Title: Wetland Availability in Oklahoma

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Abstract:

Wetlands, with their special characteristics, are a vital resource to humanity and the natural ecosystem as a whole. This project looked at the relationship between wetland availability in Oklahoma County's using data management design and spatial analysis. After a detailed look at the data available and the wetland diversity within Oklahoma, this analysis found that there is no relationship between county size and wetland coverage. However, there may be a relationship between county location and wetland availability.

Introduction

This project concerns itself with an analysis of wetlands in Oklahoma counties. Many know the state of Oklahoma to be a somewhat hot, dry state with plains and grassland throughout. Although that is true, Oklahoma has many rivers and some with a substantial amount of water flow. Some of these rivers have created natural lakes known as oxbows, and the rivers have also allowed for Oklahomans to damn off large lakes to create a sustainable source for drinking water and recreation. With the creation of lakes and ponds across the state, and the rivers, there is a lot of opportunity for wetlands to form, perhaps more than you would imagine. As a nonnative Oklahoman working as a wetland delineator for the state, I have found it surprising just how much wetland is present here. Because I work with wetlands daily, I thought it would be interesting to find out which counties across the state had the most acreage of wetland coverage and which ones had the least. This analysis, other than being interesting to me, could be useful for identifying which counties are most at risk for wetland habitat shortage and potentially water shortage. Because wetlands also have unique characteristics when it comes to how they hold and filter water, maintain vital ecosystem productivity, and provide habitat for a diverse variety of species, protecting and maintaining them is one of the most environmentally conscious acts we can do.

Research Context:

Spatial data has been utilized by environmental scientists trying to understand and improve human disturbance effects on ecosystems for decades. One such example comes from conservation efforts of birds of prey in Europe, when scientists used raw species distribution data converted to polygons to a community composition data frame in order to analyze their spread across the continent (Ștefănescu & Marinescu, 2021). In Indonesia Green open space detection was done by using a Planetscope-3A image with 3 meters spatial resolution covering 2 million km2 and analyzed using a vegetation index approach; all with the goal for preserving habitat and keeping as much green space as possible during urban planning (Budi & Akhyar, 2021). Because it is known that systems with many species produce more biomass and capture more resources than those with only a few species, preserving wildlife habitat is essential for the sustainability of humanity and the planet. When it comes to wetlands, scientists note that although hydrology is the main factor controlling the presence and distribution of wetland vegetation, wetland size is also an important predictor of plant communities and especially species richness (Hopple & Craft, 2013). This is why my project focuses on finding the areas of Oklahoma with the least amount of wetland acreage, and therefor likely the least species richness in the state.

Materials and Methods

Plan

In the planning stage of this project ideas for a spatial analysis question were brainstormed and the possible sources to find the data needed to complete them was considered. Once the decision to look at wetland data in Oklahoma counties was made, a plan describing what spatial queries would need to be asked in order to answer research questions was compiled.

Collect

To find out how many wetlands are in each of the counties in Oklahoma census data with county delineated polygons were used along with all the wetland polygons currently mapped for the state. The Fish and Wildlife Service houses the National Lakes Assessment Data for all the United States, including a large dataset for Oklahoma, this is where the geodatabase for the wetland shapefile was sourced from. The United States Census website was used to source the county polygons, and they were a set of TIGER/Line shapefiles that included census data for the entire United States.

Assure/ Describe

The two downloaded geodatabases were first uploaded into ArcPRO in order to determine their projection and SRID. The wetland data and census data were projected differently, one in NAD_1983_Albers and the other (the census data) was not projected, so ArcPRO tools were used to change the wetland projection to match the census data. There were issues trying to get the massive wetland shapefile (over 900,000 polygons) to export correctly, so the data was pared down by cutting all riverine polygons, making the shapefile contain approximately 600,000 polygons. The shapefiles were then exported, and metadata was used to confirm and update table attribute meanings before being uploaded into PgAdmin for PostGIS analysis. Once in PgAdmin the wetlands data had to be updated and projected again to match the census SRID due to being modified earlier.

```sql
ALTER TABLE wetlands6
  ALTER COLUMN geom TYPE geometry(MULTIPOLYGON, 4269)
    USING ST_SetSRID(geom,4269);


select st_srid(geom)
From wetlands6 limit 1;
```

Data output Messages Notifications

	st_srid integer
1	4269

A new table was created to cut the census data down to only include Oklahoma county information before running validity checks on both sets of data.

```sql
CREATE TABLE oklahomacensus AS
SELECT *
FROM censusshapefile
WHERE statefp = '40';
```

```sql
SELECT ST_IsValid(oklahomacensus.geom), ST_IsValidReason(oklahomacensus.geom), gid AS County_polygons
From oklahomacensus
Where ST_IsValid(oklahomacensus.geom) = 'False'
Order by st_isvalid;
```

output Messages Notifications

st_isvalid boolean	st_isvalidreason text	county_polygons integer

```sql
SELECT ST_IsValid(wetlands5.geom), ST_IsValidReason(wetlands5.geom), gid AS Wetland_Polygon
From wetlands5
Where ST_IsValid(wetlands5.geom) = 'False'
Order by st_isvalid
```

a output Messages Notifications

st_isvalid boolean	st_isvalidreason text	wetland_polygon integer
false	Ring Self-intersection[-292111.039999999 1246127.63]	8972
false	Ring Self-intersection[-287146.220000001 1236872.97]	29609
false	Ring Self-intersection[-277850.6 1241408.41]	31961

Next, spatial queries were run in order to determine what the smallest wetland in the dataset was, and conversely which one was the largest by acreage; this process was done more efficiently in this very large dataset by utilizing the “order by” and “desc” command.

```sql
SELECT  namelsad AS county, ST_Area(geom) AS county_size
FROM oklahomacensus AS census
Order by county_size;

SELECT wetland_ty,
   ST_GeometryType(geom),
   ST_Area(geom)
  FROM wetlands5
  Order by st_area;
```

output Messages Notifications

wetland_ty character varying (50)	st_geometrytype text	st_area double precision
Freshwater Forested/...	ST_MultiPolygon	0.00249818002490
Freshwater Emergent ...	ST_MultiPolygon	0.00353200502490
Freshwater Emergent ...	ST_MultiPolygon	0.00371397504891

```sql
SELECT  namelsad AS county, ST_Area(geom) AS county_size
FROM oklahomacensus AS census
Order by county_size;

SELECT wetland_ty,
   ST_GeometryType(geom),
   ST_Area(geom)
  FROM wetlands5
  Order by st_area DESC;
```

output Messages Notifications

wetland_ty character varying (50)	st_geometrytype text	st_area double precision
Lake	ST_MultiPolygon	356582456.993403
Lake	ST_MultiPolygon	309518188.4084919
Lake	ST_MultiPolygon	212007689.46024573

Areal spatial queries were also run on the county census polygons in order to determine the largest and smallest counties in Oklahoma.

```sql
SELECT DISTINCT namelsad AS county,
    ST_GeometryType(geom),
    ST_Area(geom)
  FROM oklahomacensus
  Order by st_area DESC;
```

output Messages Notifications

county character varying (100)	st_geometrytype text	st_area double precision
Osage County	ST_MultiPolygon	0.6012273182081098
Texas County	ST_MultiPolygon	0.5354082885610647
McCurtain County	ST_MultiPolygon	0.4815129807889738

```sql
SELECT DISTINCT namelsad AS county,
    ST_GeometryType(geom),
    ST_Area(geom)
  FROM oklahomacensus
  Order by st_area;
```

output Messages Notifications

county character varying (100)	st_geometrytype text	st_area double precision
Marshall County	ST_MultiPolygon	0.10794672124126267
Murray County	ST_MultiPolygon	0.10805799935712658
Washington County	ST_MultiPolygon	0.1108550524998979

Finally, a spatial join query was run twice in order to determine which counties in Oklahoma had the largest wetland acreage and which ones had the least.

```sql
select DISTINCT census.namelsad As county,
    SUM (wetlands.acres) As total_wetland_acres,
    count (wetland_ty) as count
from oklahomacensus AS census
join wetlands6 as wetlands
on ST_Intersects (census.geom, wetlands.geom)
Group by census.namelsad
Order by total_wetland_acres;
```

output Messages Notifications

county character varying (100)	total_wetland_acres numeric	count bigint
Adair County	11248.6335773953634	8118
Harper County	11758.70107378219094166	7484
Garfield County	13930.831921687393682	12300

```sql
select DISTINCT census.namelsad As county,
    SUM (wetlands.acres) As total_wetland_acres,
    count (wetland_ty) as count
from oklahomacensus AS census
join wetlands6 as wetlands
on ST_Intersects (census.geom, wetlands.geom)
Group by census.namelsad
Order by total_wetland_acres DESC;
```

output Messages Notifications

county character varying (100)	total_wetland_acres numeric	count bigint
Haskell County	309635.0789827269374	12768
Pittsburg County	241105.2648014961620	26006
Okmulgee County	238086.8729291448832	20300

Results

During validity checks all polygons delineating the county census data came back as valid with no issues. However, the wetlands data, with its thousands of polygons, came back with 60 invalid polygons, all with the same error meaning of a self-ring intersection. There was an attempt to have the PgAdmin software bulk correct the polygons, however it did not seem to resolve the issue and those 60 polygons were ignored moving forward. The smallest wetlands included in the dataset were a mix of emergent wetlands and forested wetlands. The largest wetlands in the dataset were all lakes. The top 2 largest counties in Oklahoma were Osage County and Texas County, the smallest were Marshall County and Murray County. The counties with the top three highest acreage of wetlands were Haskell, Pittsburg, and Okmulgee County. The Counties with the least wetland coverage were Adair, Harper, and Garfield County.

Discussion

Different steps of the Data Life Cycle were used throughout this project, and not always in the circular order they were meant to flow in. Due to inexperience and error, there were many times during the Integrate and Analyze phase when I had to go back to the Assure step and change parts of my data in order to analyze it correctly. PgAdmin will serve as this data's archiving service due to its ability to store and save the data I have uploaded and all the changes I have made to it.

During the Analyzing step of this project, it was discovered that neither the top three largest or smallest counties held either the least coverage of wetlands or the most. It has been determined that in Oklahoma, there is likely no relationship between county size and wetland coverage. Nor is there a relationship of the location of counties when it comes to counties with the least wetland coverage, as the bottom three were randomly spaced out all across the state. There is, however, likely a relationship between the counties with the most wetland acreage, because the top three, all were located near the mid-southeast side of the state, surrounding its largest lake, Lake Eufaula.

Conclusion

In Oklahoma, where all of the major large lakes are manmade, wetlands are a vital resource that should be protected. This project used spatial data and analysis to show that it does not matter how small or large a county is in order to predict wetland coverage. However, where green spaces are allowed to thrive and where lakes are taken care of, wetlands can persist even in this hot state known for its vast grasslands.

References

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