**NASA DEVELOP National Program**

Mobile County Health Department and NASA Marshall Space Flight Center at NSSTC

*Summer 2017*

**Short Title: Coastal Alabama Oceans**

**Subtitle:** Using NASA Earth Observations to Evaluate Water Quality in Coastal Alabama to Enhance Marine Wildlife Management

**VPS Title:** When Bay is Acting Salty: Monitoring Water Quality in the Mobile Bay and Mississippi Sound

**Project Team**

**Project Team:**

Mercedes Bartkovich (Project Co-Lead), bartkovichm@gmail.com

Xin Hong (Project Co-Lead), xin.hong.11.29@gmail.com

Leah Parker

Amy Schwarber

**Advisors & Mentors:**

Dr. Jeffrey Luvall (NASA Marshall Space Flight Center)

Dr. Robert Griffin (University of Alabama in Huntsville)

Dr. Maury Estes (NASA Marshall Space Flight Center, University Space Research Association)

Dr. Kenton Ross (NASA Langley Research Center)

Joseph Spruce (Science Systems and Applications, Inc)

Leigh Sinclair (University of Alabama in Huntsville, Information Technology and Systems Center)

**Project Overview**

**80-100 Word Objectives Overview:**

The Mobile Bay and Mississippi Sound have historically provided vital habitat for a diverse array of wildlife species, including Eastern oysters and West Indian manatees. Located along the coast of Alabama and Mississippi, the health of these estuaries can have both direct and indirect effects on marine wildlife, commercial fisheries, and water recreational activities. Local research organizations need more precise and economical water quality measurements than those provided by their current methods. This project created time series analyses and habitat suitability maps to enhance the understanding of salinity, turbidity, and temperature effects on oyster and manatee habitats within the Mobile Bay and Mississippi Sound.

**Abstract:**

The Mobile Bay and Mississippi Sound are the main coastal estuaries along the Alabama and Mississippi Gulf Coast. They serve as the primary drainage outlets for the Mobile Bay and Pascagoula River watersheds and provide a gradient of coastal water salinity conditions needed for a diversity of wildlife species and coastal habitat types. Coastal water “health” conditions have a direct impact on the native biota that are sensitive to water quality, including the Eastern oyster (*Crassostrea virginica*), a keystone species, and the West Indian manatee (*Trichechus manatus*), a vulnerable species. This project addressed the dynamic coastal ecosystem by creating time series analyses to monitor salinity, temperature, and turbidity changes for the Mobile Bay and Mississippi Sound from June 2007 to May 2017. The Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) was used to detect salinity and sea surface temperature, while Landsat 5, Landsat 8, and Sentinel-2 Multispectral Instrument (MSI) were employed to detect turbidity levels and validate sea surface temperature. Such data products were used to compute habitat suitability maps for oysters and manatees in the Mobile Bay and Mississippi Sound to assess the optimal areas and conditions for habitat restoration initiatives. Project partners will use product results to better understand manatee movements and habitat suitability for oysters.

**Keywords:**

Aqua MODIS, Landsat, Sentinel-2, time series analyses, habitat suitability maps, Mobile Bay, Mississippi Sound, water quality

**Partner Organizations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Alabama Coastal Foundation (ACF) | Mark Berte, Executive Director | End User | Yes |
| The Nature Conservancy (TNC) | Dina Knight, Conservation Information Manager | End User | No |
| Dauphin Island Sea Lab, Manatee Sighting Network | Dr. Ruth Carmichael, Senior Marine Scientist II | Collaborator | No |

**Community Concerns:**

* Sediments, pollutants, and runoff from the Mobile Bay Watershed and the Pascagoula River Watershed collect within the Mobile Bay and Mississippi Sound and affect the quality of the ecosystem.
* Many community leaders, researchers, and commercial fisheries on the Gulf Coast heavily rely on measurements of temperature, turbidity, and salinity to assist their businesses, hobbies, and research.
* According to The Nature Conservancy, 35% of the nation’s oysters come from the Gulf of Mexico and globally, oyster reefs are the single most impacted marine habitat with more than 85% habitat loss of historic coverage.
* The IUCN Red List classifies the West Indian manatee as vulnerable, with less than 7,000 individuals alive in US waters.
* West Indian manatee migration patterns are impacted by the salinity changes within the Mobile Bay and Mississippi Sound. Only a limited amount of suitable habitat remains.

**Current Decision-Making Practices & Policies**:

The Alabama Coastal Foundation (ACF), The Nature Conservancy (TNC), and the Dauphin Island Sea Lab (DISL) currently depend on field measurements and buoy data in order to collect salinity, temperature, and turbidity measurements for management practices involving marine wildlife. The ACF must rely on their partners and the state for data research because they currently do not have a geospatial analyst on site. Federal and local councils decide which projects they will fund, limiting the ACF from pursuing certain research topics. The Nature Conservancy works on a plethora of restoration projects along the Alabama coast. They currently rely on field data, historical data, grants, permits, predictive models, impact assessments, and collaborative efforts to determine the most suitable areas for oyster reintroduction. The DISL Manatee Sighting Network collects data from reported manatee sightings and tracking devices on specific manatees in order to study their movement patterns. During the summer, the DISL collects *in situ* water quality data every two weeks; however, the scientists wish to improve resulting salinity models by incorporating remote sensing data. The DISL is currently researching ways to forecast manatee movement in the future.

**Decision Support Tools & Benefits:**

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| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software****Release** |
| Coastal Salinity Time Series Analysis | Aqua MODIS | This end product fills a data gap for the end user. The end user currently does not have reliable salinity measurements available for their decision-making processes. | N/A |
| Sea Surface Temperature Time Series Analysis | Landsat 5 TMLandsat 8 TIRSAqua MODIS | This end product provides the end users with measurements of sea surface temperature for the area and assists in establishing baseline conditions. | N/A |
| Turbidity Time Series Analysis | Landsat 5 TMLandsat 8 OLISentinel-2 MSI | This end product provides the end users with measurements of turbidity for the area and assists in establishing baseline conditions. | N/A |
| Oyster Habitat Suitability Map | Aqua MODISLandsat 5 TMLandsat 8 OLI & TIRSSentinel-2 MSI | This end product benefits the end users by providing them with a visualization of promising oyster restoration locations. This product better informs the end users of where to focus resources. | N/A |
| Manatee Habitat Suitability Maps | Aqua MODISLandsat 5 TMLandsat 8 OLI & TIRSSentinel-2 MSI | This end product benefits the end users by providing them with a visualization of areas where habitat may be changing for manatees. This product better informs the end users of where to focus resources. | N/A |

**Project Benefit to End User**:

The project partners have expressed the need for a less time consuming method to obtain water quality data and for direction on where oyster rehabilitation efforts should go next. The Time Series Analyses and Habitat Suitability Maps created from this project will reduce the cost and time that is typically associated with water quality sampling and provide project partners with additional information for research. The ACF would like to ensure that the information from this project has a large impact for all of its partners throughout the state. As a result, they will not only utilize information from the project themselves, but will use the information to educate the public and will distribute the resulting products amongst their partners, including DISL and TNC. The Nature Conservancy will use the Time Series Analyses and Habitat Suitability Maps to supplement data not only for oyster restoration, but also for overall ecological community restoration. The DISL will use the Time Series Analyses and Habitat Suitability Maps to expand their Manatee Sighting Network research.

**Project Details**

**Applied Sciences National Applications Addressed:** Oceans, Water Resources

**Study Area:** Mobile Bay, AL and Mississippi Sound, MS

**Study Period:** June 2007 – May 2017

**Earth Observations & Parameters:**

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| Aqua MODIS | Sea surface temperature, remote sensing reflectance | Daily composites of Ocean Color were used to detect sea surface temperature and calculate an algorithm that can estimate salinity levels throughout the Gulf Coast. |
| Landsat 5 TM | Surface reflectance, temperature | Bands 3 and 4 were used to detect turbidity, and band 6 was used to detect sea surface temperature along the Gulf Coast. |
| Landsat 8 OLI & TIRS | Surface reflectance, temperature  | Bands 1, 2, and 3 were used to detect turbidity, and bands 10 and 11 were used to detect sea surface temperature along the Gulf Coast. |
| Sentinel-2 MSI | Surface reflectance | Bands 4 and 8 in Sentinel-2 MSI were used to detect turbidity along the Gulf Coast. |

**Ancillary Datasets Utilized:**

* Mobile Bay National Estuary Program (MBNEP) Buoy Data – water quality measurements throughout the Gulf Coast
* Dauphin Island Sea Lab Manatee Tracking Data – GPS and manatee sighting locations
* Alabama Department of Environmental Management with the Alabama Department of Public Health Water Quality Summary – data from water monitoring sites along the Mobile Bay from Perdido Bay to Dauphin Island
* Mississippi Department of Marine Resources (MDMR) Buoy Data- data from water monitoring sites along the Mississippi Sound
* USGS Water Resources Water Quality Daily Data – data from water monitoring sites along the Mississippi Sound
* National Data Buoy Center (NDBC) Buoy Data – water quality measurements throughout the Gulf Coast
* Gulf of Mexico Coastal Ocean Observing System (GCOOS) Buoy Data – water quality measurements throughout the Gulf of Mexico

**Software Utilized:**

* Esri ArcMap – raster processing and manipulation, vector data processing, map creation of Aqua MODIS, Landsat 5 TM, Landsat 8 OLI and TIRS, and Sentinel-2
* SeaDAS – raster processing and manipulation of remote sensing reflectance and sea surface temperature data
* ACOLITE – Landsat 5 TM, Landsat 8 OLI and TIRS, and Sentinel-2 MSI data processing to analyze turbidity
* Exelis ENVI – raster processing and manipulation of Aqua MODIS, Landsat 5 TM, Landsat 8 OLI and TIRS, and Sentinel-2 MSI data to analyze temporal water quality changes

**Project Handoff Package**

**Transition Plan:**

During the last week of the project, the team will meet with the Executive Director of the ACF, Mark Berte, the Conservation Information Manager of TNC, Dina Knight, and the Marine Biologist at DISL, Dr. Ruth Carmichael, and give them the handoff package as well as present the material. These items will be sent to the ACF, TNC and DISL electronically as well. Final results of the project will also be presented at the Mobile Bay NEP Science Advisory Council meeting after the project has concluded.

**Team POC:** Mercedes Bartkovich (Project Co-Lead), bartkovichm@gmail.com; Xin Hong (Project Co-Lead) xin.hong.11.29@gmail.com

**Handoff Package:**

* All deliverables
* Link to VPS
* Excel file with data
* Text file explaining data
* Habitat suitability map for (1) manatees and (2) oyster restoration
* Maps that show time series analyses for (1) salinity, (2) turbidity, and (3) temperature
* All shapefiles and ArcMap documents