastal beaches and barrier islands from North Carolina to Texas, the eastern coast of Mexico and the Caribbean Islands (Elliott-Smith and Haig 2004; USFWS 2012). (See figure 1)

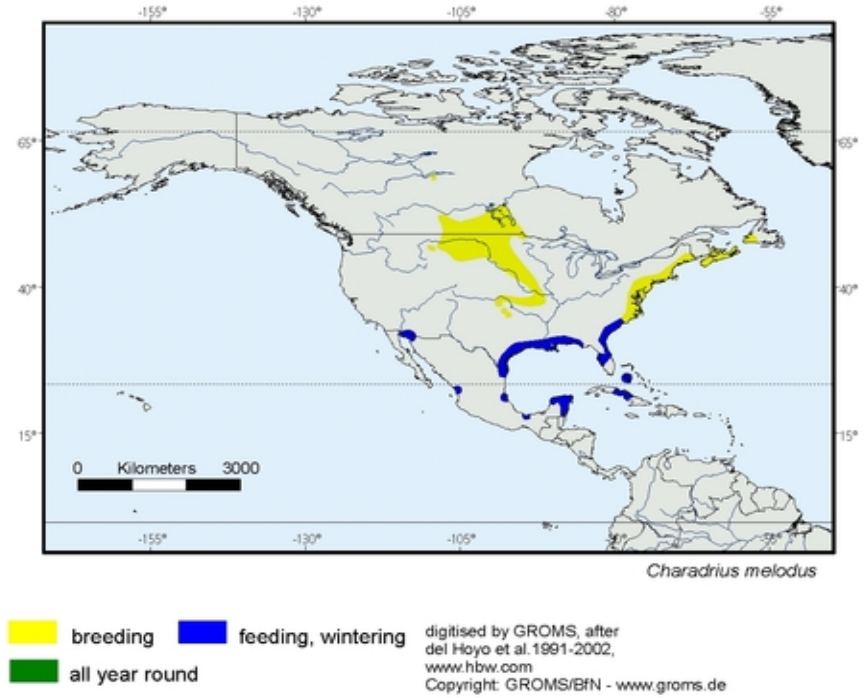


Figure 1.

The USFWS listed the Piping Plovers as a threatened species in 1985 due to range-wide habitat loss acerbated by inappropriate water management practices. They first were placed on the federal Endangered Species List (ESA) in 1985 (Elliott-Smith and Haig 2004). Approximately half of the breeding population of Piping Plovers breeds in the Great Plains (USFWS 2012).

Interior Least Terns is the smallest North America member of the gull and tern family. They are slender with a streamlined body, white breast and body, with grey and black long, narrow, pointy wings. They also rely on sandy habitats. They nest along major river systems such as the Missouri, Mississippi, and Platte rivers (See figure 2).

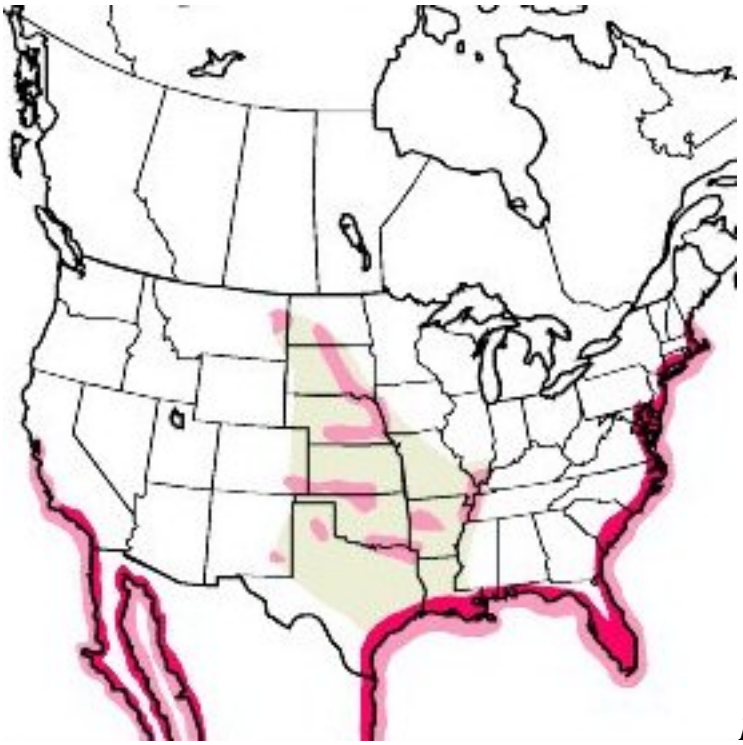


Figure 2. (*The Interior Least Tern population is the light pink color in the middle of the country.*)

They feed on small fish, and need open sandy beaches for nesting (Thompson et al. 1997). The USFWS listed the Interior Least Terns as an endangered species in 1985, as a result of habitat loss that was acerbated by channelization of the rivers (Thompson et al. 1997)

Whooping Cranes are the largest migratory bird in North America. They spend the winter along the Gulf of Mexico, near Aransas, Texas then migrate to Wood Buffalo Park in northern Canada to nest in the summer. On their journey north in the spring they stop along the Platte River for 6 – 8 weeks to feed, rest and rejuvenate before they finish their migration (NGPC 2012) (See figure 3). The USFWS listed Whooping Cranes as an endangered species in 1967.

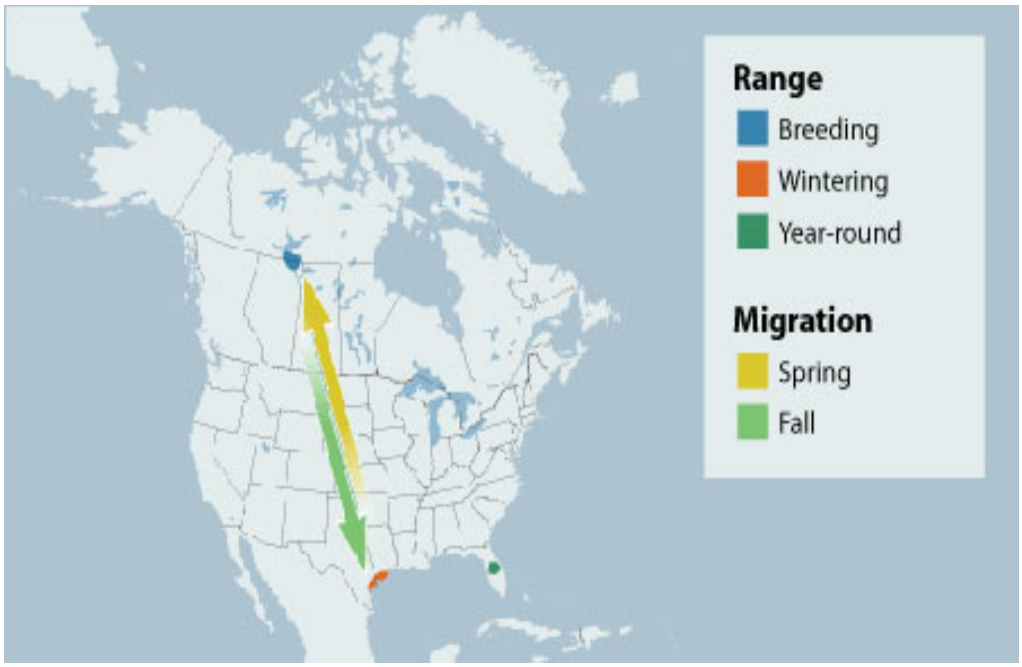


Figure 3.

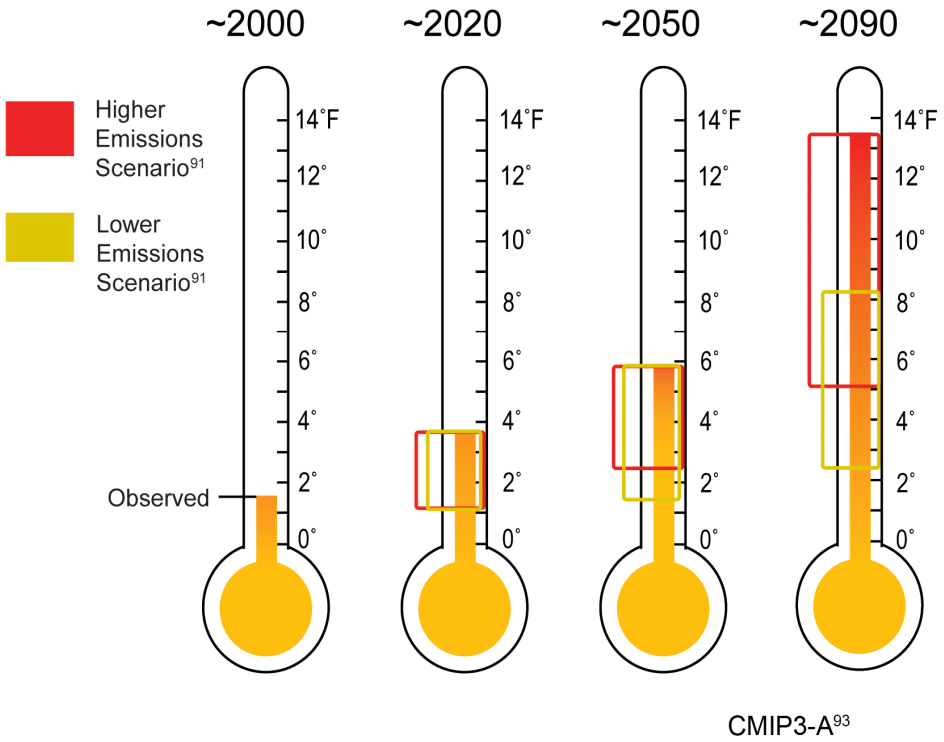
Two of these federally listed species, Piping Plovers and Interior Least Terns, rely on the Platte River's sandy riverine habitat for nesting. The habitats that they need are open, largely unvegetated sandbars, or beaches; they need the sandbars to be covered in less than 25% vegetation to nest successfully. Their beige and brown speckled eggs are camouflaged against the sand and gravel, which helps to protect them from predators (Thompson et al 1997; Elliott-Smith and Haig 2004).

Successful breeding by both terns and plovers requires the river to have regular floods to overtop the sandbars to keep the amount of vegetation down. These floods usually occur in the late winter and early spring, so that in late spring and summer, the river levels are lower, exposing sandbars that are vegetation free (Elliott-Smith and Haig 2004). However, if a flood were to occur on the Platte River during the birds' nesting season, their eggs and chicks could be washed away, eliminating one year of reproductive output. Droughts, with low water flows in the

river, could potentially decrease the number of chicks that survive by allowing predators access to the sandbars or by reducing the amount of available food (Elliott-Smith and Haig 2004).

In a study of the effects of climate warming, Rahel (1996) describes how temperatures are increasing across the Great Plains causing snow in Colorado and Wyoming to melt, which is affecting (reducing) the depth of the total winter snow pack—the snow pack that feeds the Platte River. This potentially could lead to stream flow and ecological changes in the Platte River that could affect the terns and plovers nesting habitat. The Southwest Climate Change Network (http://www.southwestclimatechange.org/impacts/water/snowpack) conducted a study that looked at the snowfall and snowmelt for time periods before the 1950s and the present day. They found that 1) snow is melting earlier now than it previously had, 2) less snowfall has been occurring more in recent years and 3) there are more rainstorms occurring more recently, especially in April compared to the 1950's. As a result, the timing of spring snowmelt is changing and consequently, the stream flows in the Platte River are changing. They predict that climate warming will continue to occur and strengthen these patterns of change to the Rocky Mountain snowpack. The result of this will be earlier peak flows in rivers, and more rain in the winter instead of snow, which in turn will affect droughts, water supply, floods, and river flow phenology.

The rising temperature could affect the birds and other wildlife. Sandel (2011) provides information on how the speed of climate changes might affect birds, in particular, which animals are expected to be most affected by climate change and why. Animals with specific climatic range requirements are predicted to have a harder time adapting to the changing conditions and are more likely to face extinction. (See figure 4 for temperature predictions)



The average temperature in the Great Plains already has increased roughly 1.5°F relative to a 1960s and 1970s baseline. By the end of the century, temperatures are projected to continue to increase by 2.5°F to more than 13°F compared with the 1960 to 1979 baseline, depending on future emissions of heat-trapping gases. The brackets on the thermometers represent the likely range of model projections, though lower or higher outcomes are possible.

Figure 4.

Eschner (1983) analyzed the historical hydrologic and morphological changes in the channels of the Platte River from 1838, pre-irrigation and urban development, to the present day to address how land use changes on the Platte River affect the stream flows. Since this study goes back to 1838 with information about the Platte River before irrigation the analyses can examine what is impacting the river more, climate change, irrigation, or both. Before development in the United States, the Platte River was about 2 kilometers wide and was characterized by high spring flows and low summer flows. Since human development and the invention of irrigation, the flows have changed (dropped) dramatically. The width of the river

has been reduced from encroachment of vegetation growth on sandbars, channelization and armoring of the banks. Eschner (1983) also looked at how climate is predicted to change in the Great Plains. Information addressing past droughts and floods can be used to predict how climate change could intensify these events in the Great Plains. Results show that over the last decade temperatures have risen and they are predicted to keep rising into the future. The research shows that there will be less precipitation, mostly in the winter and spring. Severe weather is predicted to become more common and more severe (U.S. Global Change Reasearch Program 2012).

This study looked at how climate variability might affect Piping Plovers, Interior Least Terns and Whooping Cranes. This study addressed how climate variability on the Platte River, potentially caused by global climate change, will affect migratory birds and the environmental factors that are affecting the birds' survival. These sorts of studies are useful to help develop management policies and procedures that will protect them from becoming extinct. Specifically, this study 1) looked at how weather patterns are predicted to change as a result of global climate change, 2) considered how these changes could affect the survival of three bird species of special conservation concern and 3) considered the importance of managing wildlife in the Great Plains in light of the predicted consequences of global climate change. The hypothesis of this study is that the changing climate is going to negatively affect the survival of Piping Plovers, Interior Least Terns and Whooping Cranes, if more floods and droughts occur on the Platte River. The aim of this project was to look at what types of habitat Whooping Cranes, Piping Plovers, and Least Terns need when they migrate through Nebraska and nest on the Platte River. The potential limitation to this study is that one could never predict with great accuracy what will happen in the future, but predictions are possible. There is always a degree of uncertainty when doing a

predictive study. Further complicating this uncertainty is the problem that land use could change in the future.

Methods and Materials

Several different components of climate variability were addressed in this study. Trends in temperature and precipitation data in the Great Plains area were assembled and compared to the population sizes of terns, plovers and cranes from 1987 to 2011. Drought index data, available from the Drought Mitigation Center (http://droughtmonitor.unl.edu/archive.html), was compared with stream flow data from USGS (http://ne.water.usgs.gov/) to estimate the amount of annual water flow in the Platte River from 1987 to 2011.

Information on the birds' population sizes, reproduction, and juvenile survival from 1987 through 2012 was assembled and compared to the specific weather and water flow events that happened in those years. The data was assembled into excel spreadsheets, and statistical analyses conducted; correlation (Spearman r_s) tests were run on the data. This was done to test the hypothesis that droughts and floods were positively or negative related to the survival of the birds.

Since the study focused on how the climate change will affect the Platte River specifically, the results were then applied to these results about the habitat the birds need and described the potential problems and accommodations that climate change will bring.

Results

Figure 5, below, illustrates the number of each species counted on the lower Platte River every year from 1987 through 2012. The number of birds of each species of is on the left vertical

axis, the years are on the horizontal axis and the right vertical axis shows the annual mean stream flow in cubic meters per second recorded at Louisville, Nebraska USGS stream gage (USGS 2012; J. Jorgensen, pers. comm.). Figure 5 illustrates how the annual number of Whooping Cranes has been linearly increasing and doesn't correspond with either of the birds or annual stream flow.

Effect of Streamflow on Number of Birds per Year
Number of Birds
Annual Mean Streamflow CMS
Year
Plover
Terns
Whooping Cranes
Annual Mean Streamflow in CMS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
450
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

Figure 5

A correlation analysis (Spearman r_s) was conducted on the annual stream flow and the number of each bird species. The correlation between stream flow and the abundance of Piping Plovers was $r_s = -0.1007$ indicating a slight negative association between the amount of water flowing in the river and the number of plovers; this suggests that the number of Piping Plovers on the river was slightly higher when the stream flow was lower. A correlation was run on the number of Interior Least Terns on the river and the annual stream flow. The outcome was $r_s = 0.0779$, which is very weakly positive; this indicates that terns are more abundant when there is more water in the Platte River. A correlation was run on the number of Whooping Cranes and annual stream flow, the outcome was $r_s = 0.0936$. This indicates a slight positive correlation suggesting that there are more cranes when there is more water in the river. A correlation was run on the numbers of Piping Plovers and Interior Least Tern, the result was 0.5720 which is a strong indication that these two birds occur together and each do well in the same years. In order to say that there was a strong connection between the two the test statistic would have to be around 0.4 or higher, or -0.4 or lower, the closer the number is to 0.0 then the less the association between the two.

Figure 6, below, shows the annual numbers of plovers and terns between 1987 and 2009; it shows that increases in the birds' populations occur in the same years.

In years of low water (e.g 2002 to 2006) the graph shows lower numbers of plovers and terns fluctuate, but at a lower level than in previous years. After all those years of drought the number of plovers and terns was at an all time low in 2008 which was the year that also broke the drought and had a spike in water in the river. The year after, 2009, the numbers of each bird rebounded from the lower to more than they had been in 15 years. This indicates that prolonged droughts can have a detrimental affect on the number of birds that survive and reproduce. It

appears that prolonged droughts have more of a negative affect on the birds' survival than floods do.

Figure 6 shows that the number of terns seems to increase after years where there was more water in the river. The Piping Plover could have the same trend but seem to also do better on low water years. In the next section I will discuss reasons why the trend is like this.

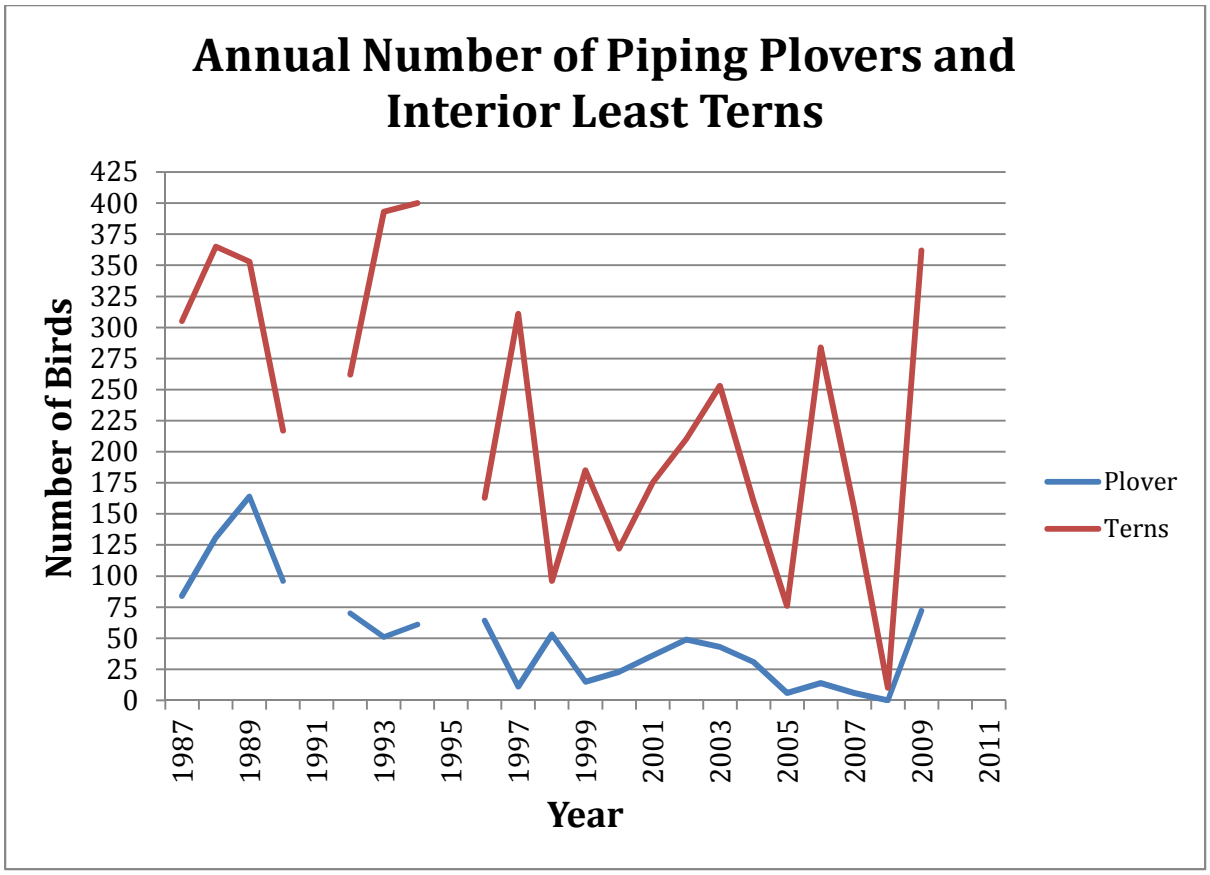


Figure 6.

Discussion

According to the results the numbers of Piping Plovers and Interior Least Terns increase in the years following a flood on the Platte River. In years with higher water, the Platte River disperses more sediment and creates new sandbars that will be available to the birds for nesting in the years to come. This would explain why there is a year or two time lag between the higher water and the number of birds on the river (USGS 2013). These new sandbars are the preferred

habitat for the birds and with water still flowing it creates a moat for the birds and protects them from predators. Both species of birds would do better when there are more sandbars available to nest on. When the river water is higher it also helps the fish population, which is the main food source for the Interior Least Tern.

The year after a flood occurs more open sandbars are exposed and, in some cases, experience up to a 78% reduction in perennial vegetation. This helps the birds nest in the years to come (Sidle et al. 1992). As seen in Figure 5, after the flood in 1993 the number of Piping Plovers and Interior Least Terns went up in the following year. According to Licht (2001) Piping Plovers do better when there is less water flowing in the river, although, there is a threshold to the amount of water that they do well in. If the river is too low then their survival and reproduction is negatively affected and, for proper management of the species, that point can be hard to find (Licht 2001).

During droughts the water availability makes it difficult for plover and tern fledglings to survive. Close proximity to water is a necessity for the chicks, if they cannot get to water, they will not survive. Adult birds experience higher mortality during droughts too. Besides water they both must forage, plovers eat freshwater invertebrates and terns eat freshwater fish. With low water or no water the amount of invertebrates and fish in the river decreases and the birds have trouble foraging successfully. Fish and invertebrates cannot survive in low water because there is not enough oxygen in it to keep them alive (Griffin 2012). Even if the fish and invertebrates survive and the birds are able to forage, predators will be able to reach the chicks on the sandbars easier, since the water level is low. Adult birds will also be easier for predators to catch since they will not have the water acting as a moat around the sandbar protecting them.

Whooping Cranes are only on the Platte River for a few weeks before they continue their migration. If the river is flooded they will find a shallow marsh to rest at and if it is dry they find a lake of another nearby water source to rest at. This is why their numbers do not seem to have any association with the amount of water in the river. In figure 5, you can see that the number of cranes seems to be increasing annually despite the amount of water in the river.

Summary and Conclusions

This study was done in order to see if our changing climate is going to affect the Platte River, and in turn, affect the survival of Piping Plovers, Interior Least Terns, and Whooping Cranes. According to a number of different climate models for the Platte River it does look like there will be a change in the 1) amount of water in the river, 2) temperature of the water in the river, and 3) ecology of the river. This is due to the warming of the climate in the Great Plains and the Colorado-Wyoming areas, which will cause the snow to melt, sooner in the spring and change when the Platte River stream flows usually peak. Figure 4 above, shows how the temperature is predicted to change in the future.

Interior Least Terns and Piping Plovers are two species of birds that likely will be affected by any stream changes on the Platte River. They arrive and begin nesting in the spring and if the river flow changes, there could be more or less water in the Platte, which would be detrimental to their nesting success. These birds need a stream flow that is neither too high nor too low to protect their nests or to find food and water. Figure 1 shows how the birds occupy the river with high and low water levels; when looking at the graph notice that there is a one to two year time lag between high flows and increased numbers of birds. Floods bring in sediment and create the sandbars that these birds depend upon to survive, but if there were too many

consecutive years of flooding (no sandbars exposed or the sandbars overtopped) the birds would not be able to reproduce successfully. Since this is a predictive study and we cannot accurately, predict the future there is always a bit of uncertainty. Weather predictions are not always fully accurate but do have scientific data to back them up and are quite reliable.

To further this study research could be done on the other habitats of these birds, since they are migratory they do not only depend on the Platte Rivers habitat for survival but also the places that they go during the fall and winter months. Analyzing annual chick and egg survival would be a good place to help further support these predictions. There is little accurate data available on this right now, but this analysis would provide some useful evidence on what is affecting the bird's survival more, droughts, floods, or other things in nature.

After all the evidence is considered, the hypothesis was confirmed since the birds need a specific range in water level if the Platte River to survive and reproduce successfully. The changing climate could greatly hinder these birds ability to keep their populations at a sustainable level.

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