Characteristics of the Mississippi Sound Estuary and Watershed

Mississippi Sound Estuary Program

August 8, 2025

Table of contents

Preface

This website is a collection of documents characterizing the Mississippi Sound Watershed, primarily through use of geospatial data. The outputs are compiled as a 'quarto book'. Each chapter is produced by a separate `.qmd` file.

The purpose of the book format is to make the outputs readily findable and accessible. It may also serve as an outline for future undertakings like the State of the Sound report.

Part I

Geographic Setting

Some info here about different ways of describing where we are and what comprises the watershed: USGS HUCs, DEQ's division into different basins, and EPA EcoRegions.

Possibly also the definitions from the CCMP of MS Sound, MS Sound Estuary, and MS Sound Watershed.

1 Watersheds

1.1 HUCs

Nice explanation of HUCs on this USGS page.

The HUCs that make up the Mississippi Sound Watershed are 0317 (Pascagoula) and 0318 (Pearl).

Show some mappy breakdowns.

1.2 MDEQ Basin Boundaries

There are several waterways that don't actually end up in either the Pearl or Pascagoula Rivers. So the Mississippi Department of Environmental Quality uses a slightly different division.

NEED TO CONFIRM, but I think: HUC12s are the same between MDEQ's classification and the USGS HUCs. They're just grouped differently, and the streams that empty into bays or straight into the Sound are the 'Coastal Streams Basin'. There is also a 'Coastal Offshore' grouping, that is comprised of the Sound itself, the islands, and the 3-mile zone beyond the islands.

About

The `.qmd` file that generated this section was: **watersheds.qmd**.

For information on data processing, see Appendix A.1.1.

2 EPA Ecoregions

For some geological classification that isn't based on watershed boundaries, we turn to the EPA's Ecoregions.

2.1 Level 3 Ecoregions

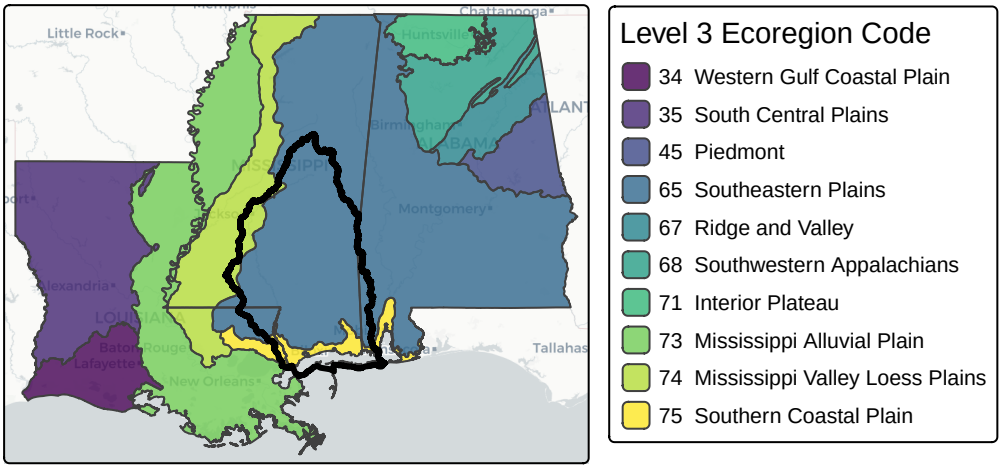

Figure 2.1: Level 3 Ecoregions in Louisiana, Mississippi, and Alabama; the Mississippi Sound Watershed is outlined in black.

The Mississippi Sound Watershed contains 4 level-3 ecoregions:

- 65 Southeastern Plains
- 73 Mississippi Alluvial Plain (in the very southwest corner)

- 74 Mississippi Valley Loess Plains
- 75 Southern Coastal Plain

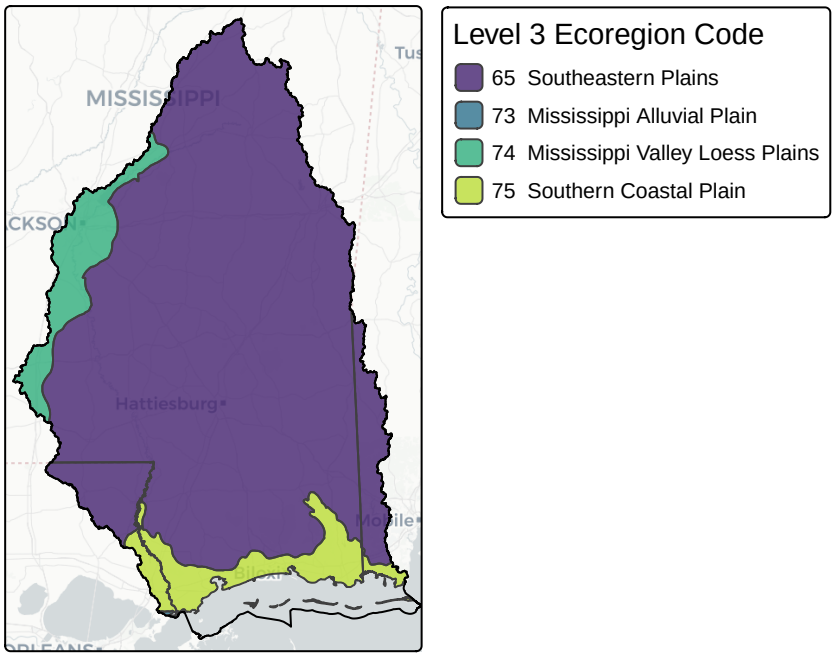

Figure 2.2: Level 3 Ecoregions in the Mississippi Sound Watershed only.

2.2 Level 4 Ecoregions

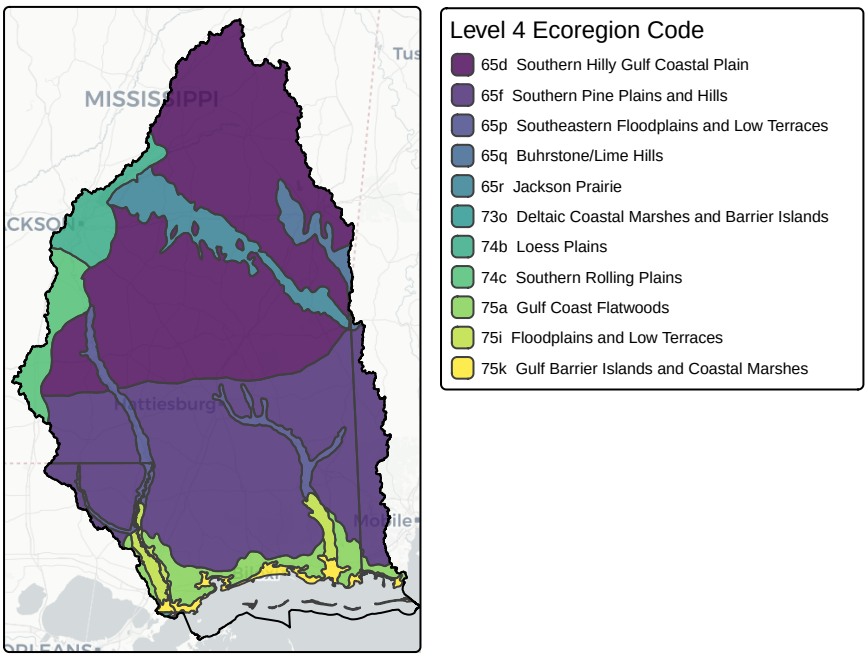

Figure 2.3: Level 4 Ecoregions in the Mississippi Sound Watershed.

About

The `.qmd` file that generated this section was: **EPA_Ecoregions.qmd**.

For information on data processing, see Appendix A.1.2.

Part II

Climatology

Pieces of this part will be things like precipitation, temperature, etc.

3 Precipitation

The maps and information below were generated from gridded (spatial) climate normals: values averaged over 15, 30, or 100 years. Data were obtained from the National Centers for Environmental Information (NCEI).

3.1 Annual Totals

The coast receives more rain annually than more inland portions of Louisiana, Mississippi, and Alabama (Figure 3.1). Based on 30-year climate normals (1991-2020), median annual precipitation in the Mississippi Sound Watershed is 60 inches. The lowest annual totals, around 56 inches per year, occur in the northern part of the watershed, with coastal areas receiving around 66 inches per year. These 30-year normals are somewhat higher than the 100-year baseline period of 1901-2000 (min: 52 in; median: 58 in; max: 64 in).

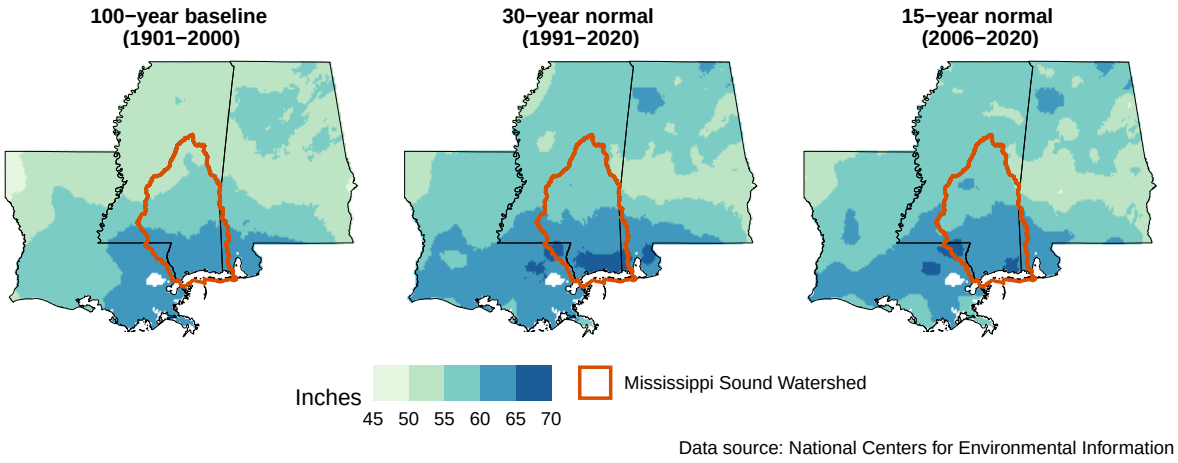

Figure 3.1: Annual Precipitation averaged over 100, 30, and 15 years.

3.2 Monthly Totals (30-year normal)

Seasonal patterns of precipitation also differ throughout the Mississippi Sound Watershed (Figure 3.2). Coastal areas receive most annual precipitation from June through August (up to 8 inches along the coast in July), while more inland areas receive the most from winter through spring. Tropical storms and hurricanes can and do cause higher precipitation totals than these averages; the peak of hurricane season is typically September-October.

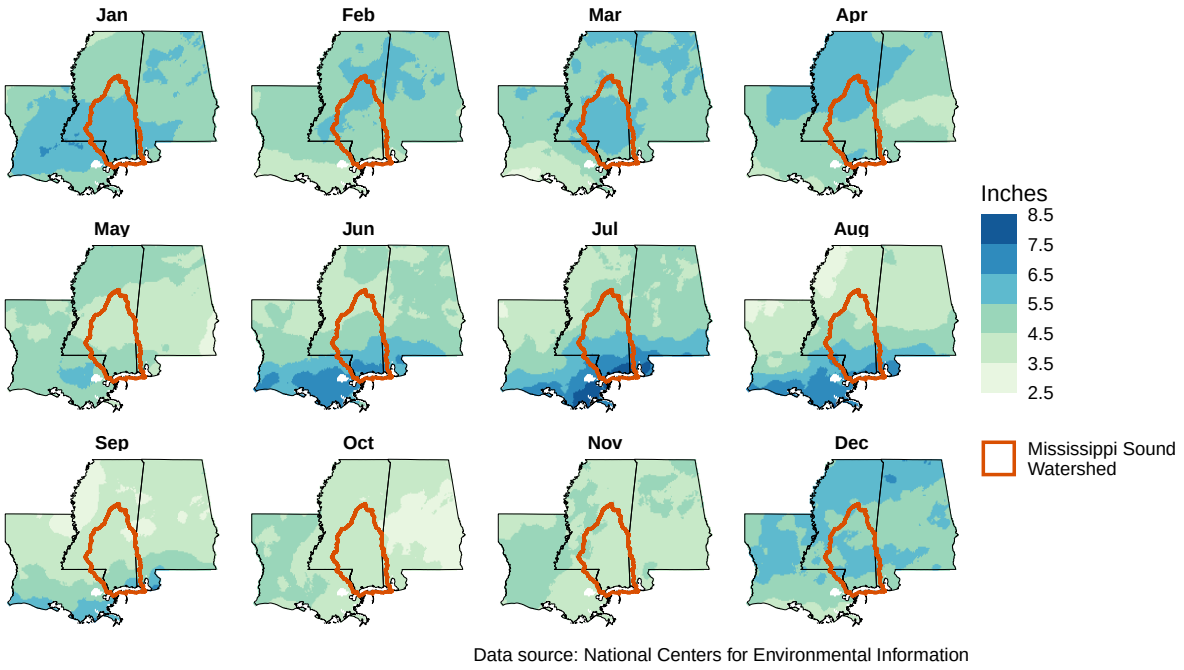

Figure 3.2: Monthly Precipitation, averaged over 30 years.

About

The `.qmd` file that generated this section was: **precipitation.qmd**.

For information on data processing, see Appendix A.2.1.

4 Temperature

The maps and information below were generated from gridded (spatial) climate normals: values averaged over 15, 30, or 100 years. Data were obtained from the National Centers for Environmental Information (NCEI).

4.1 Annual Mean Temperature

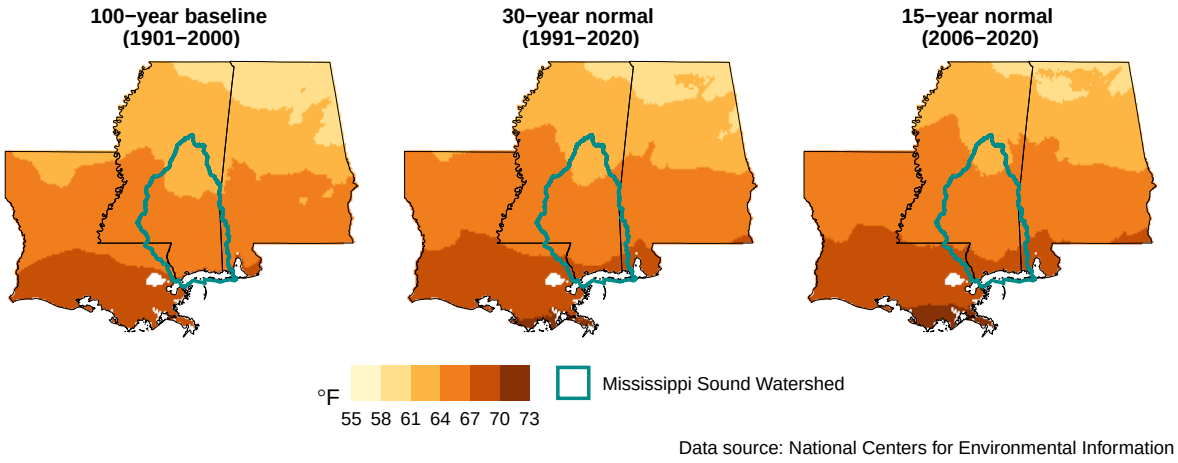

Figure 4.1: Annual Mean Temperature averaged over 100, 30, and 15 years.

4.2 Monthly Mean Temperature

4.2.1 30-year normals

Based on monthly averages over a 30-year period (1991-2020; see Table 4.1 and Figure 4.2), the coldest month in the Mississippi Sound Watershed is January. The lowest mean January value, in the northern part of the watershed, is 43.5 °F, with temperatures along the coast being higher at 52 °F. The hottest month is July, at 79.8 °F in the northern part of the watershed and 82.7 °F along the coast.

Table 4.1: Monthly mean temperature by month in the Mississippi Sound Watershed, averaged over 30 years (1991-2020). For each month, the minimum, mean, and maximum of the monthly means within the watershed are provided.

Month	min	mean	max
Jan	43.5	48.1	52.0
Feb	47.4	52.0	55.7
Mar	54.7	58.5	61.4
Apr	61.9	64.9	67.9
May	70.1	72.5	75.3
Jun	77.2	78.8	81.1
Jul	79.8	81.1	82.7
Aug	79.3	80.6	82.9
Sep	74.0	76.2	79.4
Oct	63.1	66.1	70.8
Nov	52.3	55.9	60.6
Dec	45.8	50.1	54.3

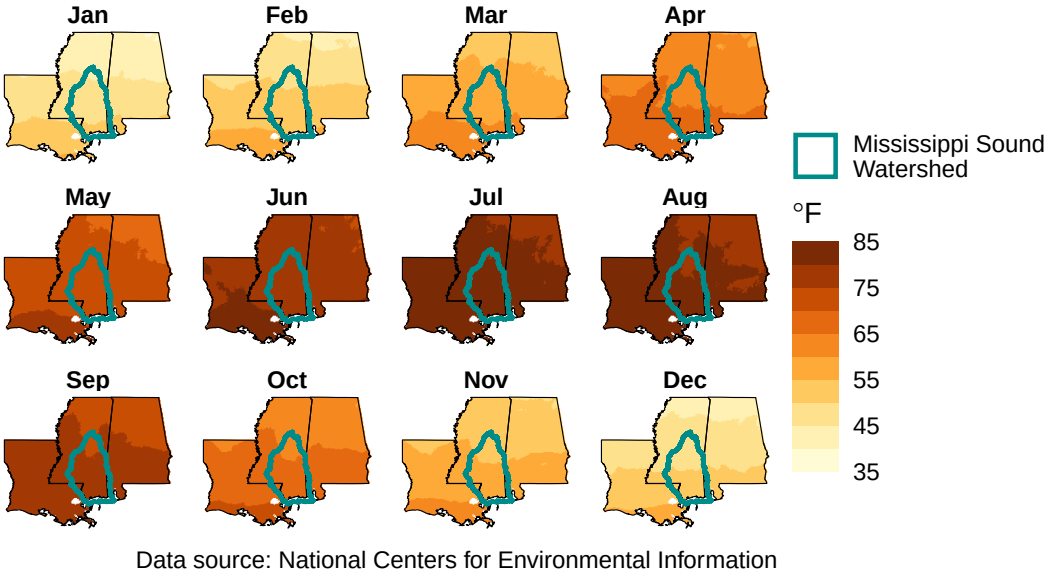

Figure 4.2: Monthly mean temperature averaged over 30 years (1991-2020).

4.2.2 Comparing time periods

The maps below show only a subset of months. Each map contains the averages over a 100-year baseline, and 30- and 15- year normals. Each time period is a row, and the months line up vertically. Louisiana in particular shows some differences based on the time of aggregation in March and June.

4.2.2.1 Cool Months

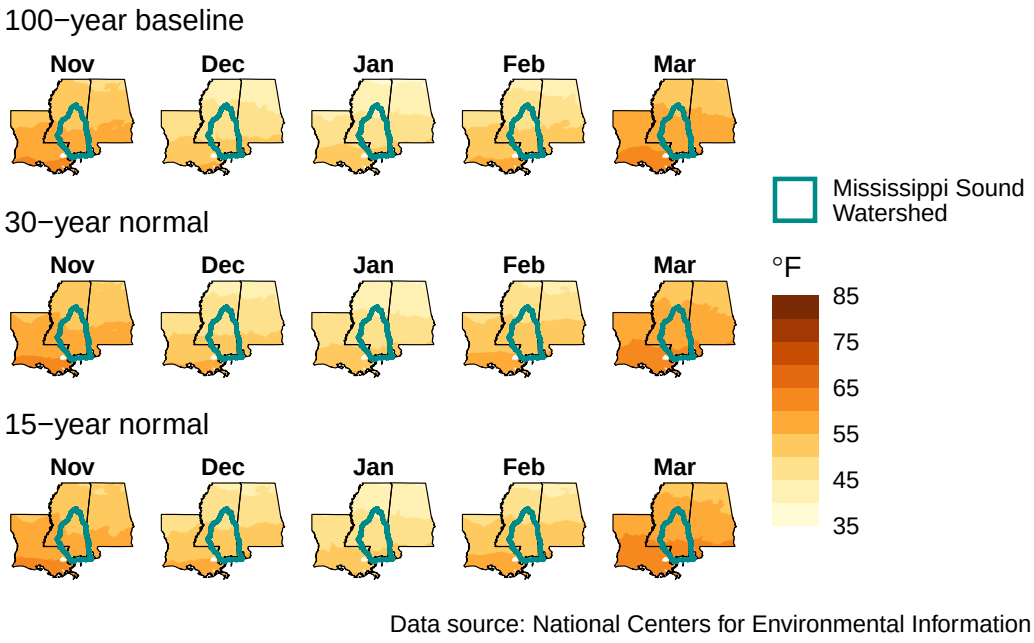

Figure 4.3: Comparison of long-term winter temperature averages across a 100-year baseline, and 30- and 15-year normals.

4.2.2.2 Warm Months

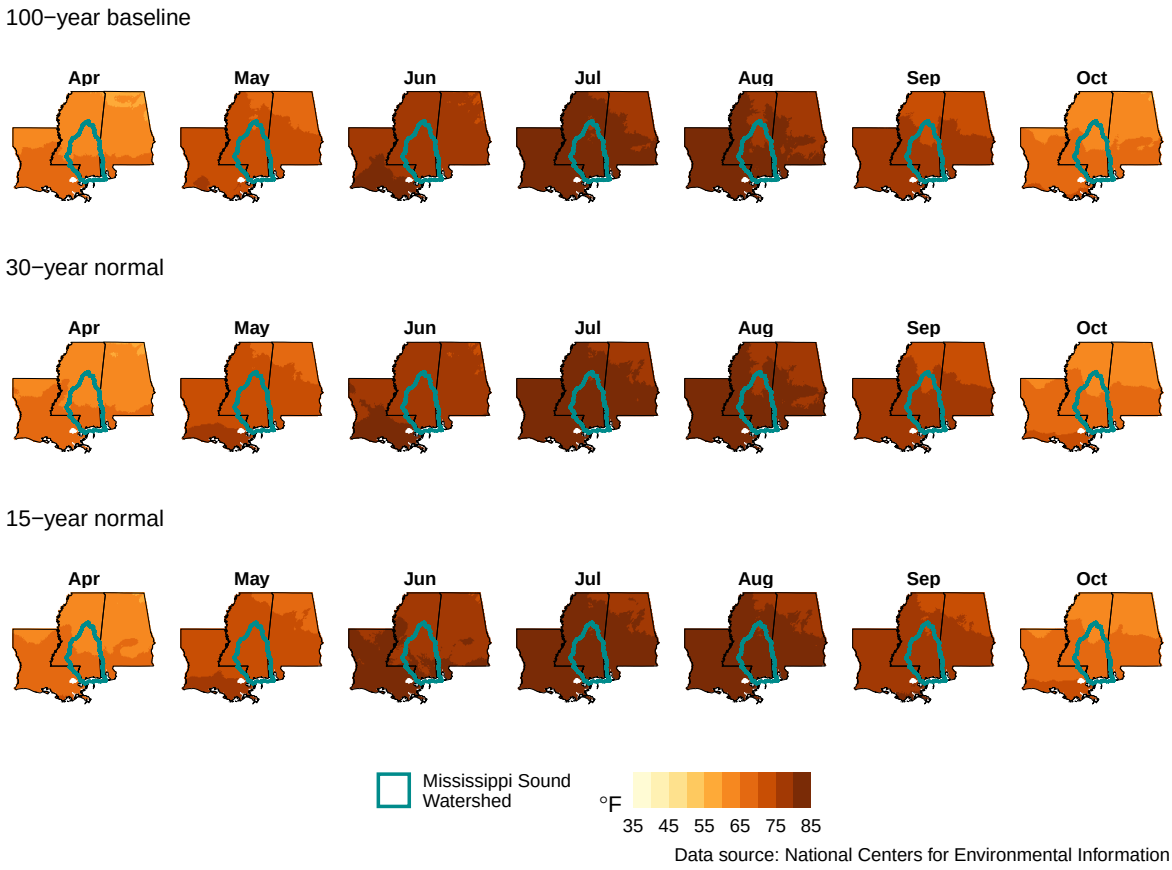

Figure 4.4: Comparison of long-term spring and summer temperature averages across a 100-year baseline, and 30- and 15-year normals.

About

The `.qmd` file that generated this section was: **temperature.qmd**.

For information on data processing, see Appendix A.2.2.

Part III

Hydrology

Freshwater inflows from the different sources, salinity characteristics, etc.

5 Streams and Waterbodies

5.1 Amount of water

e.g. how many miles of streams, how many acres of lakes/ponds/etc. in the watershed

TO-DO: Calculate this by basin (MDEQ definitions, not HUCs)

5.1.1 Stream Lengths

Table 5.1: Length (mi) of stream types in the MSEP watershed

Type	total_miles
Artificial Path	1,496.8
Canal/Ditch	145.3
Coastline	308.7
Connector	26.6
Stream/River	5.2
Stream/River: Intermittent	20,350.3
Stream/River: Perennial	11,730.7

5.1.2 Waterbody Areas

Table 5.2: Total area (acres) of water body types in the MSEP watershed

Type	total_acres
Lake/Pond: Intermittent	70.6
Lake/Pond: Perennial	67,602.0
Lake/Pond: Perennial; Average Water Elevation	27,726.5
Lake/Pond: Perennial; Normal Pool	9.5
Reservoir	48.2
Reservoir: Aquaculture	471.6
Reservoir; Treatment	954.8

Table 5.2: Total area (acres) of water body types in the MSEP watershed

Type	total_acres
Swamp/Marsh	251,495.2

5.2 Designated Uses

The Mississippi Department of Environmental Quality (MDEQ), per the federal Clean Water Act of 1972, is responsible for classifying surface waters in Mississippi into 'designated uses' (e.g. fish and wildlife, recreation, shellfish harvesting, public water supply) and creating water quality standards to ensure designated uses can be met. More detail on designated uses and water quality standards can be found on MDEQ's website.

A 305(b) report (the most recent as of this writing is from 2024; pdf available here) is generated every other year, and quantifies how many and which water bodies are / are not meeting the criteria for their designated use.

Here, we are only summarizing designated uses within the Mississippi Sound Watershed - not assessment of whether criteria are met. See the 305(b) report linked above for more detailed information.

The tables below do not include the general 'Fish and Wildlife' designation; that designation applies to most waters of the state.

Table 5.3: Miles of streams with each designated use in the MS Sound Watershed

Code	Description	Miles
REC	Recreation	1,011.6
PWS	Public Water Supply	26.3
SHF-REC	Shellfish Harvesting & Recreation	25.3
FW1	Fish and Wildlife	10.4
EPH	Ephemeral	1.8

Table 5.4: Area of non-linear waterbodies with each designated use in the MS Sound Watershed

Code	Description	Square Miles	Acres
REC	Recreation	742.2	475,019.3
PWS	Public Water Supply	34.8	22,259.2
SHF-REC	Shellfish Harvesting & Recreation	22.0	14,100.5
PWS-REC	Public Water Supply & Recreation	0.2	119.8

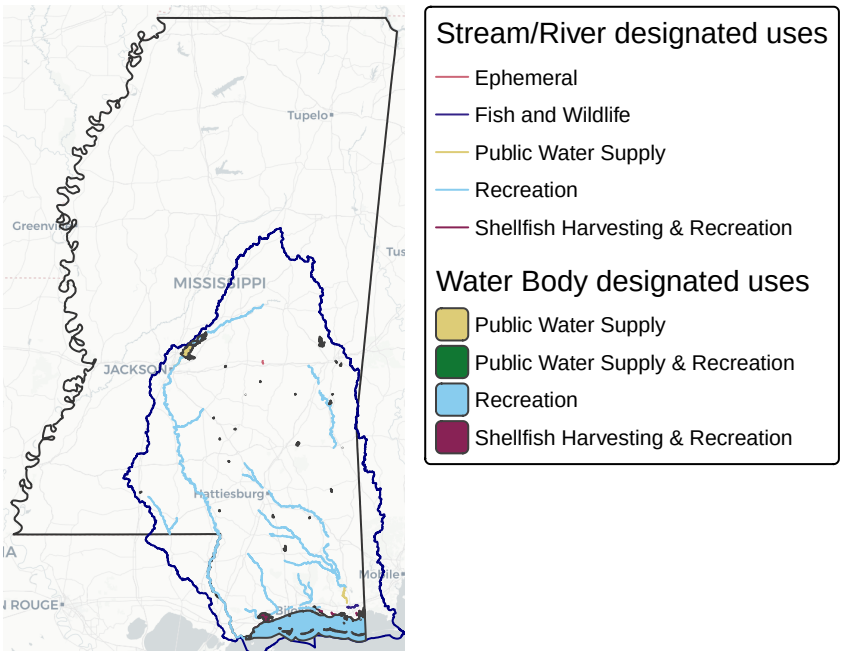

Figure 5.1: Designated uses of streams and waterbodies of the Mississippi Sound Watershed (navy outline on map), within the state of MS, as defined by MDEQ in the 2015 Water Quality Standards dataset. Data provided by MDEQ.

5.3 Impairments

303d, TMDLs - How many, where are they, what are the TMDLs for. What problems are we dealing with in the watershed.

About

The `.qmd` file that generated this section was: **streams_waterbodies.qmd**.

For information on data processing, see Appendix A.3.1.

6 Freshwater Inflows

Pearl River, Pascagoula River, bays. Do some summarizing based on USGS gage data?

About

The `.qmd` file that generated this section was: **freshwater_inflows.qmd**.

For information on data processing, see Appendix A.3.2.

7 Salinity

Summarize the info from the Gulf Data Atlas (e.g. the maps that went into the CCMP). Would be great to summarize the USGS salinity data and DMR's sampling data as well - some seasonal and annual details would be great.

About

The `.qmd` file that generated this section was: **salinity.qmd**.

For information on data processing, see Appendix A.3.3.

Part IV

People and Land Use

Here's where population calculations and land use/land cover summaries can be generated.

8 Population

The values calculated below are based on 2020 US Census data. The population estimate for the entire state of Mississippi was ~2.96 million in 2020.

8.1 Entire watershed

This estimate includes the portions of the watershed in Louisiana and Alabama:

1,718,504

8.2 Watershed in the state of MS

This estimate includes the state of Mississippi only:

1,539,090

About

The `.qmd` file that generated this section was: **population.qmd**.

For information on data processing, see Appendix A.4.1.

9 Land Use / Land Cover

Summarize LULC info by MDEQ basin here

About

The `.qmd` file that generated this section was: **landuse_landcover.qmd**.

For information on data processing, see Appendix A.4.2.

Summary

Unsure what would go in a summary chapter ……

A Data Processing

In general, links to original data sources are provided in each section below. Because data files are routinely updated, the files as downloaded and used in this document are also available online. These files are provided for reproducibility and transparency; for your own analyses, we encourage you to seek out data from the original linked sources.

A.1 Geographic Setting

A.1.1 Watersheds

Jump to Chapter 1

A.1.1.1 HUCs

stuff

A.1.1.2 MDEQ Basins

Shapefiles were provided by the Mississippi Department of Environmental Quality in August 2025. The zipped shapefiles are available in the DEQ_basins folder of the msepCharacterization data files directory. **However, we encourage you to contact MDEQ to get the most up-to-date files for your own analyses.**

A.1.2 EPA Ecoregions

Jump to Chapter 2

Level 3 and 4 Ecoregion shapefiles were downloaded from the EPA's website on 16 June 2025 for the states of MS, AL, and LA.

The original downloaded files along with their metadata files are available in the EPA EcoRegions folder of the msepCharacterization data files directory.

Those files were read in, combined, and clipped to the Mississippi Sound Watershed boundaries (using the `outline_full` object from the `{msepBoundaries}` package) using the script `EPAEcoRegion_subsetting.R` (on github) in the `R_preprocessing` folder. Three objects resulted: `level3_lamsal`, level 3 ecoregions for the 3 states combined; `level3_mssoundwatershed`, level 3 ecoregions trimmed to only the Mississippi Sound Watershed area; and `level4_mssoundwatershed`, level 4 ecoregions trimmed to only the Mississippi Sound Watershed area. The level 4 ecoregions for the entire three states were not retained because there were so many categories; it really only makes sense to look at these at the smaller level.

The resulting objects were saved as layers of a geopackage, `EPA_EcoRegion.gpkg` in the `data/processed` folder. These files are available in the processed folder of the msepCharacterization data files directory.

A.2 Climatology

A.2.1 Precipitation

Jump to Chapter 3

Precipitation normals (over 15 and 30 years, and a 100-year baseline: 2006-2020, 1991-2020, and 1901-2000 respectively) were downloaded as "gridded normals" from the National Centers for Environmental Information Climate Normals website as netCDF (.nc) files. The downloaded files as used are available in the Precipitation_NCEI folder of the msepCharacterization data files directory.

These were subsetted to only monthly and annual value layers (removing layers with sd, min, max, and flags) and trimmed geographically to the states of MS, LA, and AL in the file `Precipitation_subsetting.R` (on github) in the `R_preprocessing` folder.

The resulting files were saved as netCDF files `prcp_15yearNormals.nc`, `prcp_30yearNormals.nc`, and `prcp_100yearBaseline.nc` in the `data/processed` folder. These files are available in the processed folder of the msepCharacterization data files directory.

A.2.2 Temperature

Jump to Chapter 4

Average Temperature normals (over 15 and 30 years, and a 100-year baseline: 2006-2020, 1991-2020, and 1901-2000 respectively) were downloaded as "gridded normals" from the National Centers for Environmental Information Climate Normals website as netCDF (.nc) files. The downloaded files as used are available in the Temperature_NCEI folder of the msepCharacterization data files directory.

These were subsetted to only monthly and annual value layers (removing layers with sd, min, max, and flags) and trimmed geographically to the states of MS, LA, and AL in the file `Temperature_subsetting.R` (on github) in the `R_preprocessing` folder.

The resulting files were saved as netCDF files `tempAvg_15yearNormals.nc`, `tempAvg_30yearNormals.nc`, and `tempAvg_100yearBaseline.nc` in the `data/processed` folder. These files are available in the processed folder of the msepCharacterization data files directory.

A.3 Hydrology

A.3.1 Streams and Waterbodies

Jump to Chapter 5

A.3.1.1 Stream Lengths and Waterbody Areas

Stream Lengths and Waterbody Areas were calculated from the EPA's NHDPlus dataset. Files for the South Atlantic (03f) and Lower Mississippi River (03g) regions were downloaded on 12 June 2025. The original downloaded files are available in the EPA NHDPlus folder of the msepCharacterization data files directory.

Those files were read in, combined, and clipped to only the Mississippi Sound Watershed boundaries (using the `outline_full` object from the `{msepBoundaries}` package) using the script `EPANHD_subsetting.R` (on github) in the `R_preprocessing` folder. The resulting files were saved as geopackages `EPA_NHDplus_flowline_MSEP.gpkg` and `EPA_NHDplus_waterbody_MSEP.gpkg` in the `data/processed` folder. These files are available in the processed folder of the msepCharacterization data files directory.

A.3.1.2 Designated Uses

Shapefiles of designated uses, already limited to the portion of the Mississippi Sound Watershed that lies within the state of MS, were provided by the Mississippi Department of Environmental Quality (MDEQ) in April 2025. These files provide the designated uses for each waterbody from the 2015 Water Quality Standards dataset. The Mississippi Sound Watershed is made up of MDEQ's Pearl River, Pascagoula River, and Coastal Streams basins. Per MDEQ, "all waters in those 3 basins not specifically listed in the data provided are classified as Fish and Wildlife." See their website for more information.

The zipped shapefiles are available in the DEQ_designated_uses folder of the msepCharacterization data files directory. **However, we encourage you to contact MDEQ to get the most up-to-date files for your own analyses.**

A.3.1.3 Impairments

Not done yet but see MDEQ's online TMDL Tool.

A.3.2 Freshwater Inflows

Jump to Chapter 6

Stuff

A.3.3 Salinity

Jump to Chapter 7

Stuff - Gulf Data Atlas especially

A.4 People and Land Use

A.4.1 Population

Jump to Chapter 8

A.4.1.1 Dasymetric Population Estimates

The EPA EnviroAtlas's dasymetric population datasets "intelligently reallocate … population from census blocks to 30 meter pixels based on land cover and slope". The national datasets for 2010 and 2020 were downloaded as raster files on 24 July 2025. Only the 2020 dataset has been used here.

The original downloaded file (zipped; ~3.6 GB) is available in the Population folder of the msepCharacterization data files directory.

The dataset was trimmed to Mississippi Sound Watershed boundaries (using the `outline_full` object from the `{msepBoundaries}` package) using the script `Population_2020_subsetting.R` (on github) in the `R_preprocessing` folder.

The resulting file, `Population_Dasymetric_2020.tif`, is available in the processed folder of the msepCharacterization data files directory.

A.4.2 Land Use / Land Cover

Jump to Chapter 9

Stuff

About

The `.qmd` file that generated this section was: **data_processing.qmd**.