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# Preserving Wetlands in Maine

**Sean Flynn***

*Unity College, United States*

***Corresponding Author**
Sean Flynn*, Unity College, United States.

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***Abstract***

*Wetlands can be found throughout the United States and, more specifically, within the State of Maine, and the wetlands within the area need to be protected. Using many geographic information systems and analysis measures, there are many potential wetland areas that can support endangered and threatened species. The final results show over 10 locations for wetland habitats in the county that is near the Moosehead Region. With the forestry business cutting down trees, the preservation of the identified areas is crucial for endangered and threatened species populations.*

**Keywords:** Wetlands, Maine, GIS, Moosehead Region

## Background

There are wetlands located all over the United States and to see if there are significant wetlands present in the specified area and wanted to examine the identified regions to see if there is enough support for the state of Maine's endangered and threatened species that are on the list. The geologic history of the bedrock found in the State of Maine spans nearly 0.5 billion years. There have been numerous cycles of deposition, deformation, and igneous activity that show subduction and collision from plate tectonics and reveal the unique bedrock that can be seen from observations [1].

The state of Maine's forest industry contributes 8.5 billion dollars to the economy and supports approximately 33,000 jobs. The outdoor recreation sector brings 8.2 billion dollars and approximately 76,000 jobs. Another industry, commercial seafood, brings 700 million dollars, and finally, the farming industry brings 1.4 billion dollars to the economy of Maine. Furthermore, creations in compound materials, technology for the environment, and biobased products create significant opportunities for the economy to grow based on the natural resources that are found in Maine [2]. As shown in Figure #1, the location surrounds the Moosehead Region Conservation Easement.

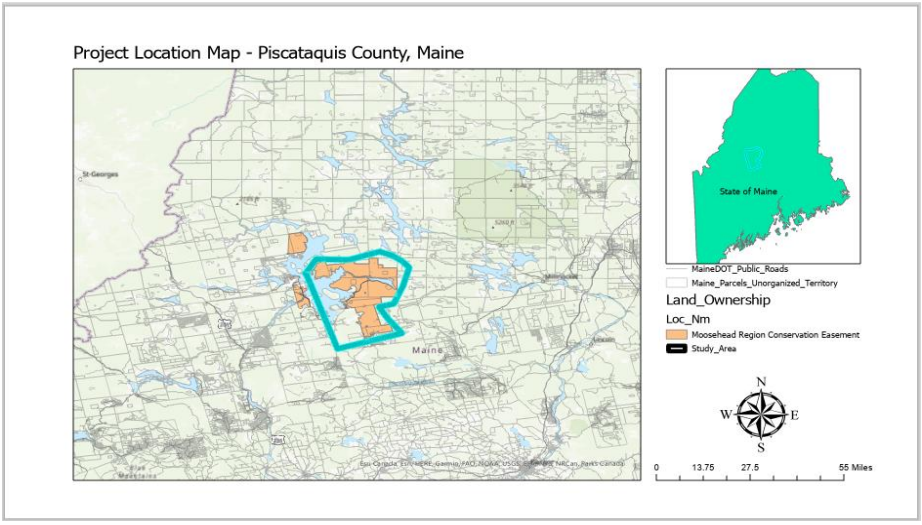


**Figure** *#1 – Location of study area*

Piscataquis County is located in the center of the State of Maine, covering 3,960.86 square miles, and the county seat is located in Dover-Foxtrot. Piscataquis County is surrounded by Aroostook County to the north, Penobscot County to the southeast, and Somerset County to the west. Piscataquis County is the least populated county in Maine, with a decline in population from 1990 to 2020 [3].

Maine's climate consists of cold and snowy winters and has a mild summer. The temperature for winter shows a range of 25 degrees to temperatures that are less than 15 degrees depending on where the person lives in Maine. Additionally, the average temperature ranges from 60 degrees to 70 degrees in the summertime. Additionally, 90% of the state of Maine is covered in forest, along with over 3,500 miles of coastline, which makes ecosystem services extremely sensitive to climate change [4].

According to the 2010 census, Piscataquis County had a population of 17,535. Currently, Piscataquis County is mainly used for forestry. The remaining area shows woodland areas, wetlands, and other land-use functions. Looking at the map above, the focus of my analysis is on the middle of Piscataquis County, near the area of Moosehead. Beginning in the late 1940s, the United States Forest Service has inventories of Maine's forests. There are periodic inventories of the forests in 1959, 1971, 1982, and 1995. In 1999, both the State of Maine and the Northeastern Research Station inventoried nearly 20 percent of the forest plots every year. Additionally, in 2003 and 2008, two annual inventories were completed (McCaskill et al. 2010). The Penobscot River is part of the Penobscot Watershed. The Penobscot River is considered the second largest river system in New England and has a drainage area of 8,570 square miles. The west branch is located near the Quebec border, and the east branch of the river can be found at the Allagash River. The river unloads into Penobscot Bay [5].

## Methods

The entire county was scanned using land cover data that Maine Geo Libary developed in 2004 and the protected land dataset that Maine GeoLibary also produced in 2014. The land cover data have a full range of eight separate categories to show the potential for any given project. After looking, many potential wetland areas could be turned into a conservation project, and my focus narrowed down to the Moosehead Region of Maine.

Figure 2 below Displays The Focus Area Around The Moosehead Region With Wetland Areas Highlighted Green.

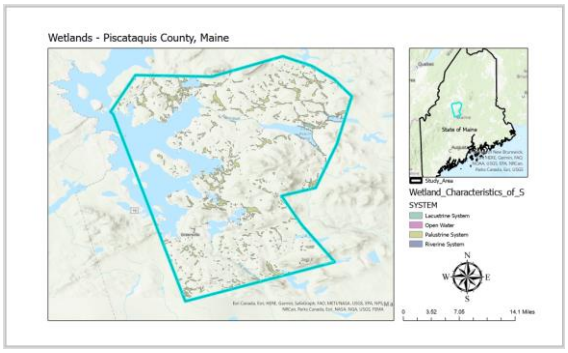


**Figure 2 – Wetlands That Can Be Found Within The Area of Interest**

After the focal point for the area was created, I then needed to locate and download any vital data that were needed for analysis to determine what wetland areas could be used for conservation. The data used included protected lands, soil, elevation data in the form of a DEM, Landsat Imagery, high-resolution imagery, and threatened and endangered species data.

The high-resolution aerial imagery was downloaded from Google Earth (Figure 3),

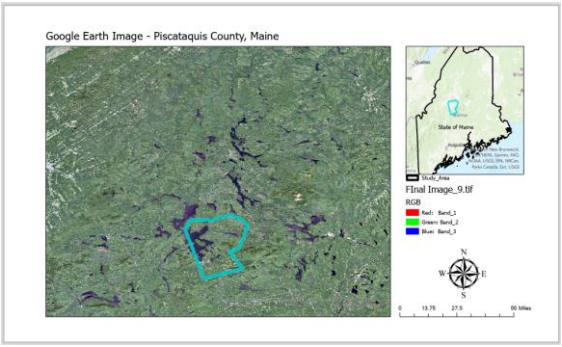


**Figure 3- Google Earth Imagery from 2016**

was critical to verify the most current conditions on the ground and show any new developments from the land cover dataset. The Landsat Imagery data sets were downloaded from the Earth Explorer website and were used to show any percent change over time to identify potential wetlands. After the data were downloaded, a visual analysis was used to see if there was a presence or an absence of wetlands to understand any developmental trends with the land cover data, the Landsat Imagery Data, and the high-resolution imagery.

Once the visual analysis was completed, the presence of wetlands was verified by looking at the high-resolution imagery. Then, I added the wetland data to the map. Finally, I used endangered and threatened species data to confirm the areas of wetland habitats and soil data to show hydric soil capacity. As shown in Figure 3,

the DEM was downloaded to show various aspects of the areas that include the slope and hill terrain with unique values.

The DEM was downloaded from EarthExplorer (Figure 4)

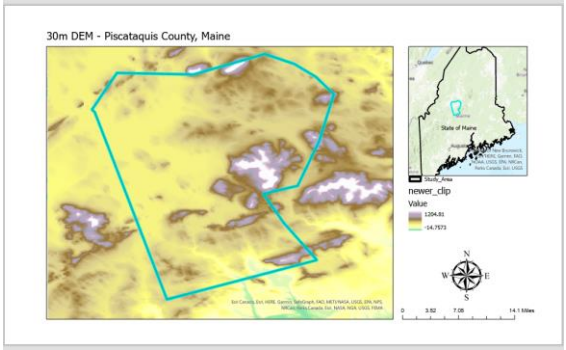


**Figure 4-30 Meter DEM with unique values**

## Discussion

After the analysis, suitable locations were found for potential wetland protection areas within the county. The remaining wetlands surrounding the Moosehead Estuary had the most prominent area and great potential for wetland habitats. The results of the Landsat analysis show various vegetation types that utilize the band combination 7,5,4 for analysis of vegetation. The band combination that can be seen in Figure 6 shows the various vegetation and water features within the area. However, many of the farming fields show up as the same color as urban areas. To fix this, the band combination of 5,4,6 was used, as shown in Figure 5. This is a cleaner usage to differentiate urban areas in the project area.

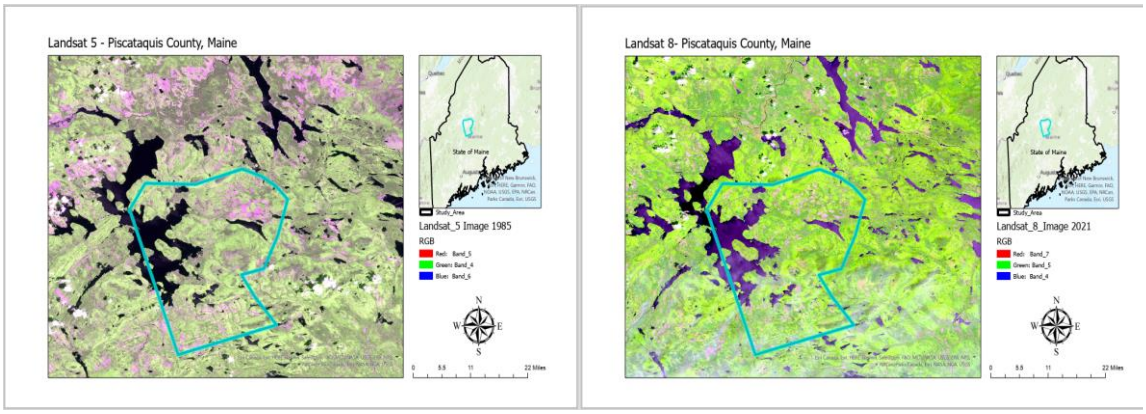


**Figure 5 –6** ***Comparison between the Landsat 5 color band and Landsat 8 color band***

Here is a direct comparison between the Landsat 5 image and the Landsat 8 image comparing unsupervised classification systems. As you can see, there are many areas that are classified in error, as shown in Figures 7 and 8.

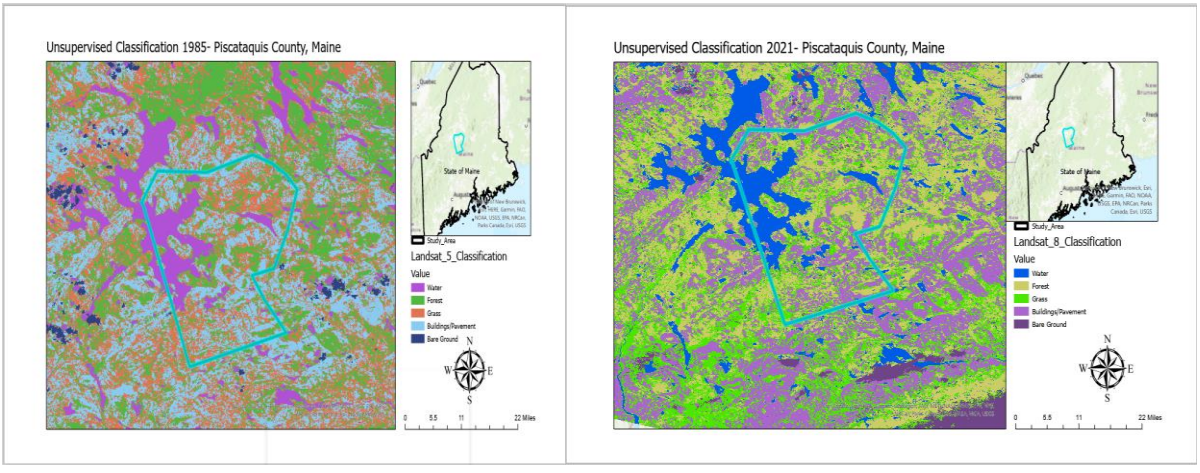


**Figure 7-8 –** ***Comparison of land classifications***

The results of the unsupervised classification of Landsat imagery comparing 2021 and 1985 show much more forest in the southern section of the focus area, as shown in Table 1.

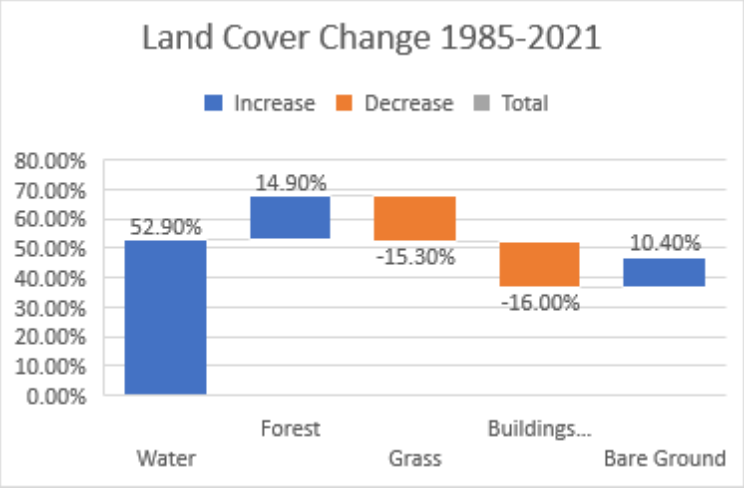


**Table 1-** ***Land cover change over time***

Looking at the difference between 1985 and 2020, the areas that were developed areas decreased by 16%, and the forest increased by 14.9%. Even though the analysis helped, there were problems with the unsupervised classifications. Wetlands were classified as water, and some grass was classified as barren land. The primary concern was with Landsat 5 classification and could not distinguish roads from barren land.

The final analysis shows that the comparison of the health of vegetation with the Landsat data from 2020 and 1985 provided enough information. The Landsat 5 imagery from 1985 shows areas of healthy vegetation in the area of interest, and in 2021, the vegetation is considered to be classified as unhealthy, as seen in Figures 9 and 10. The final change/no change can be seen in figure 11.

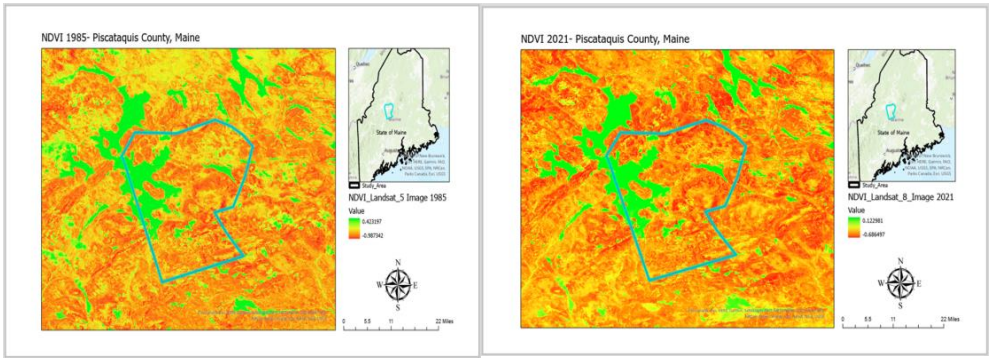


**Figure 9-10 –** ***Comparison between NDVI between 1985 and 2021***

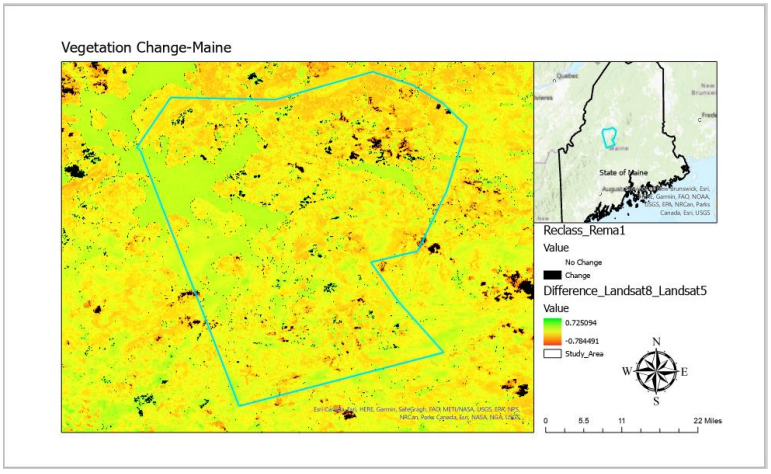


**Figure 11 –** ***Calculation of the difference between NDVI 1985 and 2021***

The change had to do with the number of trees that had been cut down from the forest industry. Furthermore, there were also large areas of unhealthy vegetation in the Landsat 8 imagery. The change is due to the decrease in population. This is probably because other counties have better jobs. Overall, the Landsat 5 image contains unhealthy vegetation. This is considered to show a change in vegetation health, as shown in Figure 12.

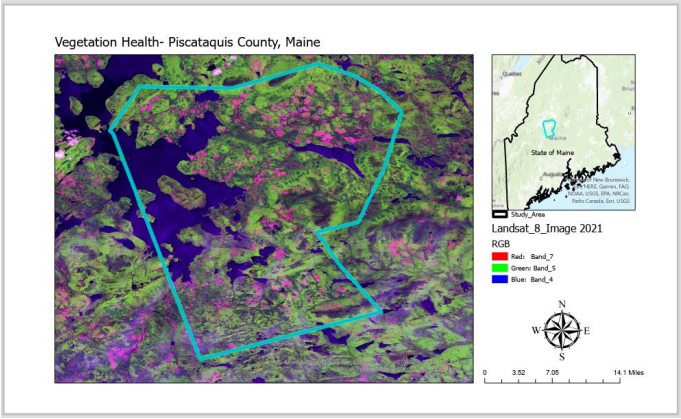


**Figure 12-** ***Vegetation Health***

The change has to do with urban areas. To determine what species used these areas for whatever functions, I downloaded the endangered and unique interest species data. As shown in Figure 6, there have been observations for both endangered and threatened species. I added it to the map to show where these observations have been seen within the project areas.

Figure 13 shows the different endangered species that can be found within the project area.

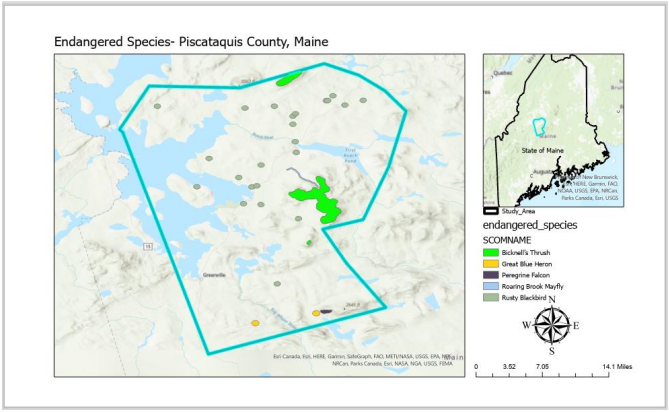


**Figure 13-** ***Endangered and Threatened Species***

Finally, as shown in Figure 14, the finalized results show that there are many areas for wetland preservation that can be found in the Moosehead region that have hydric soils.

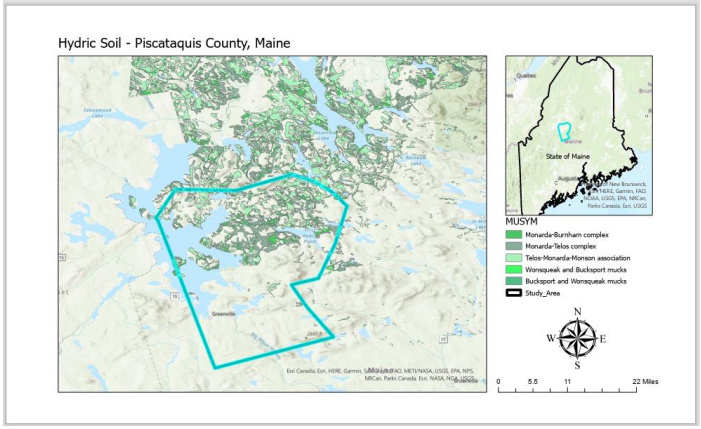


**Figure 14-** ***Prominent areas for more wetlands with hydric soil***

## Results

The Clean Water Act is the primary system for the regulation of pollutants within the waters of the United States and the regulation of water quality standards. The Environmental Protection Agency created the national water criteria for water quality and has recommendations for any pollutants that are/can be found in surface water [6].

There are six goals to maintain Maine's wetlands. The first goal is to identify and protect wetlands that are important. The second goal is to have a better understanding of wetlands through assessments. The third goal is to provide practicable levels of protection. The fourth goal is to encourage private landowners and towns. The fifth goal is to improve communication between agencies, and finally, the sixth goal is to create a wetland program [7]. Wetlands are defined as water that will cover soil or can be in the presence that is either at the top of the soil or around for different periods, including the growing season of the area, and are home to various species for breeding or hunting purposes [8].

Hydric soils are soils that develop certain conditions in which growth can become favorable for hydrophytic vegetation. This means that unless the water is drained through the soil, the biota will be supported by the layer of soil. This is part of the three-prong test to identify wetlands. The other two tests included soil and vegetation measures [9].

Combining timber management with biodiversity conservation to recognize keystone species that habitat co-exists with other species. Using sufficient habitats for keystone species, other areas of biodiversity will excel. Looking at these species, the management of biodiversity can become an educational tool for forest management [10].

## Conclusion

Overall, many areas in the county have many areas of wetlands that need to be protected, especially within the Moosehead region, which supports both endangered and threatened species. Even though this is a great idea, the analysis shows that the wetlands

are not protected. Many different species rely on wetlands, and the conservation of these areas is essential to provide bedding and hunting grounds for these unique populations. There are many other steps that need to be completed to fully answer the project research question. The first thing that needs to be done is to go to the actual site location in the State of Maine and conduct several surveys on the plant species and endangered and threatened species. Since farmland can be converted into wetlands, I would need to visit the farmlands and do a soil survey of the area to show whether the area would be a potential site. Because of the unsupervised analysis, the better option would be to do a supervised analysis to show a better outcome on the classifications. Sharing the complete analysis and results with the county and any nonprofit organizations to come up with some kind of plan to kickstart a conservation plan to protect wetlands [11-20].

## Declarations

### Ethics approval and consent to participate

Not Applicable.

### Consent for publication

Not Applicable.

### Availability of data and material

The availability of data can be found within the data citations and are open source. The data compilation was used through ArcGIS Pro.

### Competing interests

The author states no competing interests.


### Funding

The author received no funding through any source.


### Authors' contributions

The author did all the research by themselves.


### Acknowledgements

Not Applicable


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