Impacts of Sea Level Rise on Red-throated Loons (Gavia stellata)

Abstract

The Red-throated Loon is one of many bird species that utilizes the coastal regions of Western United States, Canada, and Russia. The fate of the Red-throated Loon in relation to sea level rise is an important point to address due to their status as an indicator species. A vital component to Red-throated Loon success is reproductive success. Red-throated Loons occupy the coasts of Alaska for most of the year which begs the question of habitat selection specific to this region of the United States. Through raster and vector analysis, a total of four Red-throated Loon locations from XY data were impacted by varying levels of inundation. It is important to note that the analysis performed in this project was a simplified analysis of sea level rise. The true consequences of sea level rise, when we incorporate storm surge, tsunamis, and tidal variability, are worse. Despite rising sea levels not having an apparent effect on Red-throated Loons through my analysis, there are other consequences of climate change that could impact Red-throated Loons, such as water acidification.

Introduction

The Red-throated Loon is one of many species of bird which utilizes the coastal regions of Western United States, Canada, and Russia. Red-throated Loons are considered to be large water birds but small loons. They have a thin, pointed bill and are easily identified by the slight upward tilt of their head. During the summer they are in their alternate plumage and have red throats and a

creamy gray head. During the winter, they are in basic plumage and are mostly gray and white in color. Red-throated Loons are ecologically isolated in their use of habitat and execution of foraging methods (Bergman and Derkenson, 1977). Researchers have discovered their selected habitat consisting of partially drained basins and open waters for foraging. The fate of the Red-throated Loon in relation to sea level rise is important to address due to their status as an indicator species. An indicator species is a species of wildlife that indicates the health of an entire ecosystem based on their presence, absence, or abundance. A vital component to Red-throated Loon success is their reproductive success.

Their reproductive success is analyzed according to the availability of food resources and levels of predation (Eberl and Picman, 1993). Both of these components influence habitat selection and should not be ignored when analyzing the potential impacts of climate change and sea levels rising. Red-throated Loons occupy the coasts of Alaska for most of the year. This begs the question of habitat selection specific to this region of the United States, as shown in Figure 1. My hypothesis is that Red-throated Loons will be great affected by rising sea levels due to their selected habitats being degraded.

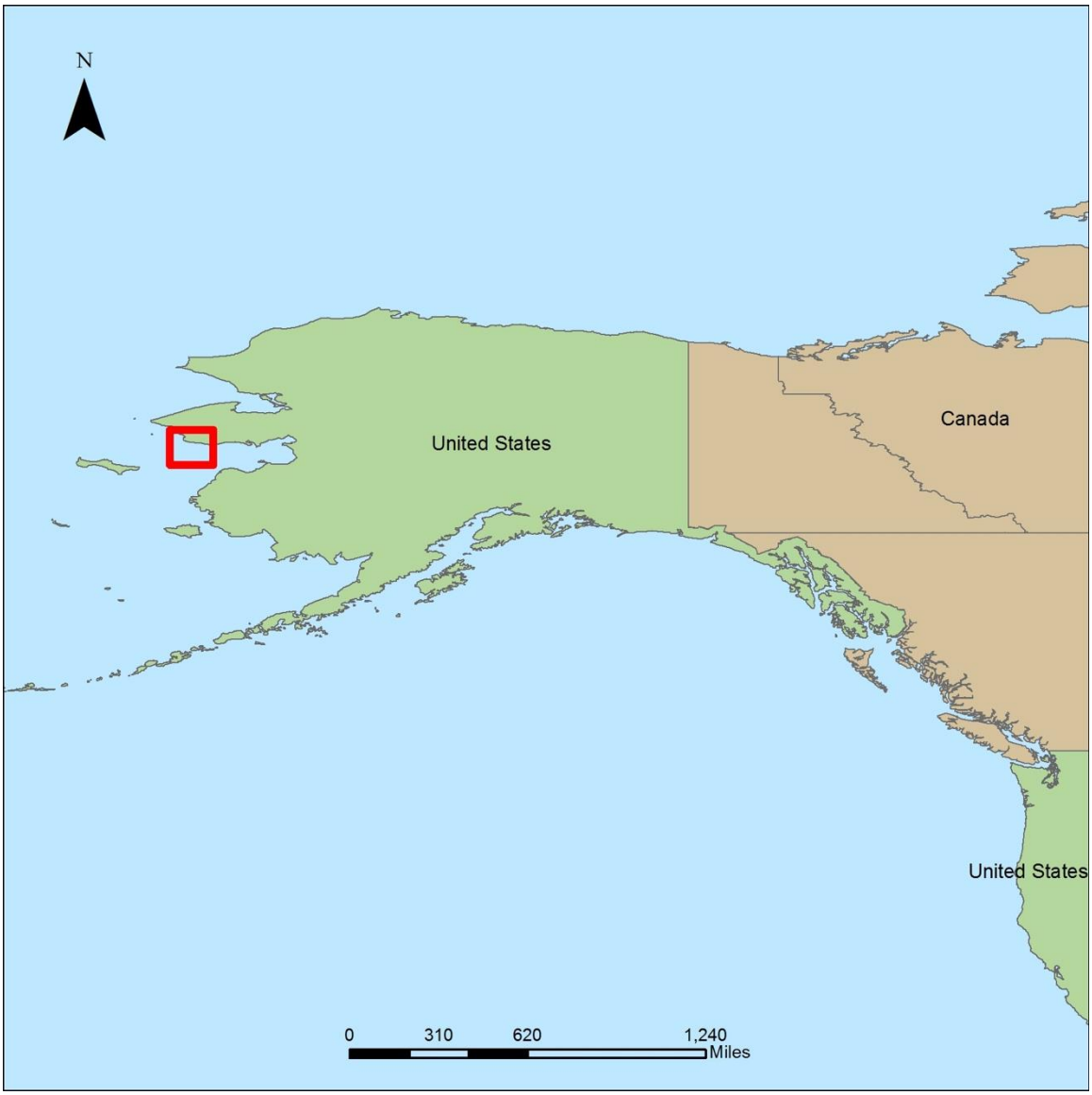

Figure 1. Locator map of analysis area. Analysis was completed in the Nome and Teller regions of Alaska.

Methods

I began my analysis by obtaining the correct data and making sure the data was accurate enough to use in my analysis. In order to model sea level rise, I downloaded Digital Elevation Models (DEMs) for the areas of my analysis. I chose to concentrate on the regions of Nome and Teller, Alaska because there was a concentration of data here. This data was found on the National

Elevation Dataset website. I also downloaded XY data on migratory and wintering locations of Red-throated Loons from the U.S. Fish and Wildlife Service's Geospatial Services homepage. This data was collected from satellite transmitters eliciting signals for 8 hours every 48-120 hours from four breeding populations in Alaska. Once I located all of my required data, I made sure all of the necessary information regarding spatial reference systems, contact information, and the original date of creation was available by completing QAQC forms. To begin the analysis I made sure all of my DEMs were in the correct projection prior to creating a mosaic of them.

Once the mosaic was created, I was able to utilized the 'map algebra' tool within ArcMap to complete my raster analysis. I began by creating a raster for sea level, one, two, five, and ten meters above sea level. I then subtracted the sea level raster from the one, two, five, and ten meter rasters. The results included rasters for each level of inundation. I was then able to reclassify the original DEM to display the above inundation levels. I also used the 'map algebra' tool to set bodies of water to null so there would be no data shown for these areas. At this point, I was able to display my XY data and export the points as a shapefile. In order to complete the last part of my analysis, I converted the inundation rasters to polygons and used the 'select by location' tool to identify how many points of data intersected with areas of inundation. With this selection, I exported the points as a separate shapefile and changed the symbology so they would stand out from the unaffected data points. A comprehensive flow chart of my analysis methods is shown below in Figure 2.

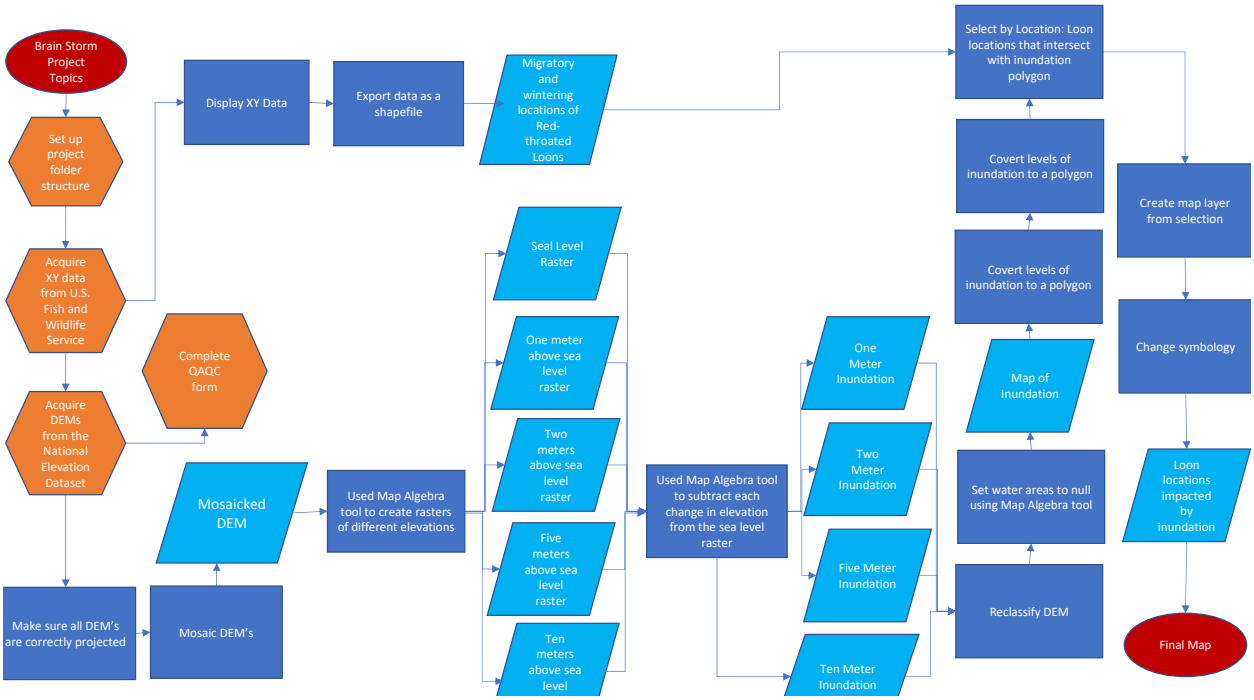

Figure 2. Flow chart of methods used in the analysis of potential impacts of rising sea levels on Red-throated Loons in the regions of Nome and Teller, Alaska. Flow chart designed by Jaime Carlino on June 30, 2018.

Results

The results of my analysis showed that overall, Red-throated Loons would not be impacted by sea levels rising. The main concern in my analysis was that selected habitat, which was represented by the XY data, would be degraded by sea levels rising and have a negative impact on Red-throated Loon populations. A total of four out of 19,943 Red-throated Loon locations were impacted by varying levels of inundation as show below in Figure 3. I was curious to see how much inundation would need to take place in order to greatly impact Red-throated Loons. By increasing my search distance during the select by location portion of my analysis to 200 meters, only two more loon locations, making a total of six locations, were affected by two hundred meters of inundation.

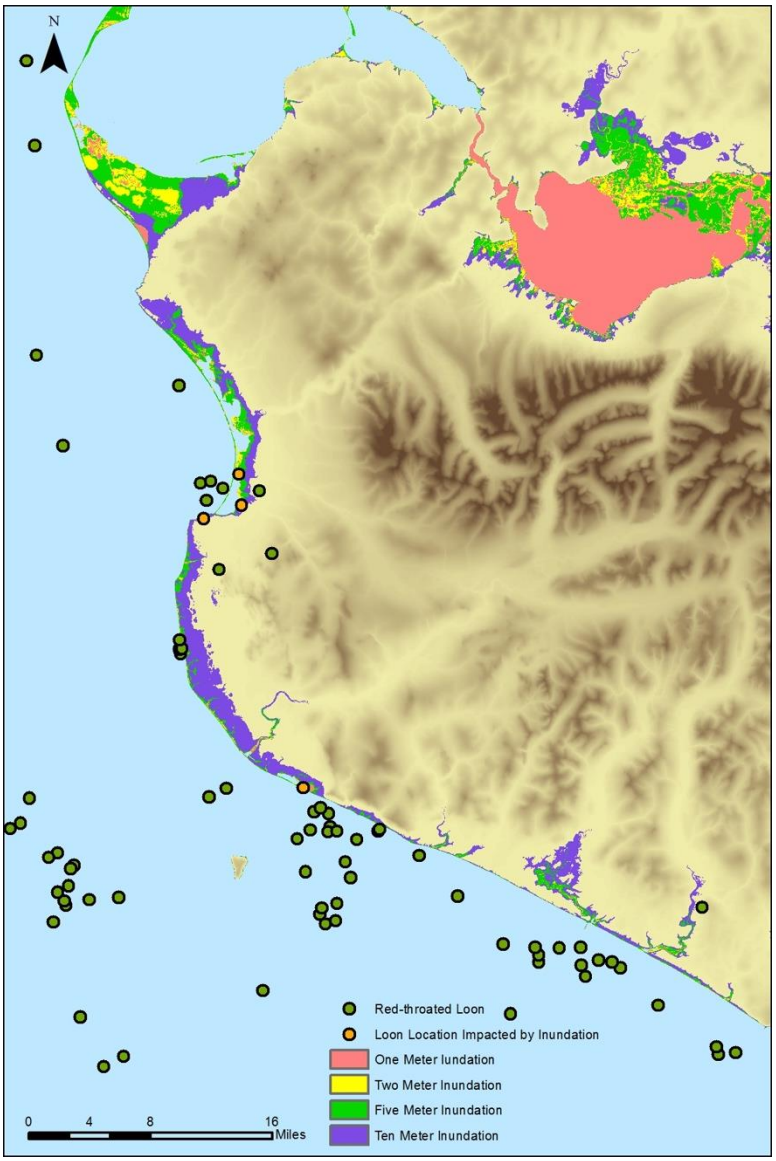

Figure 3. General Red-throated Loon locations and loon locations impacted by varying levels of inundation. Inundation levels distinguished as one, two, five, and ten meters. Map produced by Jaime Carlino on June 28, 2018.

Conclusion

The question driving this project was whether Red-throated Loons would be affected through loss of selected habitat due to sea level rise and if so, to what degree. Through my analysis, my hypothesis of sea level rise greatly impacting Red-throated Loons through habitat loss was shown to be false. A total of four Red-throated Loon locations were impacted by varying levels of inundation. It is important to note that the analysis performed in this project was a simplified analysis of sea level rise. The true consequences of sea level rise, when we incorporate storm surge, tsunamis, and tidal variability, are worse. Another component worth studying in relation to Red-throated Loons coping with the effects of climate change is water acidification. As mentioned previously, Red-throated Loons forage in open bodies of water; both fresh and seawater. In a study done in Sweden, there was an abundance of certain species of fish foraged on by Red-throated Loons that are greatly affected by freshwater acidification. These loons greatly rely on these species of fish to feed themselves as well as their young (Eriksson, 1994). Despite rising sea levels not having an apparent effect on Red-throated Loons through my analysis, there are other consequences of climate change that could impact Red-throated Loons.

Acknowledgements

Thank you to U.S. Fish and Wildlife Service and the National Elevation Dataset for their data contribution to this project. Without data obtained from these organizations, this project would not have been so successful. Additional thanks go to Humboldt State University's Geospatial Curriculum for providing quality courses of which promote comprehensive learning of geospatial concepts such as GIS analysis.

Bibliography

Bergman, R., & Derksen, D. (1977). Observations on arctic and red-throated loons at Storkersen Point, Alaska. *Arctic, 30*(1), 41-51.

Christine, E., & Picman, J. (1993). Effect of nest-site location on reproductive success of red-throated loons (Gavia Stellata). *The Auk, 110*(3), 436-444.

Eriksson, M., (1994) Susceptibility to freshwater acidification by two species of loon: red-throated loon (*Gavia stellata*) and arctic loon (*Gavia arctica*) in southwest Sweden. *Developments in Hydrobiology: Aquatic Birds in the Trophic Web of Lakes*, *96*(1), 439-444.