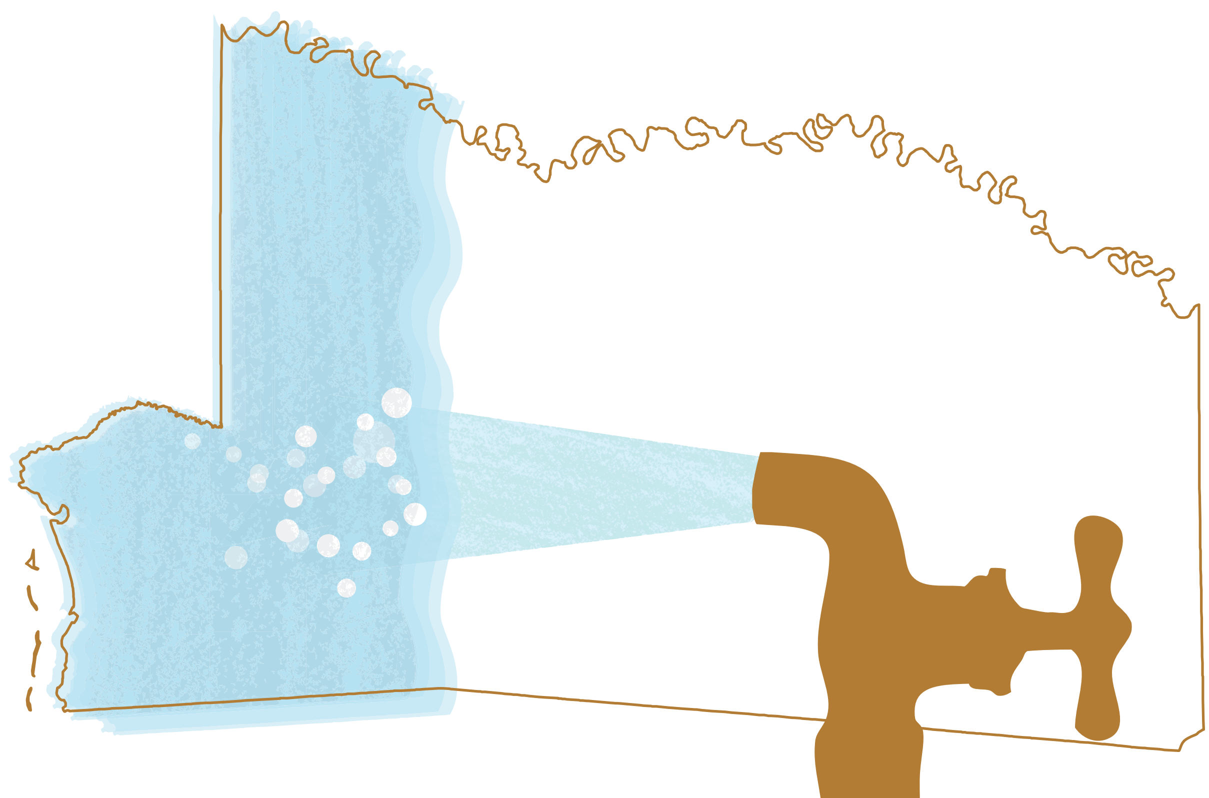
2015

Mississippi Water Resources Conference

Jackson Hilton

Jackson, MS



2015

Mississippi Water Resources Conference

Hilton Jackson

Jackson, MS

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Evaluation of Management Strategies to Promote Water Resource Conservation in Louisiana

Adusumilli, N.; Davis, S.

The need to safeguard water availability within Louisiana has become critical, not only to sustain the state's water resources, but also to the sustainability of sectors that depend on this important resource. Competition for surface and groundwater supplies in only increasing in the state due to many factors including demand from sectors like industry, power generation, public supply, aquaculture, increasing irrigated acreage of crops, and prolonged droughts periods. Hence, planning should be geared toward identification of strategies that ensure water availability for all reasonable present and future needs and promote conservation of water resources. Selection and/or implementation of a strategy depends on long-term objectives, economic concerns, and the willingness of the stakeholders to embrace the perspectives on water management. Thus, identification of strategies that include tools, practices, and policies that promote conservation and efficiency is critical to motivate adoption and reduce stress on aquifers, reservoirs, and other surface water sources. More specifically, the strategies should emphasize water conservation, economic incentives to conserve water, and public education. Potential benefits of improving water use efficiency include costs reductions, environmental protection, reduce losses and waste of water, and reduction in energy consumption. The strategies identified will provide planners and decision makers with the information needed toward developing a long-term statewide water management plan.

Utilizing NASA Earth Observations to Assist the Audubon Mississippi Coastal Bird Stewardship Program with Habitat Monitoring and Restoration Planning Activities

Barrett, S.; Beasley, B.; Wylie, L.; McDaniel, B. ; Bosarge, A.

Many migratory and coastal bird species found on the Mississippi Gulf Coast have specialized habitat requirements. The degradation of habitat for nesting and foraging from recent natural disasters and anthropogenic activity has contributed to nationally evident population decline of multiple migratory and coastal bird species. The Audubon Mississippi Coastal Bird Stewardship Program (CBSP) is working to improve coastal avifauna populations through habitat monitoring and educating the public on the importance of coastal and migratory birds. Landsat 8 Operational Land Imager (OLI) imagery from 2014 was used to produce a 15 meter land cover classification for Hancock, Harrison, and Jackson counties on the Mississippi coast. Nesting and foraging habitat suitability maps were created for several species of concern. Water quality indicator maps were also generated from Moderate Resolution Imaging Spectroradiometer (MODIS) data for the Mississippi coastline. These products allowed CBSP to gain a greater spatial understanding of how birds are using the habitat to enhance their decision making in relation to habitat and species conservation and restoration planning activities.

Background Information

In the last ten years, two major events have had a significant impact on the Mississippi Gulf Coast and the coastal and migratory avifauna that depend on this area for habitat. On August 29, 2005, Hurricane Katrina caused wide-scale devastation to the area. The storm ravaged coastal bird populations, as well as habitats critical to both native and migrating species. Almost five years later, The BP Deepwater Horizon oil spill inflicted its own damage to the area. These disasters have had an undeniable effect on the birds, both native and migratory, of Mississippi's coastal beaches. As the result of these two events, nesting success could be negatively impacted and fewer numbers of coastal birds supported in the habitat. Many bird species have strict requirements for suitable habitat and those species that migrate will often seek to return to their own hatching site. The degradation of habitat for nesting and foraging that has occurred in recent years has contributed to the national decline in numbers of migratory and coastal birds.

This project focused on several coastal and migratory bird species that are found on the Mississippi Gulf Coast during some part of the year, including the least tern, black skimmer, brown pelican, snowy plover, and American oystercatcher. Their required habitat is delicate and changes to it could quickly lead to harsh declines in population and an uncertain future for the species.

Water quality surrounding nesting and foraging habitat is also important in determining habitat suitability. Poor water quality affects the health of prey species such as invertebrates and fish and consequently, the health of the birds, as any contaminants found in prey that is eaten have the potential to be retained. Since bird populations are influenced directly by the conditions of their habitat, birds are often indicators of the overall health of an ecosystem (State of the Birds 2009).

Project Objectives

This project aimed to develop and demonstrate mapping products and methodologies for classifying and mapping coastal and migratory bird habitats along Southern Mississippi's coast and barrier islands. Bird species included the American oystercatcher, black skimmer, brown pelican, least tern, snowy plover, red knot, and short-billed dowitcher. This project provided the end-users with several mapping products including: classifications of suitable nesting and foraging habitats along the coast for several coastal and migratory shorebird species of concern, updated land cover classification, Moderate-Resolution Imaging Spectroradiometer (MODIS) derived water quality indices such as Colored Dissolved Organic Matter (CDOM) and Chlorophyll-a. These maps were utilized by project partners with the Coastal Bird Stewardship Program (CBSP) and enabled more informed decision making regarding coastal and migratory bird habitat monitoring, protection, and restoration.

Study Area and Period

The Mississippi Gulf Coast is a dynamic and diverse combination of ecosystems which include barrier islands, beaches, marshes, swamps, and forests. The area is also important for recreational and industrial development in the state. It is home to a large variety of industries ranging from a vibrant tourism scene to important fisheries to oil and gas production. This area has seen frequent change over the past decade, most notably the devastation from a series of major hurricanes, including Katrina and Rita, which severely impacted this part of the coast, as well as the Deepwater Horizon Oil Spill which released millions of gallons of oil into the Gulf of Mexico and whose full impact on the environment has yet to be seen. Although much of the area has rebounded, scars remain on both the natural and man-made landscape. The study area includes Hancock, Harrison, and Jackson counties and also includes the barrier islands off the Mississippi coast (Figure 1). This project utilized data collected from 2012 to present to capture a current snapshot of the coast. There have been no major storms to hit the coast since 2005, though more intense urbanization has occurred on the landscape of concern following the destruction of hurricanes Katrina and Rita.

National Applications Addressed

NASA Applied Science National Application Areas addressed by this project include water resources and ecological forecasting. The methods and end products developed assisted project partners in monitoring and planning migratory and coastal bird habitat restoration activities. Because this project focused on coastal bird species, the monitoring local rivers, lakes, marshes, estuaries, and the Gulf are important to the end-users. Specifically, this project focused on providing end users with maps of seasonal water quality indices such as CDOM and Chlorophyll-a to determine potential effects of water quality on bird species. The project also involved the mapping of suitable nesting and foraging habitats of coastal bird species through the use of NASA Earth observations.

Project Partners

The Audubon Mississippi Coastal Bird Stewardship Program (CBSP), Pascagoula River Audubon Center (PRAC) and the Nature Conservancy (TNC), in coordination with the Mississippi Department of Environmental Quality (MSDEQ), Mississippi Department of Marine Resources (MSDMR), and National Fish and Wildlife Foundation (NFWF), monitor and plan restoration activities for coastal and migratory bird habitat. PRAC and TNC have limited exposure to the utility and experience of using remotely sensed data. Currently, CBSP, PRAC and TNC do not employ remote sensing and GIS in monitoring and planning activities. These groups mostly rely on costly and time-consuming *in situ* surveys and field campaigns along with occasional aerial surveys. Maps of bird habitats, land cover, and water quality indicator products to the partners, enabled partners to gain a more complete understanding of how bird species are using specific coastal habitats in order to enhance their decision making processes regarding habitat and species conservation, the planning of restoration activities, and the monitoring of coastal water quality within coastal bird habitats possibly impaired by the DWH oil spill.

Methodology

A. Data Acquisition

1. Landsat 8 OLI

Landsat 8 data were acquired using the USGS Earth Explorer platform. The study area was included in path 21, row 39. The most recent and most cloud free dates were selected for summer (June 14, 2014) and winter (January 12, 2014).

2. NASA Ocean Color Web Water Quality Products
Pre-calculated Level 2 water quality products derived from Aqua MODIS were acquired using the Marine Geospatial Ecology Tool (MGET) from Duke University in ArcGIS 10.2. Chlorophyll-a, CDOM, and Sea Surface Temperature (SST) for the extent of the Gulf of Mexico for 2014.

3. Reference Data
NAIP Aerial photography was downloaded from the USDA Geospacial Data Gateway for the study area. This was used as reference data for the land cover error matrix discussed later in the results section.

4. Bird Sightings
Bird Sightings were obtained from the eBird database, which is a near real-time online checklist program launched in 2002 by Cornell Lab of Ornithology and the National Audubon society. The eBird project documents the presence or absence of species when a birder logs their observations after an outing. Local experts review unusual entries to ensure quality control.

B. Data Processing and Analysis

1. Landsat 8 OLI

a. Land Cover Classification

Updated land cover maps were created using Landsat 8 data that were downloaded via USGS Earth Explorer. Landsat path 21, row 39 location was selected because it covered the Mississippi Gulf Coast. The most recent summer and winter dates with the least amount of cloud cover, were selected. Bands 3, 4, and 5 for each respective season were layer stacked in Erdas Imagine 8.7. The stacked bands were then pan-sharpened using the 15 meter panchromatic band using the “Resolution Merge” tool in ERDAS Imagine 8.7. This created richer spectral data to obtain land cover information since this represented a “leaf on” and “leaf off” image to include in the analysis. Using the “unsupervised classification” tool, the data were sorted into twenty separate classes. The classes representing water were then identified and removed using the “mask” tool. The resulting data, representing the land area, were then reclassified into thirty-two separate classes using the same method.

The “unsupervised classification” resulted in a certain amount of error, due to the similar spectral signatures of several types of land cover. One of the most problematic errors was discovered during the class identification process last term, was the overlap between the “sand” and “developed” classes. Some of the bird species in this study utilize the sand areas for foraging and nesting behaviors, but are adverse to areas of human development, so proper differentiation of these two classes is imperative to creating accurate land cover classification and suitability maps. To correct these areas of overlap between classes, the “supervised classification” tool in ERDAS Imagine 8.7 was used to select specific areas with class confusion, and use those signatures as training classes to create new customized signatures. This tool was used to create 15 new signatures for a total of 75 signature classes. These classes were then identified and regrouped according to the specific land cover type each spectral signature represents.

During the signature class identification process, 2 new classes, for tidally influenced areas were recognized. These new classes were designated as tidal flats sand and tidal flats mud, and were added to the other classes for a total of 11 land cover types. The ability to identify these areas was likely due to the combination of two dates, a summer and a winter Landsat image for the original classification. One of the dates was likely taken during low tide and the other during high tide, which created distinguishable differences between the shallow water, the beach sand, and the tidal area that was exposed during one image and not in the other. The identification of these areas is especially important for this project because some of the bird species in this study rely heavily on these areas for foraging.

Once the final classes were determined, they were characterized, color coded, and labeled according to the specific land cover that each spectral signature represents. They were then combined and consolidated into land use types, ranging from developed land to individual forest type. The land cover classes were ranked individually for each species based on the level of importance for foraging and nesting. Land cover was ranked from one to three, with three being the most desirable nesting habitat for the bird. Since land cover is most important in determining site suitability, it was weighted by two in the final suitability model.

b. NDVI

NDVI was calculated using the same Landsat 8 OLI imagery used to create the classification to determine vegetation health in areas within and adjacent to ideal foraging and nesting sites. This was done in ArcMap 10.2 using a custom toolbox created in a previous DEVELOP term for calculating NDVI with Landsat 8 OLI spectral bands. NDVI was divided into three classes and ranked from one to three, depending on the bird's propensity for vegetation within nesting and foraging ranges. There were three separate NDVI products created: one from the summer image, one from the winter image, and an average of the two. The product used in the suitability model was based on the time of year the bird is present on the Mississippi Gulf Coast. For example, in determining least tern suitability, the summer NDVI image was used since this species arrives in the spring time and stays through the summer. The average NDVI image was used for species that can be found on the coast year-round.

2. NASA Ocean Color Web Water Quality Products

Once acquired, Ocean Color Web products were subset to the extent of the Gulf of Mexico in ArcGIS 10.2. A custom color ramp was created for each dataset in ERDAS Imagine 8.7 in order to optimize interpretability. Colorized final monthly products were also exported as jpegs and used to create time-series for partners (example shown in Figure 3).

3. Migratory Bird Habitat Maps

Since not all the birds prefer open beach, an assessment of coastal vegetation's condition and extent was necessary in determining prime nesting and foraging habitat for several coastal bird species. To identify and map specific nesting habitat zones, attention was placed on determining characteristics of each mapped land cover class that was correlated to the nesting habitat preferences of each bird species. After reclassifying the land cover and NDVI layers as specified in the data processing section, these attributes were added using Spatial Modeler in ERDAS Imagine 8.7 and a final habitat map was produced with pixel values ranging from one to nine, with nine representing the most desirable nesting and foraging habitat (Figures 4 - 10). Land cover was given a weight twice that of NDVI, due to the greater influence of cover type in the determination of prime nesting and foraging sites.

4. Sightings from citizen scientists in the eBird database were used to look at the frequency at which each bird was observed and in which nesting suitability category these were most frequently found. This allowed for the identification of sites in which particular coastal bird species are more likely to inhabit. Though the eBird points were useful in getting a spatial understanding of bird sightings, sightings include birds exhibiting foraging, nesting, and all other bird behaviors. Further support from journal publications discussing preferred species nesting habitat specifics and more relatable data sources for nesting bird populations are needed in order to conduct more rigorous evaluation of the predicted suitability. Nesting habitat maps and

other products also need to be further evaluated by the end-users in order to determine the extent of refinement needed as well as to more closely tailor the products to the end-user's needs.

Results & Discussion

1. Land Cover Classification Accuracy Assessment
In order to test and validate the accuracy of the final classification map, the "Accuracy Assessment" tool in EDRAS Imaging 8.7 was utilized. This tool randomly selected 802 points, with a minimum of 70 points per class. The points were then overlaid on top of the high resolution NAIP imagery. Each of the points was then coded according to the land cover type that was observed in the reference image. These codes were then crosschecked against the type of land cover designated during the classification process. The result is an error matrix (Figure 11), which is a comprehensive analysis that plots the classified points against the observed points.

Though the use of the Error Matrix, not only can the amount of error in each class be quantified and compared, but the correct class for each misclassification can be identified. The largest amount of error was in the "sand" class. Out of 72 total points, only 30 were classified as "sand" and also observed as "sand" in the reference image. During the reference process, the source of this discrepancy was apparent. The Land Cover Classification was created by combining summer and winter Landsat images. The NAIP image was taken during the summer. Many of the points that were created for the "sand" class corresponded to agricultural fields in the reference image, and were likely cleared or covered with dead vegetation in the winter, and were covered again with green herbaceous vegetation, at the time the NAIP imagery was taken. This theory is supported in the matrix because 28 of the 72 total "sand" class points were observed as herbaceous. The next largest source of misclassification was in the "tidal flats mud" class. This was also likely due to temporal differences between the data used for classification and the reference imagery. Out of 71 total points, only 42 were correctly observed as "tidal flats mud", but 20 were observed as "shallow water". This was due the water being lower during the time of one of the Landsat images than the water level at the time on the NAIP image. Mud flats in these areas were inundated with water and therefore not visible.

The overall classification accuracy was 78.55% including the low accuracy due to the error as discussed with the "sand" and "tidal flats mud" classes. This percentage is probably low due to the proportionality of the classes. There is a much larger portion of the overall area covered by water or forest than is covered by some of the smaller class such as sand. These larger classes are also easier to differentiate and therefore weight the over accuracy assessment by not being proportionally represented.

See Figure 2. Land Use Land Cover Classification for Mississippi Gulf Coast derived from 15 meter pan-sharpened Landsat 8 OLI images

2. Migratory Bird Habitat Maps
Nesting and foraging habitat suitability maps were created for each of the bird species in the study. By highlighting the best environments for nesting and foraging, based on the preferences of each species, a valuable tool was created for project partners to get an overview of the entire Mississippi coast and how it relates to the each of the bird species spatially.

Highlighted species for this proceedings paper include:

Least tern (*Sternula antillarum*). The nesting suitability map that was produced for the least tern clearly shows the limited area that is available for the birds to nest along the coast (Figures 4 - 5). The narrow strips of red, indicating "most suitable" habitats are isolated to the sandy beaches along the shoreline and the barrier islands. Given the amount of anthropogenic activity along the coast, especially in the high-traffic tourist areas, this map illustrates the need for protecting more of the small footprint of suitable locations for the least tern to nest.

The foraging map for the least tern highlights the shallow water and tidal flat areas as the most suitable locations. The least tern takes advantage of these shallow areas to hunt small fish and marine invertebrates (Figures 6 - 7). The areas that are adjacent to the barrier islands and directly along the coastline are prime foraging habitats.

Snowy plover (*Charadrius nivosus*). The nesting Habitat suitability map for the snowy plover shows similar suitability to the least tern, having a strong preference for the sandy beach areas (Figure 8).

In contrast with the least tern, snowy plovers do not feed on fish in the water, but forage in flat, sandy areas for insects and invertebrates found in the sand. The foraging suitability map indicates a preference for slightly higher ground feeding areas than that of the least tern and no preference for areas that are continually inundated (Figures 9 - 10).

Errors & Uncertainty

No special parameters to deal with birds that nest based on geography instead of land cover type. Incorporating this factor could allow for a more accurate evaluation of prime nesting and foraging habitats in coastal Mississippi. An example of this type of specialization is the brown pelican, which does not typically nest on shoreline beaches, but prefers more secluded beaches of barrier islands. The model also does not account for biotic constrains such as predators or human visitation. The eBird data could be subject to bias based on where the bird watchers can easily access and most frequently visit. For example, the short billed dowitcher prefers to nest in secluded, more inland forested areas such as the upper Pascagoula River wetlands, which are not as easily accessible as the shoreline. EBird sightings also include sightings of birds exhibiting various behaviors, is not restricted to sightings only of birds exhibiting nesting behavior, and does not note bird behavior at the location and time of sighting. Because of this, finding other sources that enable more rigorous evaluation of nesting habitat, such as past journal publications and breeding bird population surveys, would be more useful.

Future Work

The methodology used for this project can be used as a basic framework that addition criteria could be added to increase the customization for each species. The incorporation of more in-depth information from partnering ornithologists can further assess and refine results. Products were turned over to end-users at the CBSP and will be amended as necessary in order to further validate and increase the reliability of these products based on partner evaluation. In addition to this, more literature review will be done in order to include data and habitat specifications as outlined in peer-reviewed journal articles in statistical validation of existing maps and to reevaluate the importance of various factors in determining ideal habitat characteristics.

Conclusions

The pan-sharpening tool provided an effective means for generating higher spatial resolution land cover classifications. The products derived from Landsat OLI provided up to date land cover and habitat maps for the Mississippi Gulf Coast, including several known areas that are important for migratory birds. These areas included the Mississippi barrier islands, marshlands, beaches, and estuaries. The project mapped and assessed habitat suitability for specific migratory bird species inhabiting Mississippi's coast.

Calculating vegetation indices for the study area proved to be useful in mapping out some of the birds' preferred environments by locating regions with healthier vegetation. By creating suitability maps, project partners can distinguish which environments are most suitable for certain nesting/breeding species. This information helped to facilitate the identification of threats to these habitats and focus restoration and protection efforts in these areas.

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- Allison Anholt – CBSP – Biologist
- Mark LaSalle - Pascagoula River Audubon Center (PRAC) – Director
- Lee Trebotich – PRAC – Educator/Botanist
- Mike Murphy - The Nature Conservancy (TNC) - Coastal Field Representative

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Figure 1. Study Area: Hancock, Harrison, and Jackson Counties in South Mississippi

Figure 2. Land Use Land Cover Classification for Mississippi Gulf Coast derived from 15 meter pan-sharpened Landsat 8 OLI images

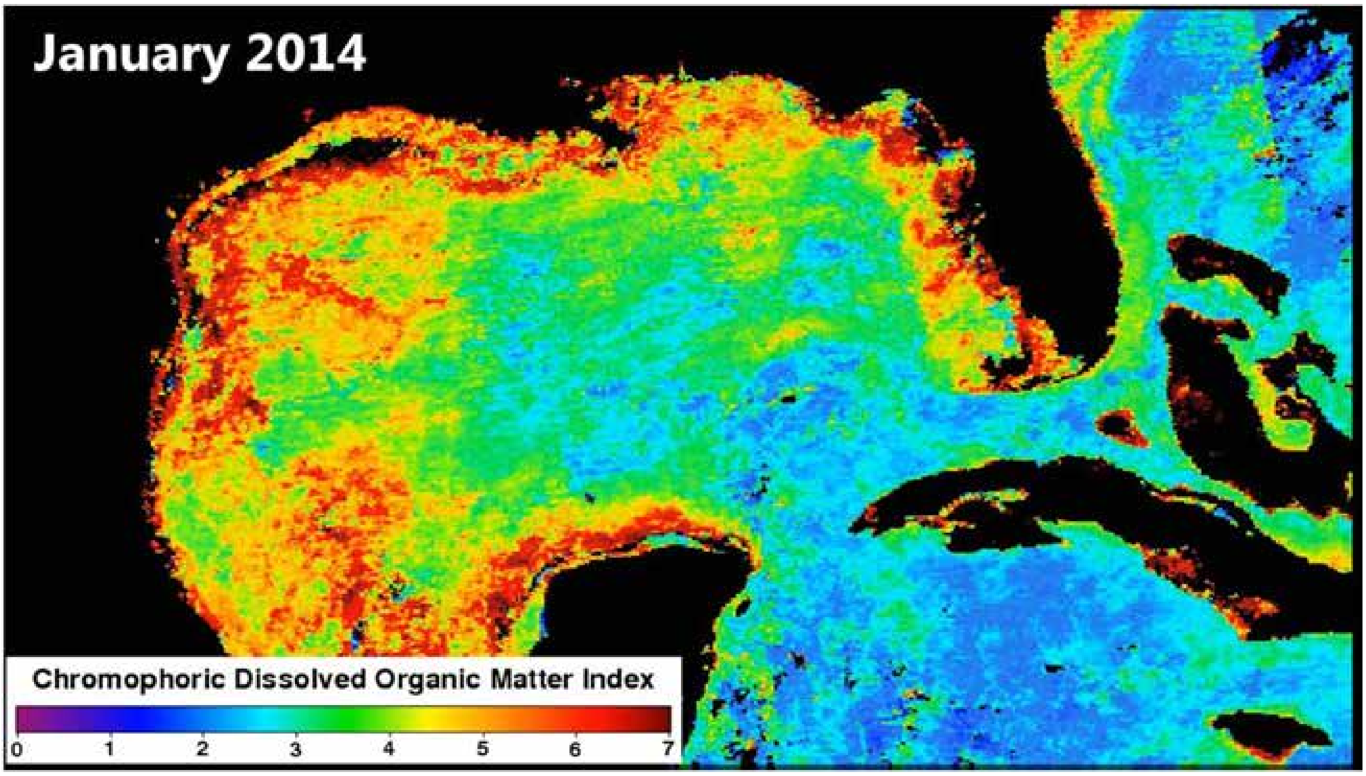

Figure 3. CDOM for the Gulf of Mexico – January 2014

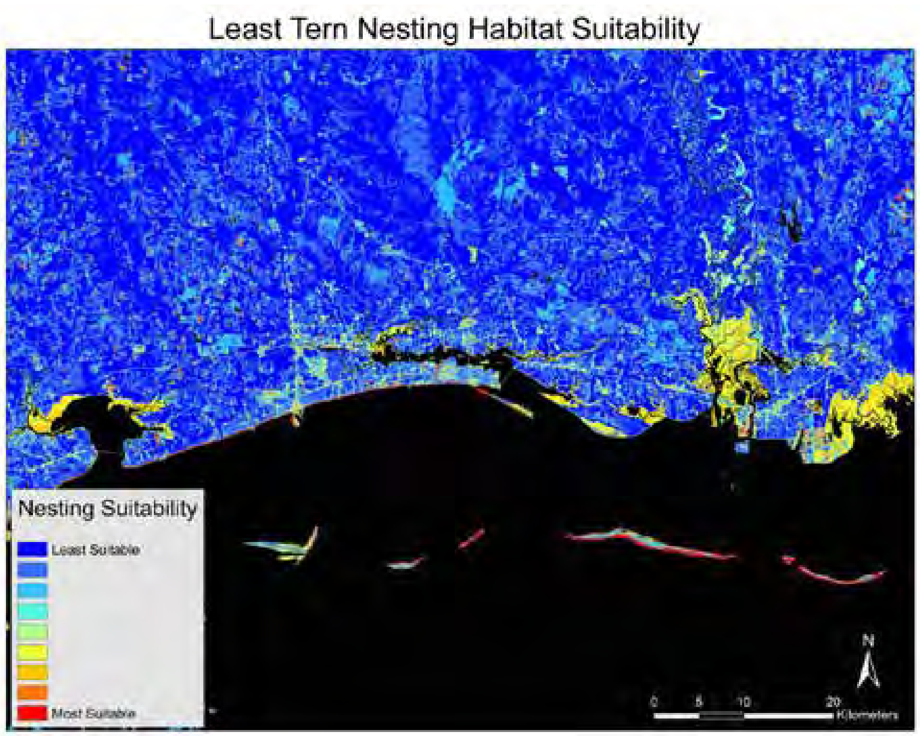

Figure 4. Least Tern Nesting Habitat Suitability – Bluer hues indicate areas less suitable for nesting, whereas redder hues indicate areas identified as more suitable for least tern nesting.

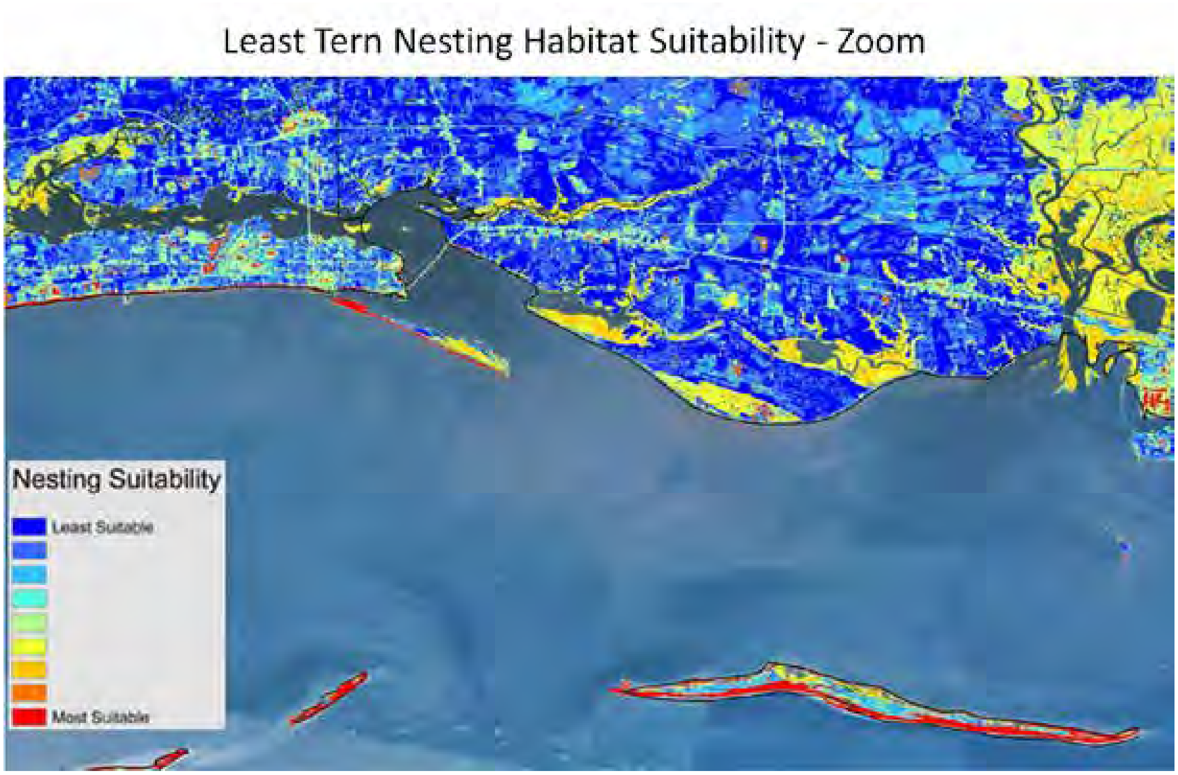

Figure 5. Least tern nesting habitat suitability – zoom of Deer Island/Horn Island area

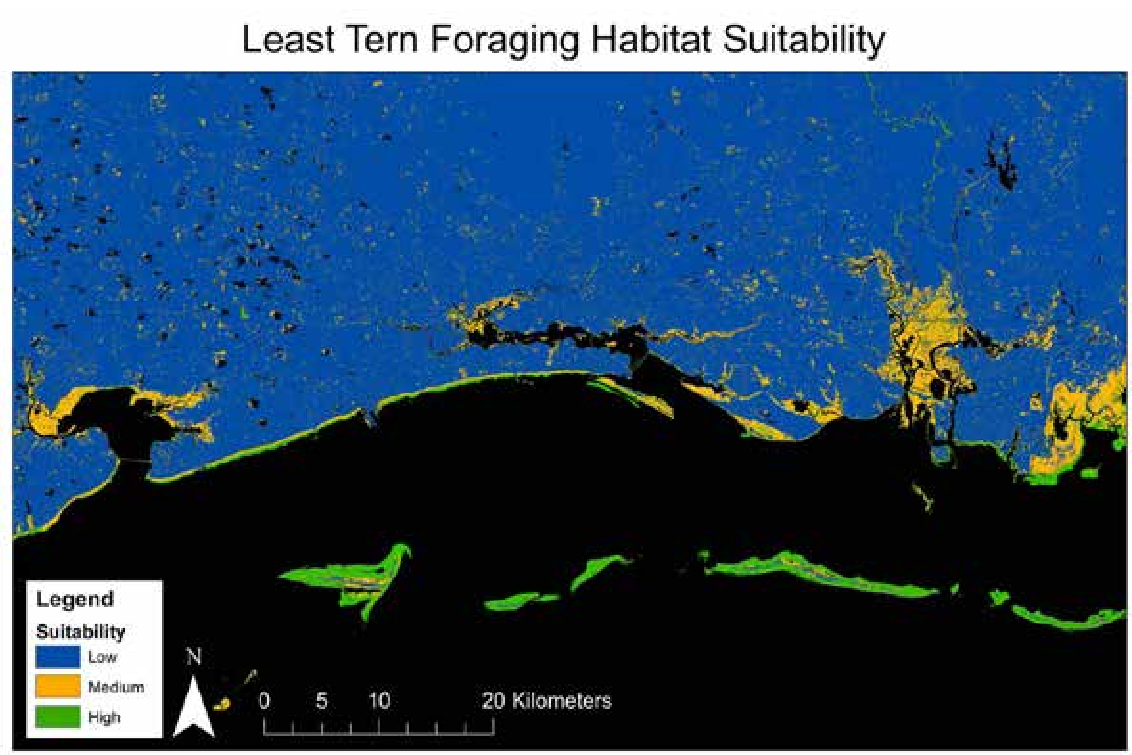

Figure 6. Least Tern Foraging Habitat Suitability -- Blue areas indicate low suitability for the least tern. Yellow areas indicate medium suitability. Green areas indicate high suitability. Shallow water and sandy areas are most suitable – the least tern eats small fish such as silversides and anchovies that swim along the shorelines. The least tern also takes advantage of dredge spoil areas for feeding. Also feeds in bays and estuarine environments.

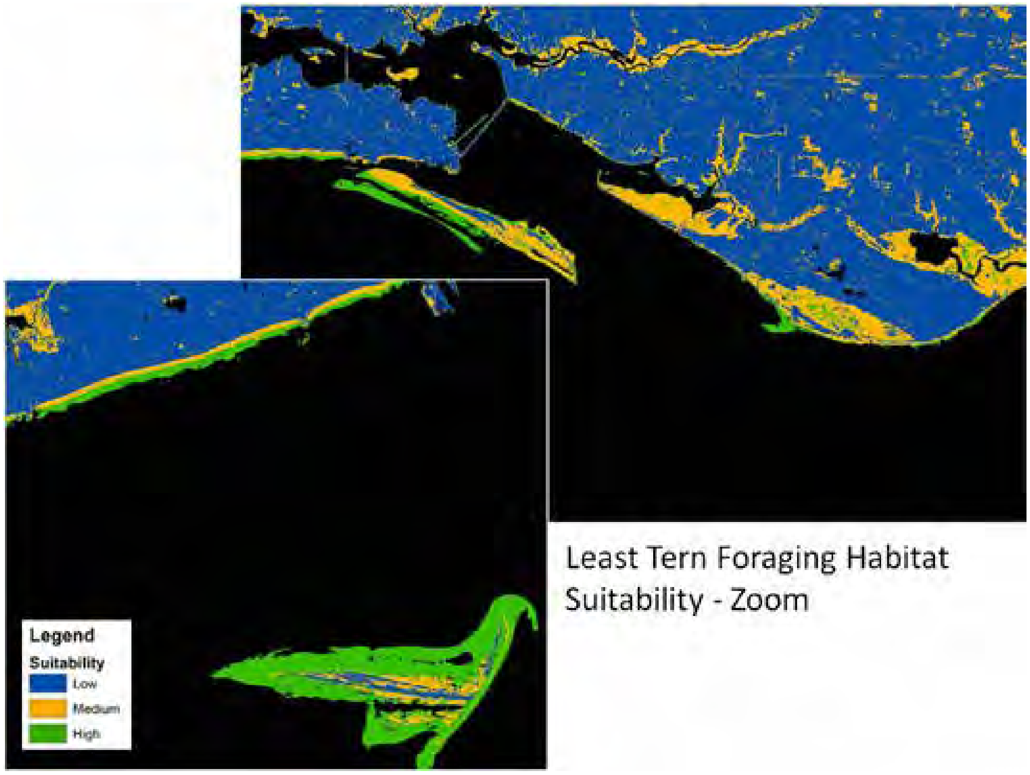

Figure 7. Least Tern Foraging Habitat Suitability Zoom -- Close-up of Cat Island (bottom) – green areas include shallow water, tidal flats, and sand closer to the water. Least tern is less likely to feed further up on the beach away from marine waters, but this is not unheard of. Deer island (top) and a shallow flat created from dredge spoils – ranked as highly suitable

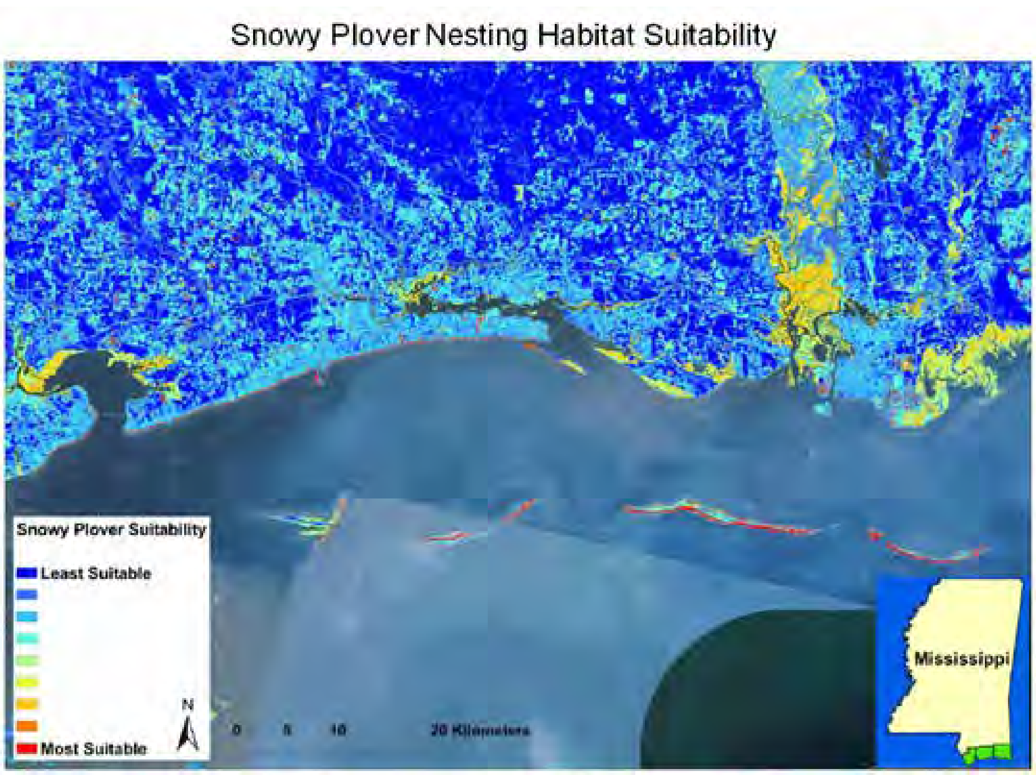

Figure 8. Snowy Plover Nesting Habitat Suitability – Bluer hues indicate areas less suitable for nesting, whereas redder hues indicate areas identified as more suitable for nesting.

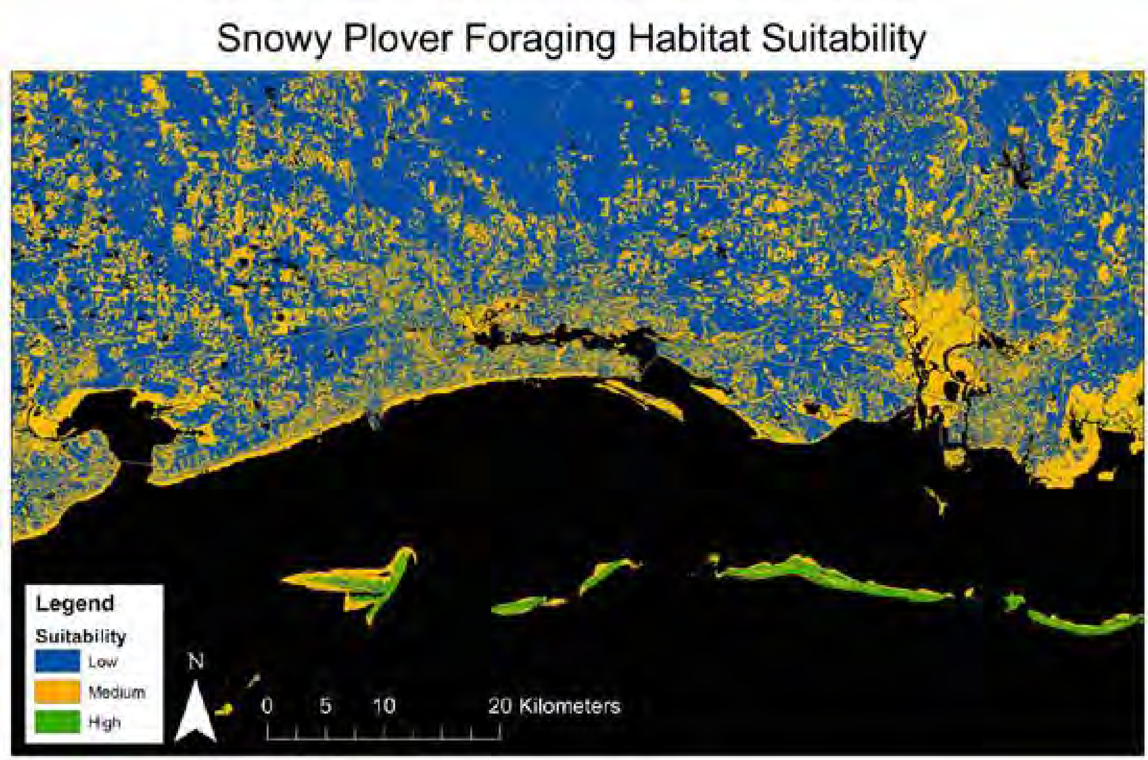

Figure 9. Snowy Plover Foraging Habitat Suitability -- Blue areas indicate low foraging suitability. Yellow areas indicate medium suitability. Green areas indicate high suitability. Sandy beaches close to the water and shallow mud flats are most suitable for plover foraging. The snowy plover will not forage in water.

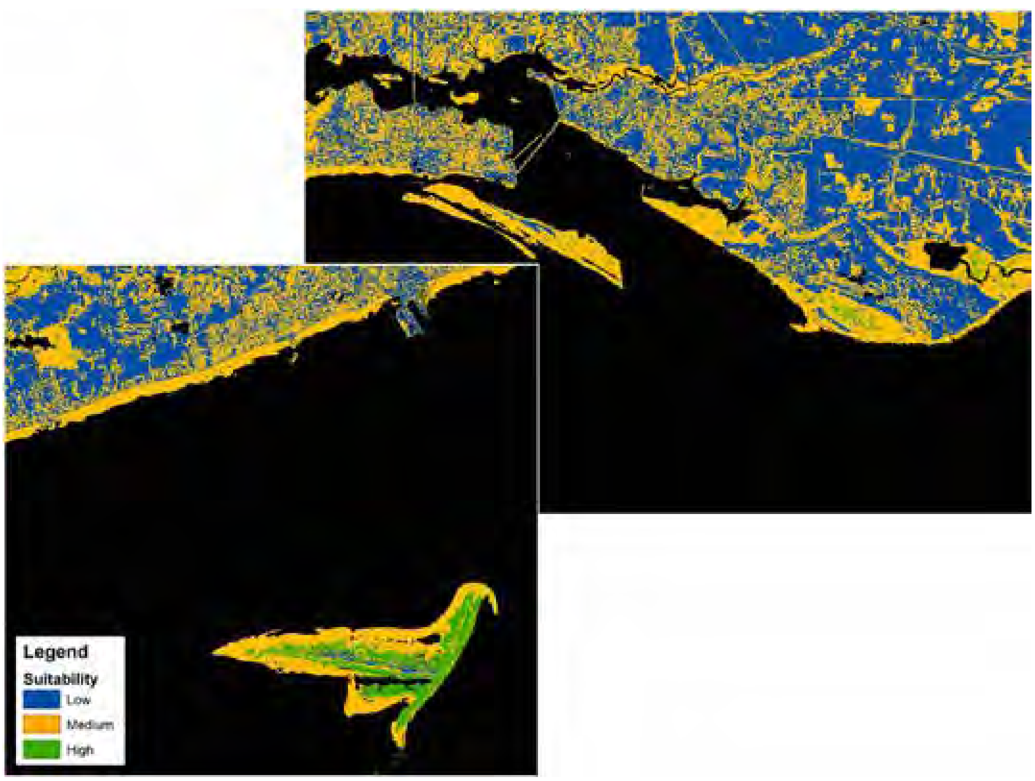

Figure 10. Snowy Plover Foraging Habitat Suitability -- Zoom of Cat Island (bottom) and Deer Island (top). Medium suitability in shallow water areas reflects SP preference for foraging in higher areas not in water. Also, prefer barrier islands to mainland beaches due to human presence

ACCURACY TOTALS

	Reference Totals	Classified Totals	Number Correct	Producer Accuracy	User Accuracy
Water	92	100	90	97.83%	90.00%
Shallow Water	112	71	68	60.71%	95.77%
Sand	33	72	30	90.91%	41.67%
Herbaceous	125	90	78	62.40%	86.67%
Marsh	65	78	54	83.08%	69.23%
Swamp	57	74	50	87.72%	67.57%
Mixed Forest	120	101	93	77.50%	92.08%
Developed	91	75	72	79.12%	96.00%
Tidal Flats – Mud	47	71	42	89.36%	59.15%
Tidal Flats - Sand	60	70	53	88.33%	75.71%
Overall Classification Accuracy =	78.55%				

Figure 11. The overall classification accuracy was seen to be at 78.55%. While some of the classifications were considerably lower, the results remain within an acceptable range.

Pathogen Indicator Monitoring in the Ross Barnett Reservoir

Capps, P.; Surbeck, C.

Man-made reservoirs are often used for both water supply and recreation. The Ross Barnett Reservoir in central Mississippi, a 33,000-acre man-made lake, provides drinking water to the city of Jackson, MS, and forty-eight surrounding communities. Further, an estimated 2.5 million people visit the reservoir each year for recreational purposes, including boating, fishing, water-skiing, and swimming. Protecting the water quality in the reservoir is important for these visitors and inhabitants along the shoreline, and for these reasons, the U.S. Environmental Protection Agency has selected it as a Priority Watershed in Mississippi. Presently, there is a concern regarding recent data collected that indicated increasing concentrations of bacteria in the Ross Barnett Reservoir.
To detect possible harmful levels of bacteria in recreational waters, pathogen indicator monitoring is used. Sources of pathogens may include stormwater runoff, failing septic systems, lake-bottom sediments, and animals and humans in direct contact with the water. A collaborative study to investigate potential pathogen contamination in the reservoir is underway by the University of Mississippi, the U.S. Geological Survey, and the Mississippi Department of Environmental Quality. The goal of the study is to determine a method of pathogen indicator monitoring that takes less time than the standard 24 hours required by current methods for detecting bacteria. Such a method would improve the swiftness of notification to reservoir users when the water quality is not appropriate for contact. Pathogen indicators and other water-quality data such as water temperature, pH, turbidity, conductivity, dissolved oxygen, nutrients and solar strength, were collected at two recreational sites at the reservoir twice a week for 23 events through the spring and summer of 2013 as part of the collaborative study. Average concentrations for all E. coli, enterococci, and fecal coliform were 264 cfu/100mL, 175 cfu/100mL, and 298 cfu/100mL, respectively. The concentrations of pathogen indicators, nutrients, and values of physical parameters were statistically analyzed to provide insight about contamination sources. This research indicated that two water quality indicators of harmful bacteria levels in the water were turbidity at sites with low water circulation and days following rain events.

Mississippi Water Resources: Mapping the Extent of Critical and Endangered Watersheds to Assist Restoration Efforts and Conservation Planning Using NASA Earth Observations

Castillo, C.; Crepps, G.; Deal, J.; Hellmich, J.; Moore, G.; Nguyen, K; Eichold, B.; Spruce, J.

Watersheds in Mississippi provide many environmental and recreational benefits to the citizens and visitors of the state. The Nature Conservancy and the Pascagoula River Audubon Center are currently working to protect coastal Mississippi watersheds, in part through an urban coastal preservation initiative. The primary objective of this project was to aid these conservation efforts by delineating watershed extents for nine coastal streams spanning across the three coastal counties of Jackson, Hancock, and Harrison. This was accomplished by using ArcGIS along with the open source Geographic Information Systems (GIS) platform Quantum Geographic Information System (QGIS) with Geographic Resources Analysis Support System (GRASS), to analyze environmental variables corresponding to the study area. An analysis of wetland areas was also performed using a Maximum Entropy (MaxEnt) model. Relevant inputs included elevation, terrain aspect, temperature, and vegetation. Earth Resources Data Analysis Systems (ERDAS) and QGIS were also used to perform a land cover classification. The analyses utilized Landsat 8 Operational Land Imager (OLI) data, National Elevation Data (NED), interpolated lidar data, and stream vectors. Overall, this project illustrated the utility of open data, as well as open-source software. Furthermore, these watershed and wetland maps can aid in protecting endangered streams.

Introduction

Background

Watersheds play an essential role in the health of their local ecologies and the communities which reside there. The identification of watershed boundaries and their delineation play a key role in the understanding and preservation of streams and wetlands. In coastal Mississippi, watersheds fall under the purview of the Mississippi Department of Wildlife, Fisheries & Parks' (DWFP) Mississippi's Comprehensive Wildlife Conservation Strategy 2005-2015, which seeks to preserve the habitats of wildlife species (MMNS 2005). The Pascagoula River is the dominant river in this region, and the largest undammed river system in the continental U.S. (Land Trust for the Mississippi Coastal Plain n.d.). While the state of Mississippi and other environmental organizations work in this area, there is little conservation or restoration detailed for many of the smaller streams on which this project focuses. In addition, much of the areas surrounding these streams are private land, adding additional complexity to their management.

Nine streams were identified as areas of concern by The Nature Conservancy (TNC) and the Pascagoula River Audubon Center (PRAC) in the coastal Mississippi region. Each watershed faces numerous and diverse challenges. Turkey Creek, for example, faces threats from urbanization and has been recognized by the EPA as a critical urban watershed with more than 200 acres recently being place in permanent conservation as a precaution to planned highway projects (NAS 2013). Invasive species pose an issue as well, particularly in Rhodes Bayou. In November 2013, the National Fish and Wildlife Foundation gave $8.2 million to the Mississippi Department of Environmental Quality to fund three conservation projects, with $3.3 million specifically going towards the mitigation of invasive species such as sapium sebifera (Chinese tallow), salvinia molesta (giant salvinia), salvinia minima (common salvinia), and eichhornia crassipes (water hyacinth) (gulflife.com 2013). Due to their coastal proximity, some of the streams are also prone to flooding. This flood risk has resulted in governmental intervention. From 1998 to 2002, 230 at-risk properties were purchased along the Brickyard Bayou under the Brickyard Bayou Acquisition Project to prevent further financial loss. The project cost approximately $19 million and has already paid for itself with losses avoided (FEMA 2006, 1-2).

Objectives
The objective of this project was to delineate the watersheds that TNC and PRAC are working to conserve. Specifically, open source geographic information systems (GIS) were used in order to create replicable methodologies. Furthermore, this project mapped wetland areas and land cover to analyze the health of the watersheds over the study period.

Study Area & Period
The study area spanned the counties of Jackson, Harrison, and Hancock in the southern coastal region of Mississippi (Figure 1). This study focused on watersheds of the following nine urban streams (from west to east): Watts Bayou, Magnolia Bayou, Bear Point Bayou, Turkey Creek, Brickyard Bayou, Coffee Creek, Oyster Bayou, Rhodes Bayou, and Bayou Chico.

The study period was from 2005 to 2014. Elevation data from 2005 to 2011 were utilized for watershed delineation. Landsat data from the year 2014 were analyzed to identify different land types as well as the extent of certain types of wetlands.

National Application Area & Project Partners
This project falls under the Water Resources Application Area, which focuses on monitoring and providing decision support tools concentrated on the availability and quality of water resources for communities, as well as the health of water systems.

The project partnered with The Nature Conservancy (TNC) and the Pascagoula River Audubon Center (PRAC), a branch of the National Audubon Society. Together, they classified nine urban streams as critical freshwater resources and endangered habitats. The TNC and PRAC are currently working together on an urban coastal preservation initiative project. This will include gathering public input and holding public workshops to support these measures, and is scheduled to begin in February 2015. The Nature Conservancy currently conducts field surveys of the watersheds to assess watershed health and identify plant species distribution as part of their Rapid Stream Assessments. Thus, remotely sensed data, such as those utilized in this study, may be used to augment this data collection to allow for more in-depth analyses and on a larger scale.

Methodology
Data Acquisition
Level 1, terrain-corrected Landsat 8 data were retrieved from the USGS Landlook Viewer for the dates of January 19, March 8, and June 21, 2014 for the land cover classification and MaxEnt model. Also for the MaxEnt model, a one-arc second resolution Aster Global Digital Elevation Model (GDEM) version 2, set to the state boundary of Mississippi, was downloaded from the USGS and the Land Processes Distributed Active Archive Center Global Data Explorer platform as a GeoTIFF. 10-meter National Elevation Data (NED) was also downloaded from the USGS National Map Viewer for a subsection of the study area as an IMG for the watershed delineation. In addition, 1-meter lidar data was downloaded from the Mississippi Automated Resources Information System (MARIS), for the immediate areas surrounding each of the nine study streams.

Shapefiles of the study creeks and watersheds were also downloaded from Entergy's Mississippi Site Selection data download site, which hosts data from MARIS. As not all of the creeks were available or labeled, Google Earth was used to identify the course of a few of the creeks, which were then manually drawn in Quantum Geographic Information System (QGIS), based on Google Earth and descriptions provided by project partners at The Nature Conservancy.

Data Processing
Each stream watershed was delineated using the open source software QGIS (with the Geographic Resources Analysis Support System (GRASS) toolbar. These watersheds were then compared to the watershed sub-basins created in ArcMap 10.2.2 using the Hydrology toolbox. Both the 1-meter and 10-meter

digital elevation maps (DEM) were run in both software packages.

MARIS provided post-Katrina 1-meter lidar data in LAS format. The LAS files were converted into three LAS datasets in ArcMap corresponding to the location of the streams within the three Mississippi counties. The LAS datasets were then interpolated into an elevation raster using a nearest neighbor approach with a void fill using the "LAS Dataset to Raster" tool in ArcMap. The 10-meter NED was downloaded preprocessed, and thus did not need to be interpolated.

The MaxEnt model required multiple input parameters including tasseled cap (TCAP) transformations for brightness, greenness and wetness; normalized difference vegetation index (NDVI); MNDWI; both thermal Landsat 8 bands (10 & 11); and NED digital elevation models including terrain slope and aspect. The model also required the input of wetland source points which were located from a Landsat 8 RGB band combination (short wave infrared, near infrared, coastal aerosol) and a supervised classification of known wetland areas trained using Google Earth source points. 100 source points each for freshwater forested, freshwater emergent, and estuarine were generated using the random point generator and a Shapefile of the wetland types obtained from the U.S. Fish and Wildlife Service. These source points were saved as a comma separated value (CSV) file for use in the MaxEnt model. The environmental layers were saved as an ASCII type raster in a single folder. All data were re-projected into the NAD 1983 UTM zone 16N coordinate reference system.

The Landsat 8 data were processed from their digital numbers (DN) to top-of-atmosphere reflectance. Dark object subtraction was also applied to account for areas that were within complete shadow (Pax-Lenney et al. s002). The normalized difference vegetation index (NDVI) was calculated using the equation

$$NDVI = \frac{B_{5,NIR} - B_{4,RED}}{B_5 + B_4}$$

The modified normalized difference water index (MNDWI) was also calculated using the equation

$$MNDWI = \frac{B_{3,GREEN} - B_{6,MIR}}{B_3 + B_6}$$

Tasseled cap transformations (TCAP) were performed using the Landsat 8 coefficients (Appendix I) experimentally determined by Baig et al. (2014) to enhance land surface characteristics. QGIS was used to perform these calculations.

Data Analysis

The elevation raster was be used as the primary input layer into the GRASS program's r.watershed tool. For the purpose of this project, no additional parameters such as percent of overland flow, location of depressions, terrain blocking overland flow, etc. were used. The minimum size of exterior watershed basin, however, was an important parameter in defining watersheds. If the value was too high, only a portion of the watershed would be mapped, while if the value was too low the watershed would encompass more than one. For the 10-meter NED, a value of 2000 was used as a minimum basin size. For the 1-meter MARIS data, a value of 20000 was used for Harrison County, a value of 35000 was used for Hancock County, and a value of 10000 was used for Jackson County. For comparable results, the same values were utilized in the sub-basin mapping in ArcMap. The option to allow for multiple flow directions was also chosen. The r.watershed outputs selected for this study were drainage direction and stream segments.

The drainage direction layer produced in r.watershed was then used as the primary input for the r.water.outlet tool. This tool requires the geographic coordinates of a specific cell selected as the outlet point for the watershed. These outlets were selected with QGIS's coordinate capture tool, utilizing the stream segments layer from r.watershed, and a shapefile of the study streams for further reference (Figure 2). These coordinates were used as the easting and northing points for r.water.outlet. The output from this tool was a raster file of the desired watershed (Figure 3).

The Hydrology toolbar in ArcMap was also utilized to delineate watershed sub-basins. To do this, the input elevation data were used to create a flow direction raster, which was then used as the input for the Flow Accumulation tool. The extents of the streams were then calculated using the Raster Calculator, the flow accumulation output, and the various minimum basin sizes described above. Using the stream drainage points created by the Raster Calculator, the Stream Link tool was then run. These outputs were then used in the Watershed tool, with final outputs of the watershed sub-basin rasters. These rasters were then converted into polygons for comparison with the GRASS watershed results.

The MaxEnt model produced graphs and tables of the predicted areas of wetland extent based on the source points' locations in relation to the environmental layers. A number of settings were used for the MaxEnt Model to account for variability within the model (Carter et al. 2011).These included setting the number of runs that the model performed to 10, resulting in average, median, maximum, minimum, and standard deviation outputs calculated from the runs. In addition, the model chooses a random 25 percent of the training data to withhold from each run to be used for result validation. Each MaxEnt run was iterated 5000 times to allow sufficient time for the model to run so that results were not over-or underestimated (Carter et al. 2011, 10).

A supervised Land Use/Land Cover (LULC) classification was performed within ERDAS Imagine. Landsat 8 bands 3, 4, and 5 (green, red, and near infrared, respectively) were used to produce a color infrared raster of the area to be classified. An unsupervised classification was first performed resulting in the raster being split into 50 categories. Using Google Earth and the National Land Cover Database (NLCD) 2011, these categories were grouped into six. Using these six categories as training data, a supervised classification was run using the maximum likelihood algorithm. The accuracy was assessed using 100 randomly generated points, whose classifications were compared manually with Google Earth. 90% of the points were in agreement with the Google Earth images.

Results & Discussion

Analysis of Results

Although outputs such as flow direction and flow accumulation showed results for the entire elevation data, the 10-meter elevation data used in ArcMap did not entirely delineate towards the lower boundaries of the counties. The only streams that were within the boundaries of the ArcMap watershed delineation were Turkey Creek, Coffee Creek, and Rhodes Bayou (Figure 4). This was due to the stream segment length that was set for the amount of streams to be created in the raster calculator. The reason for using the extent value chosen for analysis (greater than 20000) was because the output gave a reasonable amount of sub-basins and sub-basin sizes. In order to capture watershed delineations for the other streams, an extent value of 1000 would need to be used, but with that small of an extent size, the streams are split into so many segments that the watersheds are too subdivided to be a reasonable representation of stream flow (Figure 5).

The GRASS watershed methodology created individual watershed boundaries for each of the nine study streams. These were overlaid with the watershed sub-basin maps created with ArcGIS for comparison. The GRASS results (shown in pink) showed a strong correlation when compared to those delineated in ArcMap (shown in green) (Figure 6). This demonstrated the success of using the open source software.

The MaxEnt model resulted in three prediction maps of wetland extent, one for each of the three types analyzed (emergent, estuarine, and forested). Overall, the maps provided a useful prediction for locating areas where different vegetation types occurred, especially in and around the individual watersheds. The model used different source points over different environmental parameters to give 3 unique maps for the output for each of the 3 wetland types (Figure 7). The similarities between the MaxEnt and LULC results can be seen in the Turkey Creek Watershed (Figure 9), where much of the same forested areas mapped using these two methods align well.

The MaxEnt model also indicated which of the environmental variables used were most influential in the predication maps (Figure 8). For estuarine wetlands, these were the NDVI, green tasseled cap, and slope. For emergent, it was slope, and the green and brightness tasseled caps. While for forested, it was the thermal band, slope, and the brightness tasseled cap. These results suggest that slope is an important predictive variable for wetlands, while for each type of wetland, additional variables play large roles as well. This information can be used to further refine the model in future analyses and should be used in conjunction with the number of source points as well as the location of those omitted when performing the comparison analysis between the predicted and real wetland areas. The jackknife test is also useful in determining the model performance as higher jackknife number corresponds to a precise model while lower numbers correspond to one where points have been chosen randomly and no pattern is apparent. Estuarine area under the curve (AUC) values were very high (~0.90) while those for forested and emergent were much lower (~0.70). When running future models source points should be chosen with perhaps more precision so that the performance of the model will show higher values.

The Land Use/Land Cover classification map gives insight into the spatial relationship between the various land uses and cover types in the study area. The map reveals that wooded wetlands are centered along the Pascagoula River, while the emergent wetland herbaceous is found closer to the coast. Much of the forested area in the region is west of the Pascagoula River, while farm/developed/open land and urban/road/sand areas are intermingled throughout the region (Figure 9).

Comparing the Land Use/Land Cover (LULC) classification to the results given by the MaxEnt model, a high correlation between forested and estuarine/wetland herbaceous was found. The MaxEnt model found that Turkey Creek had a high concentration of forested and emergent wetlands in its central portion but almost none near its southern and northern portion. Similarly, the LULC map for the Turkey Creek watershed designated much of the central portion of the basin as forested (Figure 10). It also showed little to no emergent herbaceous wetland which also is consistent with the MaxEnt prediction of estuarine wetland within the Turkey Creek basin.

Errors & Uncertainty

While the lidar data utilized in this study provided a high resolution analysis of the study area, there were errors in the original data, such as voids and noisy data that could be cleaned for more accurate results in a future analysis. Furthermore, the addition of other parameters (e.g. real depression locations, overland flow, etc.) in r.watershed model may further improve the results. In addition, as several of the study streams themselves have been considerably altered through human interventions such as rerouting of water pathways, especially in urban areas, these effects may need to be further addressed in a watershed delineation model. Moreover, due to the limited availability of stream shapefile data, this project utilized data that were partially created through use of Google Earth and by hands-up digitizing. This may have introduced inaccuracies in the exact paths of the streams.

The LULC analysis had difficulty distinguishing between sand, roads, and urban areas due to their similar spectral properties. Furthermore, classification was challenging due to both the small nature of the study areas and their varying water levels and vegetation content.

Future Work

Because the nine study stream watersheds are part of the larger, regional stream network, the study region could possibly be impacted by streams or other water sources outside the designated study area. An expanded study area for watershed delineations could help in assessing stream interactions.

While the land cover classification illustrated the current conditions in the study areas, using Landsat data from previous years and comparing it to present conditions could identify any decrease in wetland extent. It could also predict future trends of urbanization and which areas are most prone to endangerment. Furthermore, as invasive species are a large concern of the project partners, a LULC could be valuable in determining the current proliferation and potential spread of invasive species within the study area.

Lastly, accuracy of watershed delineation, wetland extent maps, and the LULC were evaluated using Google Earth, and the US Fish and Wildlife Service Wetlands Mapper. Although these are considered reliable, ground truthing would be the next step in determining the quality of the results.

Conclusions

LULC maps can aid in identifying areas at risk from anthropogenic impacts, although further refinement of the maps produced here are needed. By understanding what the land is used for, the project partners can allocate resources to these areas when working to conserve the streams. By combining the land classification maps with prediction maps from the MaxEnt model they can further enhance their decision making. The MaxEnt model is an effective tool for determining wetland areas when the correct environmental data are used and variability is accounted for. Thus, by performing multiple runs, withholding a percentage of source points for comparison, and increasing or decreasing threshold values, the capability of the model can be better refined. In regards to the small size of the study area, both an LULC and prediction map can be used to locate potential watersheds. This project illustrated that open-source software can effectively delineate individual watersheds of small streams. Overall, these results support that watershed extent may be precisely mapped using a combination of open source data processing software and elevation data from NASA Earth Observations.

Acknowledgments

Thanks are due to the following people for their assistance in the completion of this project: Bernard Eichold, M.D., Dr. PH (Mobile County Health Department), the team's mentor; Dr. Kenton Ross (NASA Langley Research Center), DEVELOP's national science advisor; and Joe Spruce (NASA Stennis Space Center), the team's science advisor.

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Table 1: Landsat 8 Tasseled Cap Transformation Coefficients from Baig et al. (2014)

Landsat 8 Band	B2	B3	B4	B5	B6	B7
TCAP Transformation						
Brightness	0.3029	0.2786	0.4733	0.5599	0.508	0.1872
Greenness	-0.2941	-0.243	-0.5424	0.7276	0.0713	-0.1608
Wetness	0.1511	0.1973	0.3283	0.3407	-0.7117	-0.4559

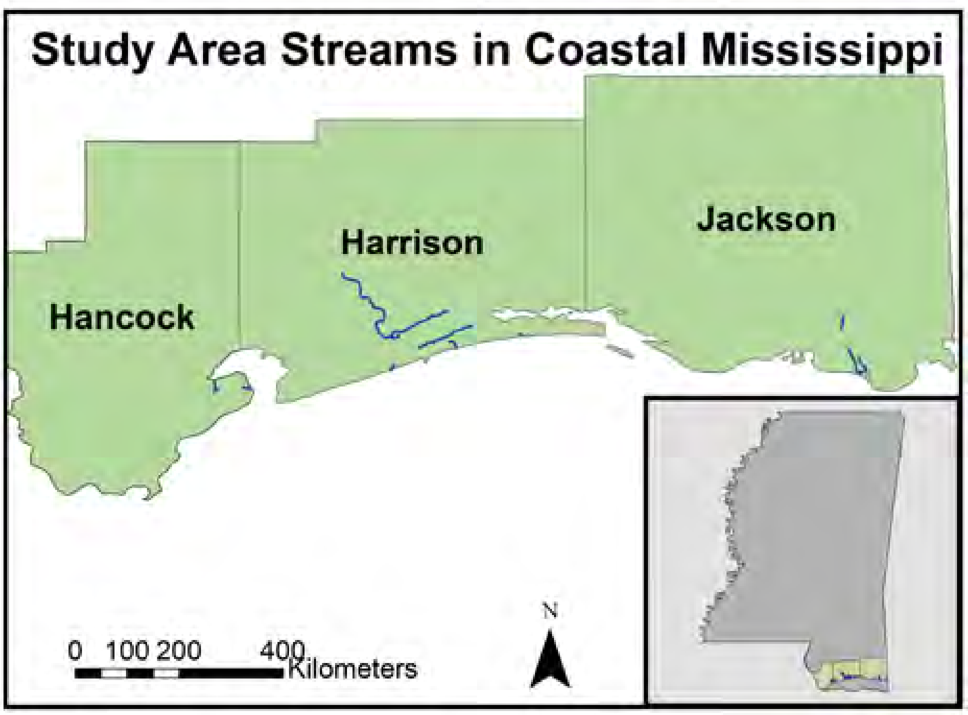

Figure 1. Study Area Coastal Counties and Streams.

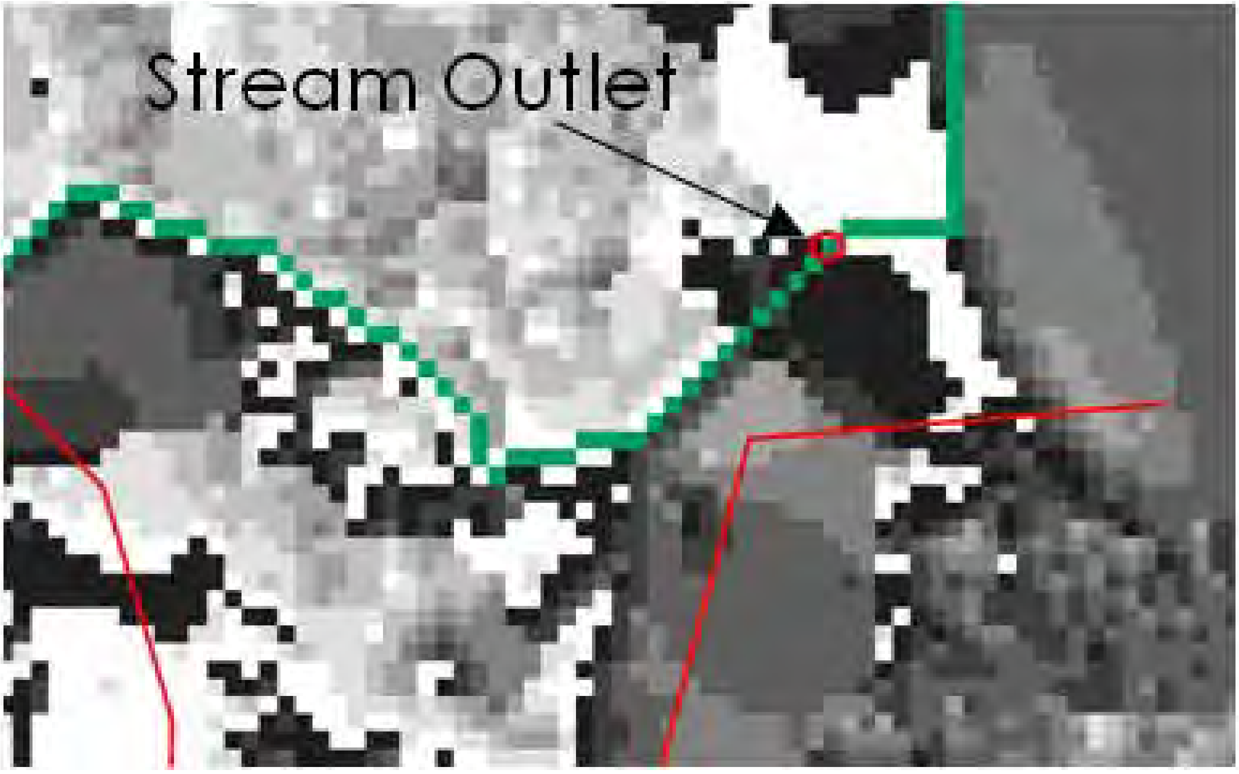

Figure 2. Stream shapefile (red) used as a reference to locate exact coordinates of stream output segment (green) for 1-meter data

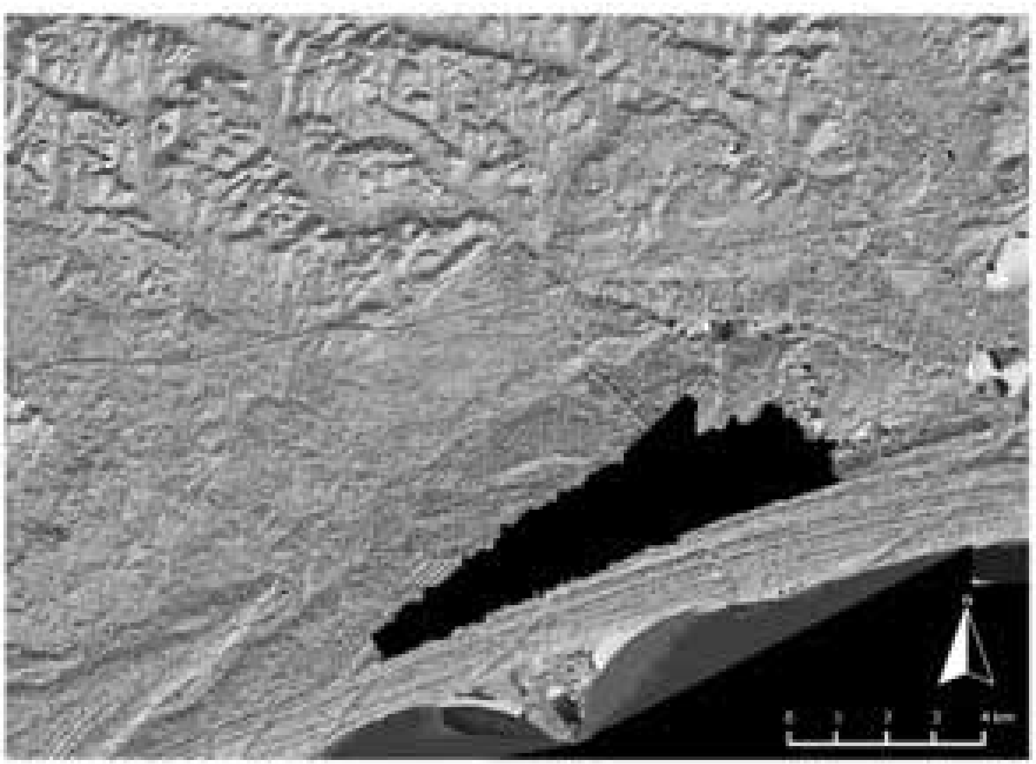

Figure 3. r.water.outlet output basin (black) over drainage direction layer from r.watershed

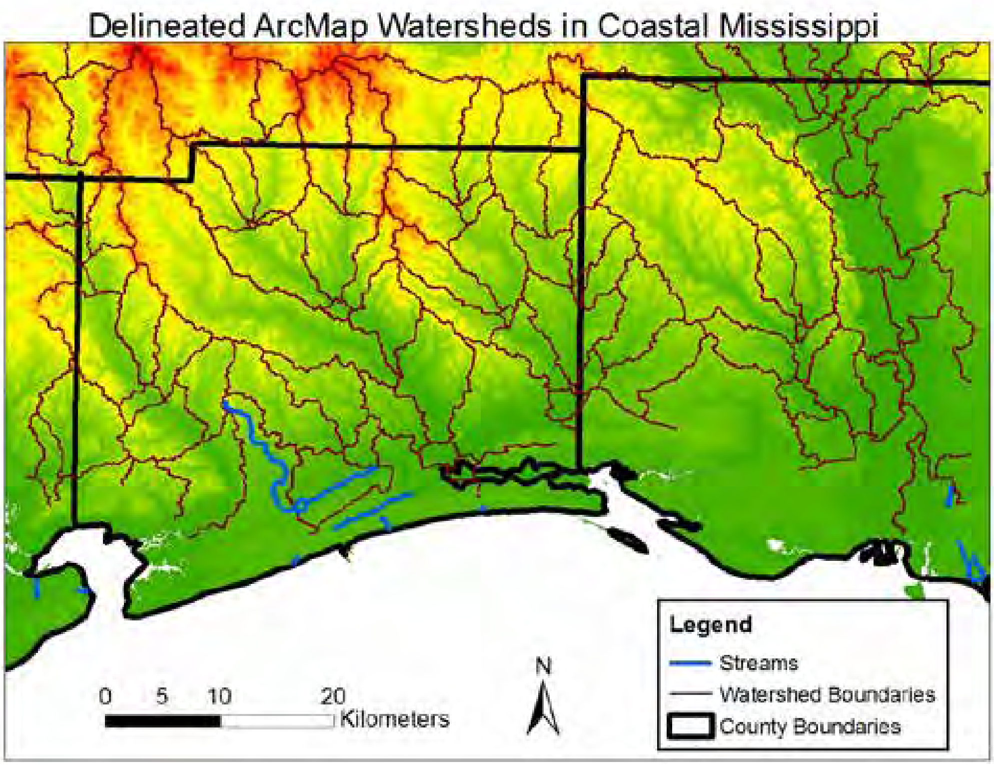

Figure 4. Watershed delineation using ArcMap of entire study area, illustrating the lack of watersheds delineated along the coast.

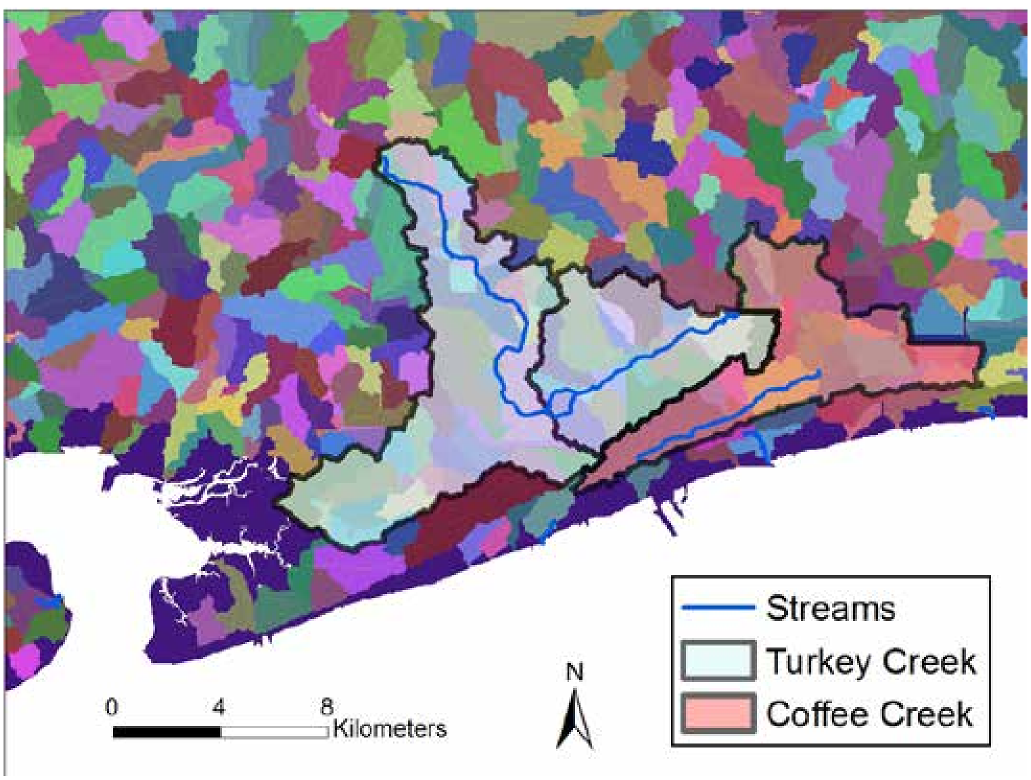

Figure 5. ArcMap watershed delineation of Turkey Creek area when using a stream extent value of greater than 1000.

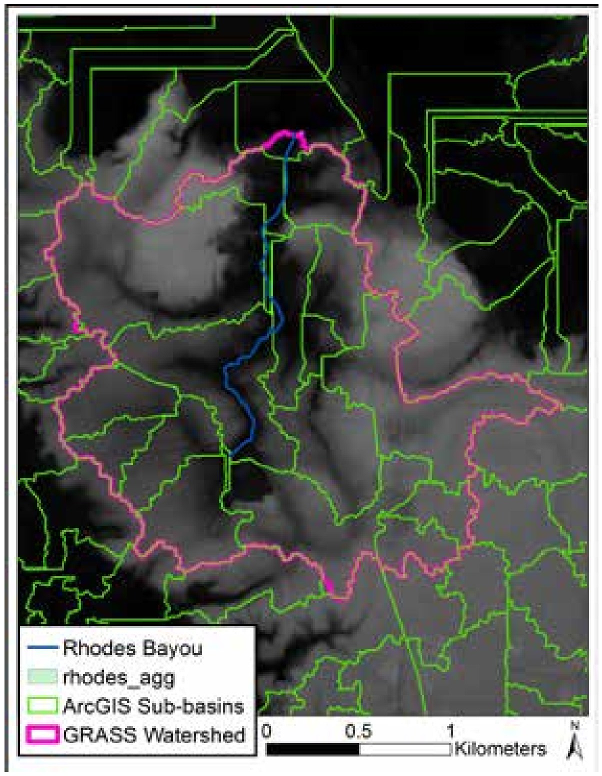

Figure 6. The 1-meter watershed basin for Rhodes Bayou, created in GRASS, is layered on top 0f the sub-basins, created in ArcMap, illustrating their agreement.

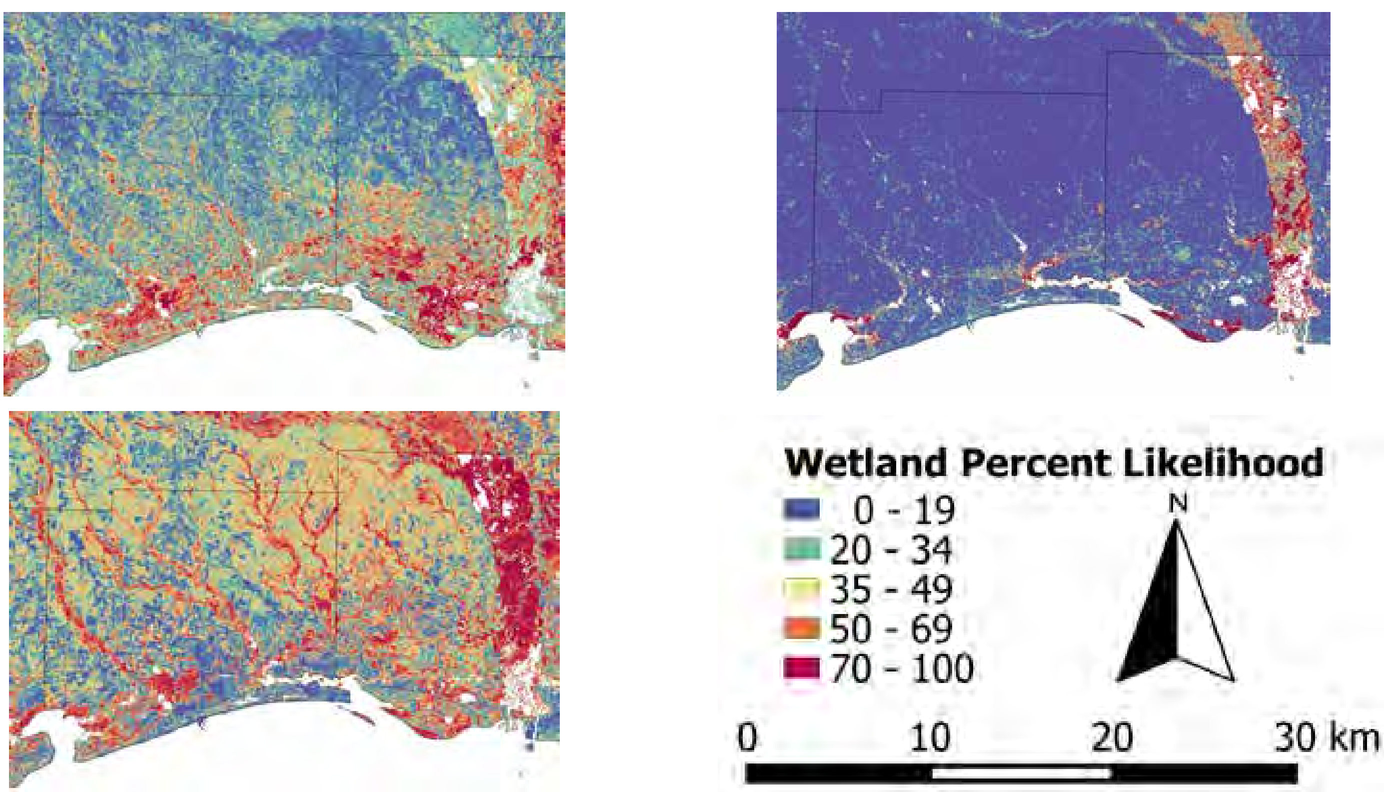

Figure 7. Three wetland prediction maps for Emergent (top left), Estuarine (top right), and Forested (bottom left) wetlands. Red areas indicate a more highly predicted area for the specific type of wetland.

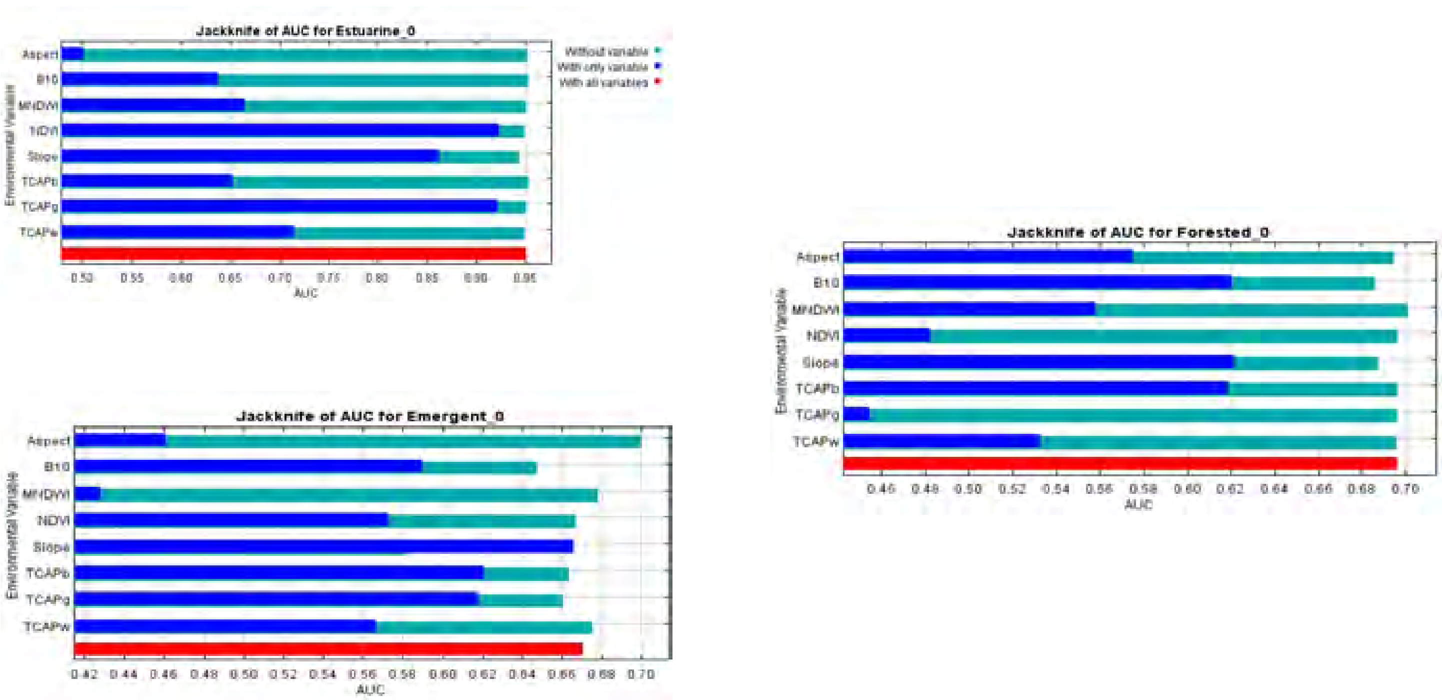

Figure 8. The jackknife tests for the three types of wetlands, indicating which variables were the most influential in each wetland's prediction map.

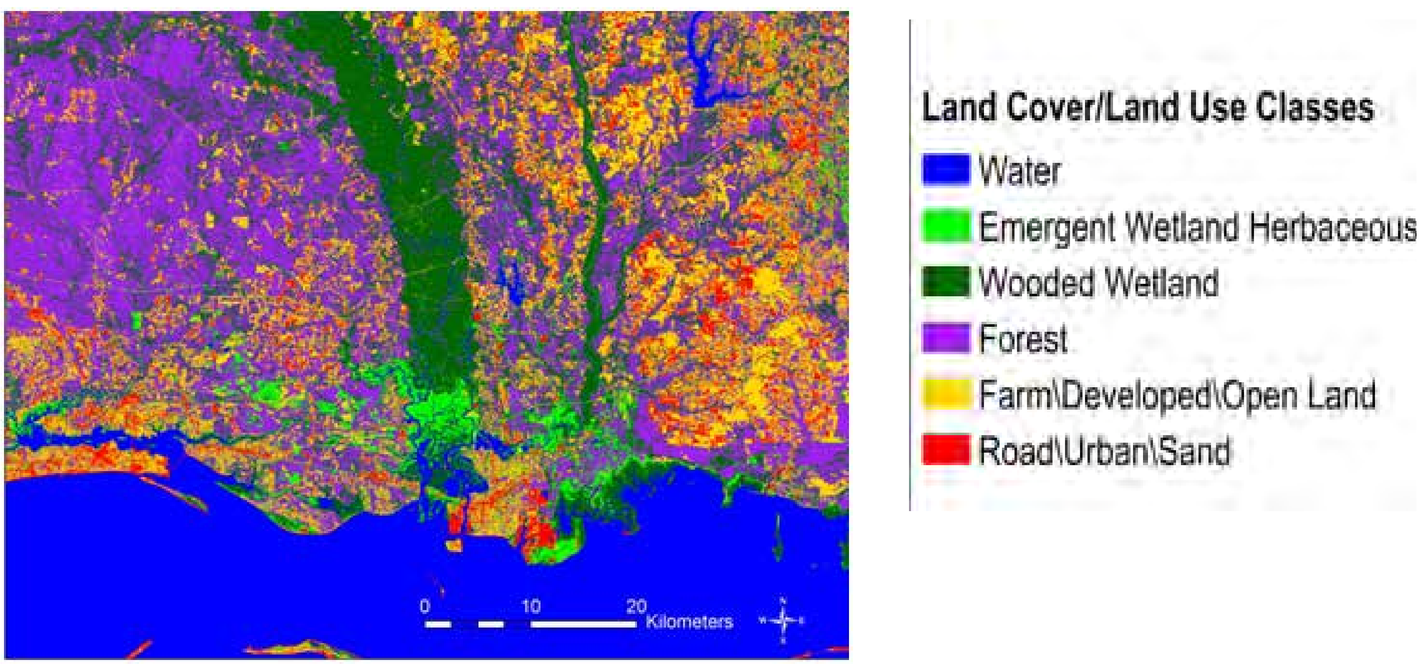

Figure 9. Land Use/ Land Cover map of study area

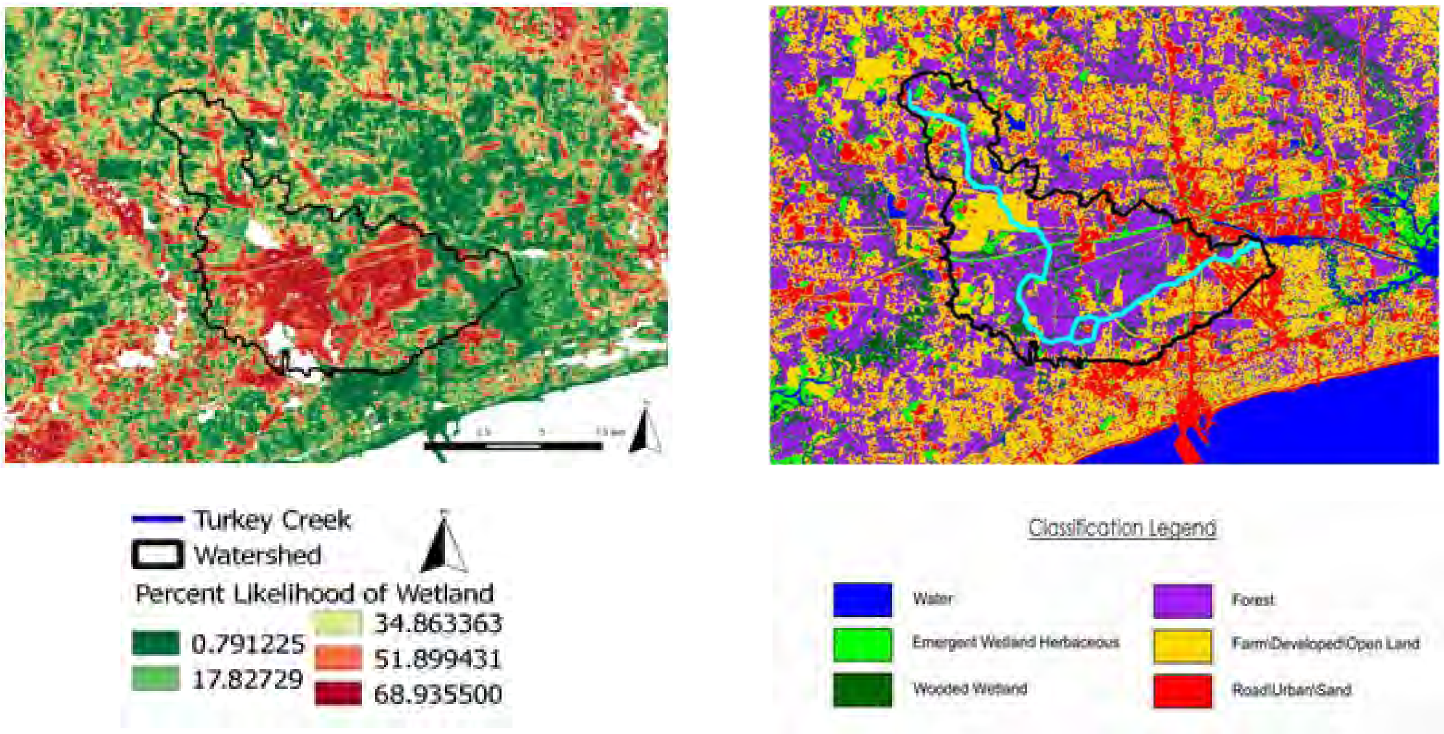

Figure 10. MaxEnt prediction map of forested wetland extent (left) compared to the Land Use/ Land Cover (right) in and around the Turkey Creek Watershed.

Planning the future with an eye to the past: Land Use and Water Quality on the Mississippi-Alabama coast

Carmichael, R.; Darrow, E.; Wu, W.; Huang, H.; Calci, W.; Burkhardt, W.; Walton, W.; Pasch, A.; Woodrey, M.S.

We conducted a 4-year study to measure land-use related nutrient source and pathogen indicator changes through time using Grand Bay, on the Mississippi-Alabama coast, as a benchmark system. The study determined how land use changes in the past have affected water quality, natural resources, and potentially human health to provide data for local land use planning and decision-making. Data showed that historical and present-day land use, particularly increased wastewater and stormwater inputs to coastal areas, has affected water quality and potential for shellfish harvest. Of the five sites tested in the Grand Bay area, Bayou Chico in Mississippi was identified as having particularly poor water quality. Wastewater treatment was demonstrated as a method to reduce water quality impairment throughout the area. On August 1, more than 40 researchers, managers and members of the public met for a one-day workshop at the Grand Bay National Estuarine Research Reserve to discuss these findings and recommend data products to guide water quality improvements on the Mississippi-Alabama coast. Stakeholders identified two products as potentially most useful to promote water quality protection: a quantitative tool to predict how future land use change will affect water quality (nutrients and pathogens) and educational materials to raise awareness among local citizen groups, from eco-tourists to municipal officials. While full implementation of these products will take time, this workshop demonstrated that communication with stakeholders was useful to guide application of scientific data. To sustain water quality and shellfisheries safe for harvest, communities will need to balance land use, particularly area of impervious surface, with suitably designed wastewater treatment alternatives (e.g.; for runoff or combined sewage overflows) and water quality outcomes appropriate for natural resource and public health protection.

Improving Port-Based Economic Development Marketing Websites

Miller, C.; Kern, T.

River and seaports are important assets for regional economic development. Many industries need to be located in close proximity or with efficient transportation connections to ports. Therefore, ports are important site selection factors for industrial attraction. The industrial site selection process typically involves an initial web-based screening of potential locations by consultants or internal real estate teams. Those few communities or states that appear to meet the criteria based on their websites are sent a Request for Information (RFI) seeking specific information. There is a final screening based on the RFI information before economic development negotiations begin so to be successful in industrial attraction certain information needs to be on a port's website or readily available. This research, which was part of the 2014 Mississippi Department of Transportation Statewide Port Needs and Marketing Assessment study, reviews the port related information requested from RFIs to compile a content analysis tool for evaluating port websites. Each of the 16 port websites in Mississippi and their associated economic development organization are evaluated using this checklist. Recommendations for marketing are developed that will improve industrial attraction and retention efforts by ports.

Anammox bacteria as biocathode of Microbial Desalination Cell (ANXMDC)

Singleton, B., Borazjani, H., Cox, M.

Discharge of nitrogenous compounds from municipal and industrial wastewater effluents is of major concerns of today's world since it has negative effects including eutrophication and hypoxia in water bodies. On the other hand, an ongoing challenge to sustainability of wastewater treatment systems is to improve the energy efficiency and cost effectiveness in removing nutrient compounds. A solution to this challenge would be to use Anammox bacteria in devices called Microbial Desalination Cell (ANXMDC). ANXMDC is a promising technology which allows for simultaneous wastewater treatment and desalination of saline water with concurrent electricity production and nitrogen removal. Exoelectrogenic bacteria in the anode oxidize organic matter while autotrophic bacteria serve as biocathode to remove ammonia in an emerging anaerobic microbial process called anaerobic ammonia oxidation (anammox). For a proof-of-concept study, the ANXMDC was fed with synthetic wastewater as organic source in the anode chamber and anammox bacteria were used as biocathode. The ANXMDC produced 0.0896 V while 100% of ammonia (NH3 as ammonium) and 88% of nitrite were removed from the cathode chamber with desalination efficiency of 53.66%. Our results demonstrate that effective batch acclimatization experiments enhanced electricity generation along with nitrogenous compound removal and desalination. This study shows that this system has potential for sustainable and cost effective treatment of nitrogenous compounds and energy recovery from wastewater.

Buffering Wave Buffers: Implications for Accelerating Restoration Efforts in the Marsh-Mangrove Ecotone

Macy, A.; Cebrian, J.; Cherry, J.

With milder winter temperatures, the black mangrove Avicennia germinans has been expanding its range pole-ward into temperate salt marshes, forming an ecotone of mixed vegetation between two ecosystem-defining vegetations (Mangrove forest and Spartina salt marsh). In stable conditions, Avicennia outcompetes Spartina alterniflora, while occasional disturbances favor Spartina. Restoration efforts along the northern Gulf of Mexico will need to account for these interspecies interactions, and understanding stress tolerance thresholds of the climax species (Avicennia) in the field may offer an accelerated path to ecosystem stability and faster return on ecosystem services. I will transplant two groups of seedlings, aged 6-12 months old and 18-24 months old, into high and low energy wave environments. There are several created wetland areas in Bayou Lafourche (LA) dominated by early stages of wetland colonizatio (i.e. Spartina alterniflora). Spartina has been suggested as a wave buffer f Avicennia, aiding in the succession to an Avicennia-dominated system, so treatments will also include areas where Spartina has been clipped. Finally, fertilizer will be applied to half the plots to stimulate a decrease in the root: shoot ratio, possibly making Avicennia more vulnerable to uprooting from waves. Project scheduled to start this summer.

Improving N and P Estimates for Swine Manure Lagoon Irrigation Water

McLaughlin, M.; Brooks, J.; Adeli, A.; Jenkins, J.

Nutrient management plans (NMPs) for confined animal feeding operations (CAFOs) require a record of N and P loads from manure land-applications, including irrigation with lagoon water. Mississippi regulations require nutrient records for lagoon irrigation water be based on at least one annual analysis. Research on swine CAFOs in Mississippi has shown that N and P levels in lagoon water, and the N:P ratio, follow predictable annual cycles, but vary significantly through the April to October irrigation season. Nutrient estimates based on a single annual analysis may not account for this variability and may over- or underestimate nutrient loads and yield inaccurate NMP records. The present study reports an improved method to more accurately estimate N and P loads in irrigation water from swine lagoons. Derived by analyses of data from Mississippi lagoons and other lagoon studies, the method used predicable annual cycles of N and P in lagoon water to fit lagoon-specific models and produce date-based data on nutrient levels. Data were converted to tables displaying estimated N and P levels in the lagoon water for each day of the irrigation season. The farm manager uses the calendar table to find estimated nutrient levels for the date of a respective irrigation event, multiplies those values by the volume of water applied per irrigated area, and enters the results in the NMP record. Similarity of curves from analyses of lagoons in Mississippi and other states suggests that the method can be applied using data from a single nutrient analysis for each lagoon. Although annual cycles followed polynomial models, the irrigation season could be reduced to simpler linear models. An interesting mathematical result from the seasonal linear model showed that lagoon water samples from early July, midway in the irrigation season, represented the average N and P levels for the season, therefore, making it possible to estimate N and P loads using the single analysis data without fitting the data to a seasonal model and calendar table. The accuracy of the single early July analysis approach without curve fitting and a calendar table was, however, dependent on lagoon water volumes being uniformly distributed throughout the irrigation season. Fitting a curve and producing a lagoon-specific calendar table was more accurate for estimating nutrient loads when irrigation events and volumes were not evenly distributed through the season. Both methods were more accurate than using a single analysis from early or late season nutrient concentrations.

A coupled SWAT-MODFLOW model to evaluate the effects of agricultural management practices on surface and groundwater

Ni, X.

Water quality pollutants, which may be generated due to various agricultural activities, can affect both surface water and groundwater resources. The objective of this study is to assess the effects of agricultural management practices and climate variability on surface water and groundwater using Soil and Water Assessment Tool (SWAT) model in the Big Sunflower River Watershed (BSRW), which is major concerned by its agricultural purpose in Mississippi. In addition, the MODFLOW model, a finite-difference groundwater model, was used to simulate groundwater flow with boundary, recharge and HRUs calculated from the corresponding SWAT model. A coupled SWAT-MODFLOW model was applied to evaluate the water quality and quantity effects due to different agricultural management practices. The SWAT model was calibrated and validated by comparing monthly stream flow to observations from USGS gaging stations with both R2 and Nash–Sutcliffe model efficiency coefficient up to 0.67. Statistics increased first and then decreased with increasing hydraulic curve numbers. The model results are expected to be better after the groundwater model is coupled and calibrated with groundwater level data. Different agricultural management practices will be applied to the coupled SWAT-MODFLOW model to evaluate the effects on water quality and quantity of surface water and groundwater.

Use of Small Unmanned Aerial Vehicle in Agricultural Research

Pennington, D.

Recent development in electronic and software systems have made the use of small unmanned aerial vehicles (UAVs) practical for a wide range of applications. In the research presented here, an electric powered, 5 lb, 66 inch wing span, foam fixed wing model airplane was fitted with a 3D Robotics, APM 2.6 autopilot for guidance and two point-and-shoot Canon cameras for imagery collection. One camera is a 1.2 MP RGB camera and the filter in the second camera was changed to allow the red band to receive and record intensity of near infra-red electromagnetic energy. Programmed flight missions were flown over 3 different fields at 100 meters above ground level or less. The same missions were flown over each field on several dates. The total number of individual images collected for each field ranged from 80 images for small plot areas to 325 images for a 65 acre production soybean field. Individual georeferenced tagged images were stitched into a single georeferenced orthophotograph mosaic for each field using the Dronemapper data system available commercially through the internet. Yield data was collected from the plot areas using conventional plot harvesting methods. Yield data from two production fields were obtained from yield data collected during harvest with combines fitted with yield monitoring systems. The remotely sensed imagery data and the spatial yield data were compared and analyzed with QGIS (free GIS software) and spreadsheets. Comparisons of spatial imagery and yield data are being made and the results of those analysis will be presented. Operational experience of a UAV system will also be discussed.

Water Quality Changes in On-Farm Water Storage Systems: A Seasonal Variability Analysis

Pérez-Gutiérrez, J.; Paz, J.; Tagert, M.

Agricultural practices adversely alter the nutrients' natural cycle. The changes are due in large part to the dramatic increase in the use of fertilizers to support agricultural production. A substantial portion of nutrients is transported to groundwater and adjacent waterbodies via surface and irrigation runoff. This environmental issue is of special concern in the Mississippi River Basin, as it is the main source of nutrients that stimulate the development of the hypoxia zone in the northern Gulf of Mexico. To address this issue, Best Management Practices (BMPs) have been implemented with the aim of reducing nutrient loading from agricultural lands in the Mississippi Delta region. Recently, On-Farm Water Storage (OFWS) systems have attracted much attention because of their benefits to the environment, farmers and landowners. However, little is known about the watershed-scale impacts of these systems, as well as the effectiveness of OFWS systems in reducing nutrient loading downstream. This study discusses water quality changes in OFWS systems by analyzing the seasonal variability of several water quality parameters collected from OFWS systems at two farms in Porter Bayou watershed, Mississippi. Preliminary results reveal considerable differences in nitrogen and phosphorus concentrations between the influent and effluent water samples. The OFWS systems examined in this study show significant nutrient loading reduction downstream.

Overview of Water Quality and Water Resource Research in the Water Quality and Ecology Research Unit, Oxford, MS

Wade Steinriede, R.; Locke, M.; Testa, S.

The Water Quality and Ecology Research Unit (WQERU) is part of the United States Department of Agriculture - Agricultural Research Service (USDA-ARS) National Sedimentation Laboratory located in Oxford, Mississippi. The stated research mission of the WQERU is to "address issues of water quality/quantity and watershed ecosystem function. Investigations pursue complimentary approaches that consider the entire landscape." This poster outlines some WQERU research that was designed to address issues relating to storm water and irrigation run-off associated with agricultural fields. Current research can be outlined in three main objectives: Objective 1) Evaluate farm and land management practices that have the potential to affect associated environmental issues such as sediment, nutrients, and water quantity. This type of research ranges from plot studies to monitoring and evaluation on the watershed scale. Objective 2) Characterize and quantify the structure, function, and processes of ecosystems associated with agriculture and their response to changes in land management. Objective 3) Perform integrated assessments of the effects of agriculture on ecosystem services for watershed-scale endpoints. This includes long-term watershed-scale monitoring programs along with modeling and using data collected from sampling and monitoring to improve the models. Through the use of a holistic grouping of studies, the WQERU is addressing needs for knowledge in the agricultural landscape.

Comparing nekton communities between fringing coastal marshes and adjacent seagrass beds

West, L.; Moody, R.; Cebrian, J.; Aronson, R.; Heck, K.; Byron, D.

Trawls and fyke nets are common sampling methods used in aquatic ecosystem studies. Sampling by trawls, which can be used to target seagrass-associated communities, is fundamentally different from sampling with fyke nets, which are positioned at fringing marsh edges to passively collect marsh organisms as the tide recedes. Thus, the two methods potentially differ in efficiency with respect to the numbers and types of organisms they can collect. In this study, we use a two-year data set to compare the community structure of marsh- and seagrass-associated nekton among five sampling sites in the northern Gulf of Mexico. We compare four metrics among sites, habitats, and sampling equipment: (1) total nekton abundance; (2) total abundance excluding the daggerblade grass shrimp Palaemonetes pugio, which is a numerically dominant species that may mask abundance patterns of other species; (3) total abundance of blue crabs and penaeid shrimp, the most abundant species after P. pugio and of commercial importance; and (4) nekton community structure. Variations in community structure between these aquatic habitats are discussed in light of differences in gear efficiency and inherent differences in the structural complexity and accessibility of each habitat to mobile fish and invertebrates. Our findings contribute to an emerging understanding of the potential for functional redundancy between fringing salt marshes and seagrass meadows, with emphasis on implications of this redundancy – or lack thereof – for commercially important species.

Sustainable Agricultural Water Management, Strategy, Technology and Practice

Sustainable Agricultural Water Management, Strategy, Technology and Practice

Gary Feng *(USDA-ARS)*	Analysis and Prediction of Water Deficit for Soybean, Corn and Cotton in the State of Mississippi
Martin Locke *(USDA-ARS)*	Tillage and Cover Crop Effects on Runoff Water and Soil Quality
Ruixiu Sui *(USDA-ARS)*	Soil Water Monitoring Using Wireless Sensor Network
J.R. Rigby *(USDA-ARS)*	USDA-ARS Long-Term Agroecosystem Research Network: A New Initiative for Long-Term Monitoring, Research, and Collaboration in the Lower Mississippi River Basin

Analysis and Prediction of Water Deficit for Soybean, Corn and Cotton in the State of Mississippi

Feng, G.

Supplemental irrigation are becoming common practice in Mississippi to stabilize and increase crop productivity and quality after crop late vegetative growing season. Agriculture consumes 90% of consumptive water use, 80% is from groundwater, only 20% is from surface water in the US second largest annual rainfall state of Mississippi. In western Mississippi, groundwater levels are declining due to increasing groundwater withdrawal for irrigation. Mississippi Delta will face a serious shortage of water for agriculture. In eastern Mississippi, the groundwater is so deep and expensive to pump for irrigation, majority of growers choose using surface pond water for irrigation. Sustainable conjunctive use of surface and ground water resources for irrigation requires knowledge of crop water requirements and deficit (difference in precipitation and evapotranspiration). Therefore, water deficit of dominant irrigated crops, soybean, corn and cotton in Mississippi western Delta and eastern Blackland Prairie regions was estimated. Historical weather data in the two regions dating back to 1800 were analyzed using time series statistical models. The patterns of changes in air temperature and precipitation in the past and future were determined. The obtained trends and other results will help understand climate change and provide agroecosystem models with information to assess agriculture sustainability and competitiveness as affected by such climate change in the future. Water requirements of the three major crops in the two regions were calculated using Hargreaves method. Spatial and temporal probability distribution and frequency of water deficit in both Delta and Blackland Prairie were analyzed. As a result, we are able to forecast water deficit of each individual crop during every growing stage in the state of Mississippi for irrigation scheduling, drainage design, rainfall harvest planning, and agronomic management practice development to make most use of both ground and surface water resources.

Tillage and Cover Crop Effects on Runoff Water and Soil Quality

Locke, M.; Krutz, J.; Steinriede, W.; Dabney, S.

Conservation management systems need to be assessed in the lower Mississippi River alluvial basin to balance production goals with environmental concerns. Complementary approaches for assessing effects of tillage and cover crops on water and soil quality in cotton (Gossypium hirsutum L.) production are reviewed here. In Study 1, no-tillage (NT) or minimum tillage (MT) with or without cover crop (rye [Secale cereale], balansa clover [Trifolium michelianum ssp. Balansae], or none) treatments were assessed from 2001 to 2006 for changes in soil characteristics and production. In 2007, a rainfall simulation study was conducted to evaluate treatment effects on runoff. In Study 2, NT, MT, MT with rye cover, and conventional tillage (CT) were assessed for effects on soil changes (2003 to 2011) and runoff water quality (2007 to 2011). Synthesis of results from these studies indicated that: (a) Cover crop and reduced tillage resulted in modest increases in soil organic matter and soil nitrogen; (b) Soil biological activity was enhanced by cover crops (e.g., enzymes, mycorrhizae); © Total runoff sediment loss was reduced by no-tillage and cover crop; (d) Nitrogen and phosphorus associated with runoff sediment were reduced in no-tillage and cover crop; € Soluble nitrogen and phosphorus in runoff was variable, sometimes higher in no-tillage and cover crop plots.

Soil Water Monitoring Using Wireless Sensor Network

Sui, R.

Mississippi Delta is one of the most productive and intensively irrigated agricultural regions in US. Although there is more than 1000 mm of annual precipitation in this region, uncertainty in the amount and timing of precipitation is one of the most serious risks to the producers. Producers in this region have become increasingly reliant on supplemental irrigation to ensure adequate yields. There are more than 17,000 water wells in Mississippi Delta used to pump groundwater from the Mississippi River Valley Alluvial Aquifer for agricultural irrigation. Increasing groundwater withdrawal is resulting in a decline in the aquifer levels. It is necessary to develop improved water management tools for water resource preservation and sustainable agriculture in this region. To increase water use efficiency and productivity, novel sensing technologies are required to determine crop water status and conduct irrigation scheduling. Crop water status and the amount of supplementary water needed can be assessed by measuring soil moisture and plant physical response to water stress. A wireless sensor network (WSN) was built and deployed in three fields to monitor soil moisture status and collect weather data for irrigation scheduling. The WSN consists of soil moisture sensors, weather sensors, wireless data loggers, and a wireless modem. Soil moisture sensors were installed at three depths below the ground surface in various locations across the fields. Weather sensors were mounted on a 3-m instrument tower. An antenna mount was designed and fabricated for use in the WSN. When field equipment such as a fertilizer or chemical applicator impacted the mount, the mount was capable of protecting the antenna from damage by the equipment. The WSN has been deployed and operated in fields with cotton, corn, and soybean crops for three years. It performed well in data collection and transmission. No major operational issues occurred with the WSN except occasional data transmission interruptions by the thunderstorms during the summer. Using the WSN system, soil moisture and weather conditions including precipitation, solar radiation, wind speed, and humidity were measured every minute and the hourly averages were reported and stored at one-hour interval. The soil moisture data and weather data were automatically and wirelessly transmitted to the internet making the data available online. Data collected by the WSN have been used in irrigation scheduling research in cotton, corn and soybean crops.

USDA-ARS Long-term Agroecosystem Research Network: A new initiative for long-term monitoring, research, and collaboration in the Lower Mississippi River Basin

Rigby, J.; Locke, M.

The Lower Mississippi River Basin is one of the most productive agricultural regions in the country links agricultural practices and associated runoff and nutrient loads from the Upper Mississippi, Missouri, and Ohio basins with the ecology of the Gulf of Mexico. In 2013 the USDA-ARS founded the Long-term Agroecosystem Research (LTAR) network consisting of 18 member locations across the United States to address long-term research and monitoring goals for U.S. agriculture. The Lower Mississippi River Basin (LMRB) is a member location of the network administered by the USDA-ARS National Sedimentation Laboratory. The LTAR network will focus activity on development of agroecosystem observatories with common standards for cross-site monitoring at all locations as well as a set of experiments to address the long-term sustainability of agriculture and the broader agricultural landscape in the U.S. A number of sustainability challenges face the Lower Mississippi River Basin including increased concerns around water quantity and quality issues.

Understanding the Impacts of Coastal Water
Quality on Ecological and Human Health

Understanding the Impacts of Coastal Water Quality on Ecological and Human Health

Kevin Dillon *(University of Southern Mississippi)*	Water Quality in Bangs Lake: Effects of Recurrent Phosphate Spills to a Coastal Estuary
Jane Caffrey *(University of West Florida)*	Factors Influencing Primary Production and Respiration in Grand Bay National Estuarine Research Reserve
Georgiana Crepps *(NASA DEVELOP)*	Mississippi Water Resources: Mapping the Extent of Critical and Endangered Watersheds to Assist Restoration Efforts and Conservation Planning Using NASA Earth Observations

Water Quality in Bangs Lake: effects of recurrent phosphate spills to a coastal estuary

Dillon, K.; Caffrey, J.; Carmichael, R.; Holcomb, S.; Griffin, C.; Allen, J.; Jones, T.; Price, K.; Baine, G

Bangs Lake, an estuarine water body in the Grand Bay NERR, has been the site of three industrial phosphate spills from a nearby fertilizer plant since 2005. Due to restricted tidal exchange in Bangs Lake, these events have had long lasting effects on water column phosphate concentrations which may stimulate biological activity and alter the biogeochemical cycling of essential elements within the water column and the sediments. To determine the fate of excess phosphate from the industrial spills, we measured soluble reactive phosphate concentrations in sediment pore water and total particulate phosphate concentrations from sediment cores (0-25 cm depth) from four locations: North Bangs Lake (closest to spill locations), Bangs Lake, and two low impact reference sites (Bayou Cumbest and Bayou Heron). We also conducted phosphate adsorption experiments and measured benthic chlorophyll concentrations with sediments from these sites to determine if the excess PO4 was fertilizing benthic microalgae to determine the fate of this excess PO4. Pore water phosphate concentrations were highest (21 uM) from 10 to 20 cm depths in North Bangs Lake cores however pore water from the surface sections of these cores had much lower phosphate concentrations (<0.5 uM). Pore water from the Bangs Lake cores consistently had elevated phosphate concentrations (2 to 5 uM) throughout the core length while pore water phosphate concentrations from one reference site were much lower (<0.7 uM), likely reflecting background levels. Phosphate adsorption experiments show that surface sediments from North Bangs Lake and Bayou Cumbest rapidly stripped phosphate from solution to final concentrations of <3 uM while surface sediments from Bangs Lake had greatly reduced phosphate adsorption capacity with much higher final concentrations (24 to 32 uM) indicating these sediments are near saturation. In 2013 and 2014, Sediment chlorophyll a concentrations were higher in Bangs Lake compared to the reference site. Sediment chlorophyll a was significantly correlated with extractable phosphate concentration in sediments (r = 0.88). In addition, grow out experiments with amendments of phosphorus to water and sediment samples stimulated the growth of cyanobacteria capable of fixing nitrogen.

Factors influencing primary production and respiration in Grand Bay National Estuarine Research Reserve

Caffrey, J.; Amacker, K.; Murrell, M.; Woodrey, M.

Advances in technology have greatly increased our ability to collect water quality data over a variety of space and time scales. For example, commercially available data sondes deployed to collect time series of temperature, salinity and dissolved oxygen data can capture events from hourly (tidal and diurnal) time scales to seasonal time scales capturing freshwater runoff and algal blooms. Analysis of data from these long-term deployments provides insights into the relative importance of anthropogenic and external drivers on estuarine ecosystem function. Dissolved oxygen time series have been used to estimate daily gross production, respiration and net ecosystem metabolism (NEM). However, long-term estimates of primary production and ecosystem respiration are rare in the estuarine literature, yet they provide fundamental information about the trophic status of these sensitive environments. When collected consistently, this approach makes it possible to resolve long-term trends, but perhaps more importantly, it provides a historical benchmark against which future patterns may be evaluated. Grand Bay National Estuarine Research Reserve is a small and relatively pristine estuary in the northern Gulf of Mexico. Freshwater input into the estuary is primarily local runoff from bayous and tidal creeks, including Bayou Cumbest, Bayou Heron, and Bangs Lake Nutrient loading to Grand Bay is relatively small, with ambient nutrient concentrations often below detection. Primary production was calculated from diurnal dissolved oxygen data sonde data using Odum's open water method. Primary production and respiration was highest in the summer and rates of these processes were highly correlated. Despite interannual patterns in freshwater flow and salinity, variability in metabolic rates was low, perhaps reflecting shifts in the relative importance of benthic and phytoplankton productivity, during different flow regimes. Primary production and water column chlorophyll a in Grand Bay following a 2005 phosphorus spill was similar that from other years. The lack of stimulation by phosphorus is consistent with nutrient addition bioassay experiments performed at Bangs Lake and Point aux Chenes. Samples collected bimonthly showed that nitrogen rather than phosphorus stimulated phytoplankton growth at both locations.

Mississippi Water Resources: Mapping the Extent of Critical and Endangered Watersheds to Assist Restoration Efforts and Conservation Planning Using NASA Earth Observations

Castillo, C.; Crepps, G.

Watersheds in Mississippi provide many environmental and recreational benefits to the citizens and visitors of the state. The Nature Conservancy and the Pascagoula River Audubon Center are currently working to protect coastal Mississippi watersheds, in part through urban coastal preservation initiatives. The primary objective of this project was to aid these conservation efforts by delineating watershed extents for nine coastal streams within the three coastal counties of Jackson, Hancock, and Harrison. As these are small streams (<0.5 miles – 17 miles), most do not have individual watersheds delineated in the Watershed Boundary Dataset (WBD). Specifically, three analyses were conducted: watershed delineation of the urban streams, a Land Use Land Cover (LULC) map of the three coastal counties, and a wetland extent map of a subset of that area. The individual watershed delineation was conducted through open source Geographic Information Systems (GIS) platform Quantum Geographic Information System (QGIS) with the Geographic Resources Analysis Support System (GRASS) toolbar. These were then overlaid with watershed sub-basins created in ArcGIS for comparison. Earth Resources Data Analysis Systems (ERDAS) and QGIS were also used to perform a land cover classification. The analysis of wetland areas was performed using a Maximum Entropy (MaxEnt) model. Relevant inputs to these analyses included elevation, terrain aspect, thermal data, and vegetation indices. The analyses utilized Landsat 8 Operational Land Imager (OLI) data, and stream vectors. Our results reveal the distribution of wetlands, forests, and urban areas within these watersheds. Overall, this project illustrated the utility of open data, as well as open-source software. Furthermore, these watershed and wetland maps will aid in the current conservation efforts of endangered streams in southern Mississippi.

Impacts of Reforestation and Ag. and Forest Mgmt. on Surface Water Quality in the Lower MS River Basin

Ying Ouyang *(USDA Forest Service)*	Impacts of Reforestation/Deforestation Upon Surface Water Quality in Mississippi River Basin
G.V. Wilson *(USDA-ARS)*	Subsurface Erosion in Response to Land Management Changes and Soil Hydropedology
Brent Frey *(Mississippi State University)*	Bottomland Hardwood Restoration and Implications for Water Quality
Abdullah O. Dakhlalla *(Mississippi State University)*	Evaluating the Impacts of Crop Rotations on Groundwater Storage and Recharge in the Mississippi Delta

Impacts of reforestation/deforestation upon surface water quality in Mississippi River Basin

Ouyang, Y.

Among the world's largest coastal and river basins, the Mississippi River Basin (MRB) is one of the most disturbed by human activity. Changes in agricultural and forest practices, clearcutting in bottomland hardwood forests, and conversions from forests to agricultural lands are largely responsible for the increased nutrient, sediment, and other pollutant loads into the Mississippi River (MR) and the adjacent Gulf of Mexico (GOM). The excess nutrient load has resulted in the increased extent and severity of the seasonal hypoxic zones, the altered species composition, and the decreased overall health of aquatic communities in the MRB and adjacent GOM. Additionally, the elevated sediment load has been recognized as both a carrier and a potential source of contaminants in aquatic environments due to their adsorption of toxic constituents. In spite of numerous efforts have been devoted to investigating the relationships between the ecological and environmental consequences of deforestation and the benefits of reforestation, very few efforts have been devoted to scrutinizing and synthesizing the effects of reforestation on water quality in the MRB. This study was undertaken to investigate (1) impacts of deforestation on water quality (e.g., nutrients and sediments), and (2) effects of reforestation and forestry management practices on surface water quality. Synthesized the review findings, we have identified the relevant knowledge gaps and recommended future research needs to assist forest and water resource managers in making timely decisions for water quality improvements in the MRB and the adjacent GOM.

Subsurface Erosion in Response to Land Management Changes and Soil Hydropedology

Wilson, G.; Rigby, J.; Dabney, S.

Flow through macropores can be sufficiently rapid to cause internal erosion and, thereby, create soil pipes. Soil pedology and hydrology interact to determine the location of soil pipes, flow rates through soil pipes and rates of internal erosion. Soil pipes tend to develop in duplex soil in that water restricting horizons cause a proliferation of biopores at the interface and foster lateral subsurface flow by perching water. Internal erosion can enlarge these preferential flow paths to the extent that soil pipe's collapse, thereby forming flute holes, sinkholes and ephemeral gullies at the surface. The soil hydropedologic properties determine the erodibility of the pipe surfaces and shear forces acting on pipe walls. Little is known about the impact of past land management practices on soil pipe formation. This paper will review the connections between hydrologic and pedologic soil properties and the impact of changes in land use from cropland to forest and forest to pasture on soil pipeflow processes using observations of soil pipes in Goodwin Creek Experimental Watershed. Three adjacent catchments, all classified as the same soil series, were surveyed for pipe collapse features. One contained no pipe collapse features, while the other two exhibited 32.6 and 15.7 collapse feature ha-1. Soils in these catchments contain a fragipan that perches water and fosters lateral flows. Subsurface layers exhibit vulnerability to internal erosion. It appears that past land management practices, including removal of forested buffers and filling in historical gullies control to a large degree the location of soil pipes and the current hydrologic response of the catchment. This paper will use field observations to highlight gaps in our understanding of the hydropedologic processes associated with soil piping and their interaction with and/or response to land management practices.

Bottomland hardwood restoration and implications for water quality

Frey, B.; Ouyang, Y.; Stoll, J.

Over the last several decades, bottomland restoration efforts have established hundreds of thousands of acres of planted hardwood stands across floodplains of the Lower Mississippi Alluvial Valley (LMAV). Major goals of these afforestation efforts are to restore forest cover for the enhancement of wildlife habitat, soil conservation, and water quality. However, few studies have evaluated the effects of bottomland afforestation on soil and water quality, particularly in relationship to different sites conditions, planting mixtures, and over time as these afforestation stands mature. Studies have suggested that bottomland forest restoration could play an important role in carbon and nitrogen removal, particularly in connected floodplains in the LMAV. This presentation will review our research investigating stand development, growth and biomass of young (10-20 year old) planted oak stands and management activities that are being considered for these stands. We will also discuss our proposed research to investigate soil and hydrological processes in relation to stand development. Knowledge of stand growth, linked with soil and hydrological processes, is needed to evaluate the role of bottomland afforestation efforts in enhancing soil and water quality. This information will be important for addressing the impacts of these forest restoration efforts and identifying opportunities to improve their efficacy.

Evaluating the impacts of crop rotations on groundwater storage and recharge in the Mississippi Delta

Dakhlalla, A.; Parajuli, P.

The Mississippi River Valley Alluvial Aquifer, which underlies the Big Sunflower River Watershed (BSRW), is the most heavily used aquifer in the state of Mississippi. Because the aquifer is primarily used for irrigating crops such as corn, cotton, soybean, and rice, the water levels have been declining rapidly over the past few decades. The objectives of this study are to (1) develop a calibrated and validated model using SWAT for streamflow and water table depths in the BSRW, (2) analyze the relationship and trends between evapotranspiration and groundwater recharge rates within the model, and (3) to model the effects of various crop rotation strategies on groundwater storage and recharge. The model performed well during the calibration periodR2= 0.53 to 0.68 and NSE = 0.49 to 0.66) and validation perio(R2= 0.55 to 0.75 and NSE = 0.49 to 0.72) for daily streamflow, which was achieved by the SUFI-2 auto-calibration algorithm in the SWAT-CUP package. The model also performed well in simulating seasonal water table depth fluctuations at the calibration sub-basin (R2 = 0.58 and NSE = 0.56) and at the validation sub-basin (R2 = 0.72 and NSE = 0.63). The crop rotation scenarios with rice planting resulted in the lowest groundwater storage (-8.3% to -9.6%) compared to the baseline crop scenario, which is due to the high irrigation rates of the rice crop. However, the rice crop rotations resulted in the highest increases of groundwater recharge rates (+19.4% to +59.5%), likely because of the response to the deficiency of groundwater needed for irrigation as well as the limited water uptake by the shallow rice plant roots. The crop rotations with corn and cotton resulted in the largest increases in groundwater storage (+9.6% to +26.7%), which is the result of the low irrigation rates as well as the short time period between planting and harvesting. The results of this study is expected to aid farmers and watershed managers to conserve groundwater resources, but still maintain crop production.

Watershed Management

Watershed Management

Kelsey Johnson *(Mississippi State University)*	Improving Water Quality through Watershed Planning, Design and Innovative Outreach Activities
Richard Ingram *(Mississippi State University)*	The Catalpa Creek Watershed Project and Watershed Demonstration, Research, Education, Application and Management (D.R.E.A.M.) Center
Tim Diehl *(U.S. Geological Survey)*	Automated Identification of Sediment Sources and Sinks: Tool Development to Support Water Quality Planning
Liya Abera *(University of Mississippi)*	Analysis of Pervious Concrete as a Stormwater Management Tool Using SWMM Modeling

Improving Water Quality through Watershed Planning, Design and Innovative Outreach Activities

Johnson, K.

Mississippi State University's Gulf Coast Community Design Studio (GCCDS), in partnership with the Land Trust for the Mississippi Coastal Plain (LTMCP) and with input from community leaders and residents, is developing a Watershed Implementation Plan for Rotten Bayou Watershed in Hancock and Harrison Counties, Mississippi. In addition to developing a written plan, the work includes extensive education, community outreach, and demonstration projects of best management practices. Meaningful engagement is critical both to address conditions that cause nonpoint source pollution and to develop a plan that has good community buy-in to ensure implementation. Innovative engagement approaches are necessary in Rotten Bayou Watershed for two main reasons. First, there is currently very limited public access to the Bayou so few residents in the watershed have a direct connection to or an appreciation of the waterways they impact. Second, there are essentially two "communities" that make up the watershed: Fenton/Dedeaux and Diamondhead. Fenton/Dedeaux is a rural community with many residents that have deep roots in the area. Diamondhead is a planned retirement community that recently became Mississippi's newest city and is made up of many transplants to the area Effectively communicating with residents in these two communities; appealing to their different interests and values; and uniting them in the cause of improving water quality in Rotten Bayou requires multiple and creative approaches to outreach. The presentation will introduce conference attendees to the unique planning and outreach methods being utilized in developing the Rotten Bayou Watershed Implementation Plan. Strategies include working with non-traditional partners such as a churches, summer library reading programs, golf courses and an educational puppet show; utilizing social media and raffles to make participation appealing and accessible; and leveraging funding from NOAA's Gulf of Mexico B-WET Program to connect students at a local elementary school to the watershed planning work. The Watershed Implementation Plan for Rotten Bayou Watershed is funded in part by a grant from the EPA to the Mississippi Department of Environmental Quality under the provisions of Section 319(h) of the Clean Water Act along with State and local match.

The Catalpa Creek Watershed Project and Watershed Demonstration, Research, Education, Application and Management (D.R.E.A.M.) Center

Linhoss, A., Balwebber, J., Pote, J.

A significant portion of Mississippi State University's (MSU) campus and property resides within the Catalpa Creek Watershed (referenced by USGS as the Red Bud-Catalpa Creek Watershed, HUC 12 #031601040601, and by MDEQ as MS #8090). This includes important MSU education and research facilities, such as the Mississippi Agricultural and Forestry Experiment Station's (MAFES) South Farm, which is used by numerous departments and programs. Unfortunately, some of MSU's land uses in this watershed may have contributed to the pollution of Catalpa Creek. Total Maximum Daily Load (TMDL) studies that apply to this watershed include those for sediment, nutrients, and pathogens. Each of these TMDLs recommend practices to reduce pollutant amounts to acceptable levels thereby providing improved habitat for the support of aquatic life and allowing for the attainment of applicable water quality standards.

On April 2013, MSU, through the Mississippi Water Resources Research Institute (MWRRI), was designated a Center of Excellence for Watershed Management with the signing of a Memorandum of Understanding (MOU) between the Mississippi Department of Environmental Quality (MDEQ), Region 4 of the U.S. Environmental Protection Agency (EPA), and MSU. The MOU recognized that MWRRI had "demonstrated to the satisfaction of EPA and MDEQ that it has the capacity and capability to identify and address the needs of the local watershed stakeholders" and was charged to "work with colleges and universities in Mississippi to engage students (graduate and undergraduate), faculty and staff from the full suite of disciplines needed to adequately address specific watershed issues" and to "draw upon other local, state, federal resources and expertise."

MWRRI, in its role as a Center of Excellence for Watershed Management, is advantageously positioned to bring resources together from various MSU departments and programs; nongovernmental organizations; and state and federal agencies to address the needs in the Catalpa Creek Watershed. This project will not only put appropriate BMPs on the ground in strategic locations in the watershed to restore water quality and habitat, but also establish a venue for watershed-based demonstrations, research, education, application and management.

Automated identification of sediment sources and sinks: Tool development to support water quality planning

Diehl, T.; Cartwright, J.

Water-quality improvement practices, including sediment retention and channel restoration projects, are commonly hampered by incomplete knowledge of sediment-source locations and transport networks within watersheds. In particular, gully systems can undermine infrastructure and pose public safety hazards through active bed and bank erosion and excessive sedimentation near their outlets. High-resolution digital elevation models (DEMs) from Light Detection and Ranging (LiDAR) are a newly-available data source useful for investigating geomorphology of stream channels and gullies. Channel and gully networks derived from these DEMs offer much higher resolution than currently available topographic maps or map-derived stream networks. The U.S. Geological Survey is working in cooperation with the Tennessee Department of Transportation and the Southwest Tennessee Development District to develop automated tools to identify locations of erosion, sediment transport, and deposition within channel and gully networks, based on landscape characteristics derived from high-resolution DEMs. By automating the identification of hotspots of channel erosion (for example incised channels and gully heads) and sedimentation (for example over-widened shallow channels and valley plugs) this project will provide a tools for local and regional efforts related to water quality, channel restoration, infrastructure protection, and storm-water management.

Analysis of pervious concrete as a stormwater management tool using SWMM Modeling

Abera, L.; Surbeck, C.

Stormwater runoff occurs when precipitation flows over the ground. Increase in impervious land cover due to urbanization causes excess stormwater runoff and affects the quantity and quality of receiving water bodies. The use of Low Impact Development (LID) controls is highly recommended to reduce the excess volume of stormwater runoff. LID controls include infiltration techniques such as pervious pavements, evaporation, and storage techniques to reduce the volume of runoff. In this study, performance assessment results of pervious concrete pavement at the University of Mississippi Law School parking area will be presented. The Law School was constructed in 2009 and is adjacent to a privately owned recreational pond. There is a high volume of stormwater runoff from the university area going to the pond, which prompts the university to implement LID tools, such as pervious pavement. Multiple in-place infiltration rate tests, using the ASTM C1701/C1701M-09 standard, were conducted to evaluate the effectiveness of the pervious pavement. Based on the test results, the average infiltration rate of the pervious pavement is 45 mm/hr, which is less than the desired rate. The U.S. Environmental Protection Agency's Stormwater Management Modeling Tool (SWMM) was used to model the area and to quantify the volume of runoff that can be expected from different intensity storms. Results show that pervious concrete is more effective for a low intensity, long duration storm than for a high intensity, short duration storm.

Spatial and Temporal Controls on Surface and Groundwater Hydrology in the MS Delta

Spatial and Temporal Controls on Surface and Groundwater Hydrology in the MS Delta

Mary Love Tagert *(Mississippi State University)*	An Update on the Mississippi Irrigation Scheduling Tool
Anna Linhoss *(Mississippi State University)*	Measuring the Uncertainty and Sensitivity of the Mississippi Irrigation Scheduling Tool (MIST)
Jeannie Barlow *(U.S. Geological Survey)*	Groundwater and Surface-Water Dynamics in the Mississippi Delta: A Coupled Monitoring-Modeling Approach for Better Understanding and Management of Groundwater and Surface-Water Resources in the Delta
Jeannie Barlow *(U.S. Geological Survey)*	Design and Implementation of a Groundwater-Streamgage Network to Assess Groundwater and Surface Water Interaction in the Mississippi Delta

An Update on the Mississippi Irrigation Scheduling Tool

Tagert, M.; Linhoss, A.; Rawson, J.; Sassenrath, G.

Since the 1970's, groundwater levels in the Mississippi Alluvial Aquifer have decreased as the number of irrigated acres in the Mississippi Delta has increased. Today, there are roughly 18,000 permitted irrigation wells dependent on water from the Mississippi Alluvial Aquifer. As concern has grown over groundwater declines, farmers have been implementing more irrigation conservation measures, such as the use of surge valves and computerized hole selection, which improve irrigation application methods. Some farmers are also using soil moisture sensors to improve irrigation timing, although this can be cumbersome, especially if irrigating a large number of fields. The Mississippi Irrigation Scheduling Tool (MIST) is a web-based irrigation scheduling tool designed to help farmers manage and schedule irrigation in a humid climate. The tool provides an estimate of crop water use based on a "checkbook" approach that determines the water balance of the soil, plus water from rainfall or irrigation, minus water used by the crop or evaporated from the soil. Daily evaporation is calculated using the modified Penman-Monteith equation. The system automatically notifies the farmer if irrigation is required when the available soil moisture balance falls below a set threshold. MIST, which is being tested in selected areas in the MS Delta region, has a web interface that allows producers to access their information from anywhere through tablet computers or smart phones. This presentation will give an update on the MIST project and summarize progress to date.

Measuring the uncertainty and sensitivity of the Mississippi Irrigation Scheduling Tool (MIST)

Linhoss, A.; Tagert, M.; Bukah, H.

The Mississippi River Valley Alluvial Aquifer has seen dramatic declines due to pumping for irrigation in northwestern Mississippi. Irrigation scheduling saves water and energy without sacrificing yield through the optimal frequency and duration of water applications. Models, based on based on crop, soil, and climatic data, can be used for irrigation scheduling. The Mississippi Irrigation Scheduling Tool (MIST) is one such model. MIST uses the Penman-Montieth equation, along with crop coefficients, and the Soil Conservation Service curve number method to calculate runoff and evapotranspiration in a field. The resulting water balance can be used to schedule irrigation events. When using a model, such as MIST, for management purposes, it is important that the user be aware of the reliability or uncertainty of the model. Furthermore, model calibration can be optimized by identifying the most important driving parameters within a model. The objective of this research was to conduct a global sensitivity and uncertainty analysis of the MIST model to quantify model reliability and identify the most important model parameters. In order to provide a realistic representation of the model's uncertainty and sensitivity, parameter probability distributions were based on measured values and compared to results that used generic percentages. Six global sensitivity analysis methods were employed to understand how those methods differ (Sobol, FAST, Morris, random, quasi-random, and Latin-hypercube sampling). The results show that the sensitivity analysis methods return similar results. However, the method by which the probability distributions were determined were important in determining the results. These results are useful in developing better modeling tools and can help farmers and managers successfully apply MIST model recommendations.

Groundwater and surface-water dynamics in the Mississippi Delta: a coupled monitoring-modeling approach for better understanding and management of groundwater and surface-water resources in the Delta

Barlow, J.; Connor, J.

The Mississippi River alluvial plain in northwestern Mississippi (referred to as the Delta), once a floodplain to the Mississippi River covered with hardwoods and marshland, is now a highly productive agricultural region of large economic importance to Mississippi. Water for irrigation is supplied primarily by the Mississippi River Valley alluvial aquifer, and although the alluvial aquifer has a large reserve, there is evidence that the current rate of water use from the alluvial aquifer is not sustainable. Prior to extensive use of groundwater for irrigation, the regional groundwater flow path generally followed the topography of the alluvial plain, discharging to the streams and rivers within the Delta. Presently, the regional groundwater flow path is intercepted by a large cone of depression in the central Delta with maximum drawdown occurring in Sunflower County, formed as a result of groundwater pumping for irrigation. Water-level declines have resulted in decreased groundwater discharge to streams to the extent that many stream reaches in the Delta are presently net losing streams throughout the year. These changes in flow to and from the aquifer have decreased the amount of water available within the alluvial aquifer and have diminished many ecosystem services provided by groundwater discharge to streams such as maintaining baseflow in streams, regulating stream temperature regimes for aquatic biota, and buffering the transport of contaminants through the streambed interface.

An effort is currently underway to update and enhance an existing regional groundwater flow model in order to develop and run conjunctive water management optimization scenarios. This effort is jointly conducted by personnel from the U.S. Geological Survey and the Mississippi Department of Environmental Quality through a memorandum of understanding between the two agencies. Key revisions to the model include updating the model through 2014 with the addition of more recent water use data, precipitation and recharge data, and streamflow and water-level observations.

Design and implementation of a groundwater-streamgage network to assess groundwater and surface water interaction in the Mississippi Delta

Roberts, B.; Barlow, J.

In 2014, the U.S. Geological Survey (USGS), Mississippi Water Science Center, in cooperation with the U.S. Army Corp of Engineers, Vicksburg District, installed and instrumented a total of ten groundwater-streamgages throughout the Yazoo Basin. Each groundwater-streamgage collects and transmits, at minimum, stream stage, stream temperature, groundwater level, and groundwater temperature. Site instrumentation consisted of installing near-stream piezometers near existing or new streamgages. These piezometers house pressure transducers with temperature recorders and provide a means to measure and record periodic water-levels in order to check the continuous data from the logger. Each groundwater-streamgage is operated and maintained on a regular schedule (approx. 8 week interval), and all data are transmitted real-time to a project web page. Groundwater-streamgages provide a framework to document the spatiotemporal variability of groundwater and surface-water interaction. Data will be used to better understand the potential connectivity between the stream and the alluvial aquifer within the Yazoo River Basin and how connectivity affects water quantity and quality throughout both. This network will also help understand and quantify the extent that the interaction between streams and the alluvial aquifer has been affected by declining water levels in the alluvial aquifer.

Water Quality of the Gulf of Mexico

Nancy Rabalais *(Louisiana Universities Marine Consortium)*	Climate Change and Coastal Eutrophication
Tiffany Toft *(National Oceanic and Atmospheric Administration)*	NOAA's Gulf of Mexico Hypoxia Watch
Jim Cizdziel *(University of Mississippi)*	New Approaches and Analytical Tools for Studying Mercury in the Gulf of Mexico: Sources and Transformations
Richard Rebich *(U.S. Geological Survey)*	Monitoring Network Design to Assess Potential Water-Quality Improvements Associated with the Mississippi Coastal Improvement Program in the Mississippi Sound

Climate Change and Coastal Eutrophication

Rabalais, N.

The world's climate has changed and human activities will continue to contribute to the acceleration of greenhouse gases and temperature rise. The major drivers of these changes are increased temperature, altered hydrological cycles and shifts in wind patterns that might alter coastal currents. Increasing temperatures alone have the potential to strengthen pycnoclines in estuarine and coastal waters, but lower surface salinity (e.g., from increased freshwater runoff) would be more of a factor in stratifying the water column. The combination of increased nutrient loads (from human activities) and increased freshwater discharge (from GCC) will aggravate the already high loads of nutrients from the Mississippi River to the northern Gulf of Mexico, strengthen stratification (all other factors remaining the same), and worsen the hypoxia situation. Reduced precipitation, on the other hand, would lower the amount of nutrients and water reaching the coastal zone and, perhaps, lead to oligotrophication and reduced fisheries productivity, or perhaps alleviate hypoxia. The increase or decrease in flow (whichever occurs), flux of nutrients and water temperature are likely to have important, but as yet not clearly identifiable, influences on hypoxia. In anticipation of the negative effects of global change, nutrient loadings to coastal waters need to be reduced now, so that further water quality degradation is prevented.

NOAA's Gulf of Mexico Hypoxia Watch

Beard, R.

The Gulf of Mexico Hypoxia Watch is a cooperative project of NOAA's National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (Pascagoula and Stennis Mississippi Labs), and NOAA's National Coastal Data Development Center (NCDDC). The purpose of the project is to collect measurements of bottom-dissolved oxygen using a Conductivity, Temperature, Depth (CTD) profiler with an oxygen sensor. The NOAA ship Oregon II goes to sea in June and July for the Southeast Area Monitoring and Assessment Program (SEAMAP) groundfish survey and collects the CTD measurements along with SEAMAP biological data. The CTD casts are done in a random pattern along the continental shelf, from the Texas/Mexico border to southern Florida, in water depths between 10 m and 200 m. After data processing, the bottom (deepest) oxygen values are sent via email to NCDDC where they are contoured and mapped. The contours show estimations of where high and low oxygen levels are likely occurring. The dissolved oxygen values range from 0 to 8 mg/L and the water is considered hypoxic if the value is 2 mg/L or less. During the cruise, values are often mapped daily, providing a near-real-time picture of the health of the Gulf. Currently, the Hypoxia Watch project includes data from 2001 through 2014. To access the data, view maps, or consult metadata for the project, please see http://www.ncddc.noaa.gov/hypoxia/.

New Approaches and Analytical Tools for Studying Mercury in the Gulf of Mexico: Sources and Transformations

Cizdziel, J.; Bussan, D.

Monomethylmercury (MMHg), a neurotoxin produced primarily by sulfate reducing bacteria in aquatic sediments, readily biomagnifies up the marine food chain. Consumption of fish containing high levels of MMHg can lead to adverse health effects in both humans and wildlife. This is of particular concern in the northern Gulf of Mexico (GoM) because, on average, residents of the Gulf Coast consume more marine fish than other U.S. residents, and because GoM fish tend to have higher levels MMHg than fish from other coastlines.1,2 Moreover, because the economy of the Gulf coast states is intricately linked to the GoM through fishing (both commercial and recreational), understanding the distribution, levels and cycling of MMHg is vital to the long-term health and stability of the region. Whereas there has been much progress on understanding the fate, transport and transformation of mercury in aquatic and terrestrial environments, there remains a major gap in understanding of the sources and pathways of MMHg entry into food webs in the northern GoM. Recent advances in analytical techniques now offer an opportunity to answer fundamental questions such as where in the GoM is MMHg produced from inorganic mercury, and where is MMHg most bioavailable. Recent work demonstrates the potential of the use of enriched stable isotopes to simultaneously determine methylation and demethylation rates in sediments,3 and for stable isotopes to serve as probes for reaction pathways and to evaluate the source/history of mercury in samples.4 In this talk and associated poster, we will introduce these techniques and show how they can be used to advance our understanding of mercury cycling and transformation in the GoM. We will include recent results from our own research utilizing these techniques to study sediment from wetlands from the Mississippi Delta and from the cold seeps in the northern GoM.

Monitoring Network Design to Assess Potential Water-Quality Improvements Associated with the Mississippi Coastal Improvement Program in the Mississippi Sound

Rebich, R.; Wilson, D.; Runner, M.

The Mississippi barrier islands have undergone extensive changes in their formations over the past several decades primarily due to wind erosion and storm surge from hurricanes. In 1969 during Hurricane Camille, a "cut" formed through Ship Island bisecting it into what is known today as East and West Ship Islands. In addition, a tremendous amount of damage and erosion occurred on the two islands and to the shoreline of the Mississippi coast in the aftermath of Hurricane Katrina in 2005. In 2009, the Mississippi Coastal Improvement Program (MSCIP) was enacted by the U.S. Army Corps of Engineers (COE), in conjunction with other Federal and State partners, with the purpose of reducing future storm damage along the Mississippi Gulf Coast. MSCIP includes construction projects along the shoreline of Mississippi as well as major restoration efforts associated with the barrier islands. One such project is to restore Ship Island by filling in the "cut" (also known as "Camille Cut") between East and West Ship Islands thus creating one island again. The restoration effort to close Camille Cut and recreate a singular Ship Island could cause shifts in water quality and aquatic habitat in the vicinity of Ship Island and other areas within the Mississippi Sound. Of particular interest will be the potential increase in turbidity and suspended sediments during the construction phase. Adaptive management planning associated with MSCIP included establishment of a long-term monitoring network design to collect water-quality data to be used as indicators of change for comparison to biological response variables also collected during the study period, and to be used as input for modeling of the Mississippi Sound system to document longer-term change in response to restoration activities in the future. The U.S. Geological Survey (USGS), in cooperation with the COE-Mobile District, has implemented a water-quality monitoring network design in the Mississippi Sound to help achieve programmatic and adaptive management goals of MSCIP. Specifically, two locations near Ship Island have been outfitted to continuously monitor specific conductance (salinity), temperature, dissolved oxygen and turbidity. Nine locations located near Ship Island and near the remaining barrier islands will be visited eight times per year, and during each visit, the same water quality parameters are measured and discrete water quality are collected for nutrient and sediment analysis. This project is a 5-year project to include 1 year of pre-construction, 2 years of construction, and 2 years of post-construction data collection.

Phosphorus Dynamics in the Mississippi Landscape

Landscape

Phosphorus Dynamics in the Mississippi Landscape

Beth Baker *(Mississippi State University)*	Using Low-Grade Weirs as a Best Management Practice for Phosphorus and Sediment Mitigation
Austin Omer *(Mississippi State University)*	Assessment of Tailwater Recovery System and On-Farm Storage Reservoir Efficacies: Quality Issues
Heather Welch *(U.S. Geological Survey)*	Contribution of Total Dissolved Phosphorus in Irrigation Runoff from the Mississippi River Valley Alluvial Aquifer to Phosphorus Concentrations in a Delta Stream
Larry Oldham *(Mississippi State University)*	Characteristics of Phosphorus in Agricultural Landscapes

Using low-grade weirs as a best management practice for phosphorus and sediment mitigation

Baker, B.; Kroger, R.; Prevost, D.; Pierce, T.

Widespread concern for nutrient enrichment of freshwater and marine environments led to the formation of the Mississippi River/Gulf of Mexico Hypoxia Task Force, which aims to reduce riverine loads of total phosphorus from the Mississippi and Atchafalaya River Basins by 45% by 2015. Recent studies highlighted advantages of using low-grade weirs, situated in drainage ditches, to reduce effluent nutrient loads, as opposed to traditional control drainage practices such as variable height risers. The overall objective of this study was to quantify the effects of low-grade weir frequency and spatial arrangement on phosphorus and sediment reduction efficiencies of agriculture runoff using field-based experimental design in the Mississippi Delta. Low-grade weirs are an innovative, relatively low-cost and low-technology best management practice in comparison to large water reservoir systems or bioreactors, making them a suitable option for large and small-scale farmers alike. Study sites were located in the Yazoo Delta Region of Northwestern Mississippi. Results of the phosphorus and sediment load reduction efficiencies of low-grade weirs showed positive reductions in most ditches, with and without weirs. Low-flow and storm-flow outflow concentrations were found to be variable between sites, with no clear significant differences between sites with or without weirs. Mean percent differences between low flow and storm flow at each site resulted in low-flow samples having significantly lower phosphorus and sediment concentrations than during storm flows. A complimentary investigation of hydraulic retention highlighted that control ditches, while not engineered for such purposes, retained water. However, because this was an unintended consequence, these systems also exhibited flooding into producer fields; this phenomenon did not occur in ditches with weirs.

Assessment of tailwater recovery system and on-farm storage reservoir efficacies: Quality issues

Omer, A.; Czarnecki, J.

The Lower Mississippi Alluvial Valley is economically important due to its highly productive agricultural land. However, producers in this region face two predominant environmental issues that are inherently linked to the intensity of the agricultural industry in this region. First, intensive agriculture practices which have resulted in increased surface transport of nutrient-laden sediments, contributing to eutrophication in receiving waters and to the Gulf of Mexico Hypoxic Zone. Second, current water withdrawals from the Mississippi Alluvial Aquifer for irrigation are not sustainable. These issues threatening environmental resources necessitate use of best management practices and groundwater conservation. This research investigates systems of best management practices as water resource conservation methods. Such practices include surface water capture and irrigation reuse systems. Referred to as tailwater recovery systems (TWR), this practice consists of a tailwater recovery ditch which may be paired with on-farm storage reservoirs (OFS). Five case studies of different TWR were monitored for nutrients during a single growing season at: inflow, edge of field, TWR, OFS, and overflow locations. Investigations highlight functionality for nutrient recycling, and descriptions of nutrient loss mitigation. Additional research includes quantification of nutrients lost and captured during rice patty drains into TWR using in-situ nitrate sensors. Although research on these systems continues, initial results from three TWR in 2013 show over 278 million liters of water being recycled applying a mean of 0.96 kg/ha total nitrogen and 0.15 kg/ha total phosphorus. These systems are proving successful in holding water on the landscape, recycling that water, and therefore nutrients. Thereby preventing those nutrients from being lost to downstream waters. This suggests that TWR have much promise for water resource conservation in the Lower Mississippi Alluvial Valley.

Contribution of total dissolved phosphorus in irrigation runoff from the Mississippi River Valley alluvial aquifer to phosphorus concentrations in a Delta stream

Welch, H.; Rose, C.

Water-quality of the Mississippi River Valley alluvial (MRVA) aquifer has the potential to influence water quality of streams located in the lower Mississippi River Valley either through irrigation runoff from fields during the growing season (May through August) or at times of baseflow when streams are comprised of mostly groundwater. Previous studies of groundwater from the MRVA aquifer have shown concentrations of total dissolved phosphorus ranging from 0.12 to 1.2 milligrams per liter (mg/L). These concentrations exceed 0.1 mg/L, which is the desired goal established by the U.S. Environmental Protection Agency for the prevention of nuisance plant grown in streams. In addition, watersheds in the lower Mississippi River Valley have been identified as having some of the highest total phosphorus yields in the Mississippi River basin, although application of phosphorus fertilizers to land in the basin is minimal. The contribution of phosphorus from the alluvial aquifer to the total phosphorus loads in the basin has not been determined. From June through September 2014, the U.S. Geological Survey conducted a study near a rice field located in Issaquena County, Mississippi, to quantify the effect of irrigation runoff on water quality in a small ditch draining the field. Thirteen groundwater samples were collected from a well screened in the MRVA aquifer used to irrigate the rice field. In addition, runoff samples were collected downstream of the well at two locations: (1) from a water furrow that drains the rice field and (2) from a ditch immediately downstream of the water furrow. All samples were analyzed for water temperature, pH, dissolved oxygen, specific conductivity, alkalinity, iron, manganese, orthophosphate, and total phosphorus. State and Federal agencies can use the results of this study to help with the establishment of nutrient reduction strategies in the lower Mississippi River Valley.

Characteristics of Phosphorus in Agricultural Landscapes

Oldham, L.; Cox, M.; Ramirez-Avila, J.; Kingery, W.

Phosphorus (P) management presents a conundrum in the diverse soils of Mississippi. This required plant nutrient is naturally abundant in bioavailable forms in many alluvial plain region soils (Delta), yet native soil P levels restrict productivity in some Coastal Plain region soils. However, some Coastal Plain and Jackson Prairie soils have elevated bioavailable P from past management with copious amounts of animal production by-products. Phosphorus movement from soil to surface waters is implicated in environmental degradation such as Gulf of Mexico hypoxia, yet P fertilizers are not widely used due to high levels of native labile P in the Delta. There exists a need for better understanding P properties and dynamics to improve nutrient and landscape management so the appropriate management practices are targeted to specific, unique regions of Mississippi. In this paper we review, using molecular to landscape scales of reference: P forms found in soils and surface waters, the relevant chemistry, plant uptake mechanisms, and movement in the landscape. The implications for management will be discussed.

Gulf of Mexico Coastal Issues

Wade Burcham *(Thompson Engineering, Inc.)*	Design and Construction of a Step Pool Storm Conveyance (SPSC) System on an Unnamed Tributary to Joe's Branch, D'Olive Bay Watershed, Baldwin County, Alabama
Shelby Barrett *(NASA DEVELOP)*	Utilizing NASA Earth Observations to Assist the Audubon Mississippi Coastal Bird Stewardship Program with Habitat Monitoring and Restoration Planning Activities
Richard Ingram *(MS Water Resources Research Institute)*	Inter-relationships of Coastal Water Quality, Ecosystem Health, Human Health, and Socioeconomics
Courtney Killian *(Mississippi State University)*	Groundwater and Surface-Water Interactions of a Stream Reach and Proposed Reservoir within the Pascagoula River Basin: George County, Mississippi

Design and Construction of a Step Pool Storm Conveyance (SPSC) System on an Unnamed Tributary to Joe's Branch, D'Olive Bay Watershed, Baldwin County, Alabama

Burcham, W.

A Step Pool Storm Conveyance (SPSC) system has been constructed to restore a severely eroded ephemeral drainage on a tributary to Joe's Branch within the D'Olive Creek watershed in Baldwin County, Alabama. The project represents implementation of one of the management measures recommended in a comprehensive watershed management plan (WMP) developed for the area. The SPSC project was primarily funded through a Section 319 (nonpoint source) grant from the Alabama Department of Environmental Management (ADEM) to the Mobile Bay National Estuary Program (MBNEP). Additional funding for the project was provided by the Alabama Department of Transportation (ALDOT), with the cooperation and support of many others. The objective of an SPSC system is to convert and dissipate, through storage pools and sand seepage filters, surface storm flow to shallow groundwater flow. SPSC systems typically are comprised of a series of shallow aquatic pools, riffle grade control, native vegetation, and an underlying sand/organic filter bed media. An SPSC system is intended not only to provide a stable drainage pathway for higher flows, but to attenuate and/or retain lesser flows and facilitate water quality treatment. SPSC systems have been used in other parts of the country. Notably, in Anne Arundel County, Maryland, there have been several applications spanning over a decade, and the County has developed specific design guidelines for their construction. However, to our knowledge, an SPSC or similar system has not been evaluated for the conditions found in the north Gulf coastal region of south Alabama This presentation will discuss the engineering design and construction of the SPSC demonstration project in Spanish Fort, Alabama. Participants will be presented with information to identify when and why a SPSC may be an effective measure to stabilize and enhance hydrologic systems. Post-construction stormwater monitoring as performed by the Geological Survey of Alabama (GSA) will be discussed, along with "lessons learned". In addition, participants will be presented with future projects where these measures are currently being planned using different constraints.

Utilizing NASA Earth Observations to Assist the Audubon Mississippi Coastal Bird Stewardship Program with Habitat Monitoring and Restoration Planning Activities

Barrett, S.; Beasley, B.; Wylie, L.; McDaniel, B.; Bosarge, A.

Coastal and migratory bird habitats in Mississippi are highly dynamic and constantly threatened by human activity. Today, these coastal and migratory species can be found on managed public lands. However, as of 2014, the Pascagoula River Audubon Center (PRAC) and the National Fish and Wildlife Foundation (NFWF) reported shorebird populations in coastal Mississippi have declined. In response, the Mississippi Audubon Coastal Bird Stewardship Program (CBSP) plans to focus habitat management on approximately twenty sites in coastal Mississippi. Activities includes planning and conducting standardized monitoring, implementing best-practice restoration projects, and a campaign to educate diverse audiences to increase understanding of the threats to and environmental and societal benefits of coastal and migratory birds. To support these efforts, this NASA DEVELOP project used current Landsat 8 OLI imagery to produce habitat classification maps that incorporated land use land cover, vegetation health, and water quality indices of areas in coastal Mississippi where these vital bird habitats are located. The project yielded maps for declining coastal bird species such as the least tern. End products and methodologies aided end-users in focusing habitat restoration efforts based on individual species' propensity to a particular area.

Inter-relationships of Coastal Water Quality, Ecosystem Health, Human Health, and Socioeconomics

Ingram, R.

Humans are a terrestrial species …we're also a social species. Our activities impact all environmental media in which we live – surface and ground water quality and quantity, air quality, aquatic and wildlife habitat, ecosystem structure, and climate. In a recent national report on water quality in the United States, 45% of assessed stream miles, 47% of assessed lake acres, and 32% of assessed bays and estuarine square miles were classified as polluted. Mississippi's current 303(d) List identifies 21 impaired water bodies in the Coastal Streams Basin, Lower Pascagoula River Basin, and Lower Pearl River Basin. In this same area 45 TMDLs have been developed. During 2014, 44 beach closures and/or water contact advisories were issued. Water quality, ecosystem health, and human health are all inextricably linked. Backed by science, acknowledgement of this is reflected in the tiered surface water designated use categories inherent in Mississippi's water quality protection standards – public water supply, shellfish harvesting, recreation, and fish and wildlife – all designed to collectively protect water quality, ecosystem health, and human health. Likewise, a strong relationship exists between water quality and socioeconomics at all scales – from the individual to the local community to the larger society. A significant portion of the coastal economy depends upon water quality to support industrial development and the creation of jobs, for the maintenance of healthy ecosystems and harvesting of marine resources, and to sustain the Gulf Coast's traditions, cultures, and quality of life.

Groundwater and Surface-Water Interactions of a Stream Reach and Proposed Reservoir within the Pascagoula River Basin: George County, Mississippi

Killian, C.; Schmitz, D.

This research had two main objectives: quantify surface-water and groundwater interactions along a stream reach, and determine the hydraulic conductivity at the site where two reservoirs are proposed. The stream reach, located in the Pascagoula River Basin in southeast Mississippi, begins at Lake Okatibbee and terminates at Pascagoula, into the Gulf of Mexico. Four USGS continuous gauging stations provided more than forty years of stream discharge data for a hydrograph base-flow-recession analysis, which determined the baseflow component within the stream. The analysis showed that baseflow decreases along the stream reach and increases again before reaching the Gulf of Mexico. Thirteen borehole samples were collected at the sites of the proposed reservoirs in George County, Mississippi to determine the hydraulic conductivity of the sediments, which showed high a hydraulic conductivity. The reservoirs will help to maintain stream ecology as well as increase surface water storage for recreational and industrial purposes.

Wetlands

Gary Ervin *(Mississippi State University)*	Water Quality-Land Use Interactions in Restored Wetlands of the Mississippi Delta
Cory Shoemaker *(Mississippi State University)*	Drivers of Plant Community Composition in Delta Wetlands
Chayan Lahiri *(University of Mississippi)*	Heterogeneous Vertical Flow through Oxbow-Wetlands: Soil Chemistry, Wetland Tree Growth, and Groundwater Recharge
Jairo Diaz *(Alcorn State University)*	Water and Environmental Science Programs for Underrepresented Communities in Mississippi

Water quality-land use interactions in restored wetlands of the Mississippi Delta

Ervin, G.

Restoration of former agricultural land to wetlands, through programs such as the Wetlands Reserve Program (WRP) and Conservation Reserve Program (CRP), often focuses on restoring functions such as water quality improvement and wildlife habitat enhancement. However, results are inconclusive as to the long-term successes of these restorations. Our work is aimed at determining whether wetland restorations in the Mississippi Delta achieve sustained water quality improvements, and whether key water quality parameters are influenced by surrounding land use. During the summer of 2014, we assessed vegetation, land use, soils, and water quality in and around 24 restored and 6 naturally occurring wetlands across a gradient of human land use in the Delta. Initial analyses were based on classifying wetlands into watersheds with high, medium, or low levels of agricultural intensity, based on data from the USDA National Agricultural Statistics Service. We found differences in soils and surrounding land use of natural vs. restored wetlands but few differences attributable solely to our a priori classification of wetlands based on surrounding agricultural land use. When we examined correlations between water quality parameters and land use within 200m of the wetlands, we unexpectedly found no significant correlations. Nutrient concentrations were quite high in these wetlands; thus, it is possible that concentrations alone may be uninformative about impacts of surrounding land use. Additional work is planned to examine changes in water quality as surface waters move through these wetlands, as this may be a better metric of ecological function for Mississippi Delta wetlands.

Drivers of plant community composition in Delta wetlands

Shoemaker, C.; Ervin, G.

Intensive agricultural practices in watersheds have the potential to lead to high inputs of non-point source pollutants as a byproduct of nitrogen and phosphorus fertilizer applications. Excess amounts of these nutrients can lead to the eutrophication of receiving water bodies and cause water quality degradation at local, regional, and national scales. To combat this problem, wetland restoration is seen as a potential remediation strategy for reducing nutrient loads entering into larger water bodies. However, wetlands differ in their ability to remove nutrients, in part a result of the plant diversity within wetlands. This study examined natural and restored herbaceous wetlands across the northern Delta in Mississippi to determine drivers of plant community composition and their subsequent effect on water quality. Six naturally occurring wetlands along with 24 restored wetlands enrolled in the Wetland Reserve Program (WRP) were sampled across 12 watersheds stratified by expected nitrogen loads (based on USDA agricultural statistics data). Wetlands were visited in May and August of 2014, with species presence and abundance recorded at 50 sampling plots within each wetland. On the restored sites, redvine (Brunnichia ovata) and trumpet creeper (Campsis radicans) frequently were recorded at 50% or more of our sample points per wetland, while knotweed (Polygonum spp.) was common throughout. Additionally, woody species, such as buttonbush (Cephalanthus occidentalis), swamp chestnut oak (Quercus michauxii), slippery elm (Ulmus rubra) and other bottomland hardwood species were found in greater abundance on the six natural sites compared to restored sites. Ongoing analyses are aimed at investigating components of water quality that may be driving or driven by plant species composition in these wetlands.

Heterogeneous Vertical Flow through Oxbow-Wetlands: Soil Chemistry, Wetland Tree Growth, and Groundwater Recharge

Lahiri, C.; Davidson, G.; Threlkeld, S.

The floodplain of the lower Mississippi River is littered with oxbow lake-wetland systems supporting dense forests of bald cypress and tupelo gum. Fine-grained sediments infilling the oxbows form low hydraulic conductivity plugs that should minimize communication between surface water and underlying groundwater, and produce pervasive reducing conditions in the soils during flooding. In forested oxbows, however, extensive root networks and decaying fallen trees have the potential to produce zones of higher conductivity and preferential vertical flow pathways. Evidence of preferential flow paths has been documented in Sky Lake, an abandoned meander loop of the Mississippi River in northeastern Mississippi. Redox potential measured hourly over an 18 month period revealed isolated zones that became oxidizing when surface water levels exceeded one meter. Changes in groundwater levels in a well located inside the meander loop were also consistent with recharge from the overlying oxbow. Advective delivery of oxygen through portions of the root zone has the potential to enhance tree growth during periods of extended inundation. Several cypress trees have been outfitted to continuously monitor sap flow and radial expansion to identify possible links between growth and changes in soil redox potential that accompany changes in water depth.

Water and Environmental Science Programs for Underrepresented Communities in Mississippi

Diaz, J.

The goal of this presentation is show current water and environmental science programs developed at Alcorn State University. Alcorn State University - ASU, a Land Grant and Historically Black University located in southwest Mississippi, offers a Bachelor of Science in Agricultural Sciences with emphasis in Environmental Science. This program prepares highly skilled individuals for lifelong environmental career in private and public organizations. Students are trained to understand, investigate, and manage the environment and the many interactions among physical, chemical, biological, economical, and societal components towards a sustainable society. The program consists of 21% social science courses, 24% basic science classes, and 55% applied science subjects. Applied environmental classes include: water quality, concepts of environmental science, geographical information systems applications in natural resources, watershed hydrology, agricultural and environmental law. ASU's Mississippi River Research Center – MRRC is actively involved in mentoring and outreach activities which support the MRRC's mission in reaching out to students and general community as well as training the next generation of minority professionals in science and applied technology areas. Since January 2013, staff and students from the MRRC have prepared and performed eight outreach activities reaching about 200 school students. Through a National Science Foundation grant, the MRRC developed an environmental science activity manual and trained 16 middle-school teachers by providing content and hands on activities in three major themes: water, erosion, and environmental consciousness. Major accomplishments in student involvement include mentoring eight students; hosting two undergraduate students from Oberlin College, OH and University of Florida, FL through the NOAA-NGI Diversity Internship Summer Program; attending six professional meetings; and reaching third place in graduate poster competition in the 71st professional Agricultural Workers in Tuskegee University, Alabama. Currently, the MRRC is leading five projects funded by the State of Mississippi, US Department of Agriculture, US Forest Service, and Monsanto. Projects are focused on evaluating the temporal and spatial water quality variation and the indication of total coliform bacteria and Escherichia coli in four small lakes at ASU; assessing climate change impacts on southern Mississippi watersheds; measuring the acid neutralizing capacity of forest and aquatic ecosystems in Louisiana and Mississippi national forests; understanding factors influencing the adoption, efficiency, and impact of irrigation systems and scheduling methods for irrigation on small and limited resource vegetable and fruit farms in Mississippi; and promoting water quality management techniques for vegetable production. Summary of major project accomplishments will be presented at the conference.

Groundwater

Dave Johnson *(US Army Corps of Engineers)*	The Mississippi Delta, the MAV and the World: The Groundwater Crisis—is there any hope?
Sandra Guzman *(Mississippi State University)*	Evaluation of Input Variables for Neural Network Models used in Groundwater Level Forecasting for Sunflower County, Mississippi
Mark Stiles *(Yazoo-Mississippi Delta Joint Water Management District)*	Groundwater Levels in the Mississippi River Valley Alluvial Aquifer
Joby Czarnecki *(Mississippi State University)*	Assessment of Tailwater Recovery System and On-Farm Storage Reservoir Efficacies: Quantity Issues

The Mississippi Delta, the MAV and the World: The Groundwater Crisis—is there any hope?

Johnson, D.

Mankind has been overdrawing its aquifers for more than 20 years in order to feed the ever expanding population. Is this a sustainable policy? In parts of the high plains aquifer of the U.S., many landowners who have been irrigating crops for over 50 years no longer can draw water from their wells. Closer to home in Arkansas, producers are now drawing water from the Sparta aquifer, which is generally reserved for drinking water, to supplement their withdrawals from the MAA for crop irrigation. USGS groundwater modeling studies show that the water level in the MAA will continue to decline for the foreseeable future. This presentation will discuss the actions the state or producers can take to reverse the decline in the MAA.

Evaluation of Input Variables for Neural Network Models used in Groundwater Level Forecasting for Sunflower County, Mississippi

Guzman, S.; Paz, J.; Tagert, M.

Declining water levels in the Mississippi River Alluvial Aquifer (MRVA) are due to the expansion of irrigated acreage and increasing water demand in the Mississippi Delta region, causing the need to develop forecasting tools and improve conservation measures. One of the tools explored in recent investigations is the Artificial Neural Network (ANN) that has grown in popularity in terms of its application in modeling and forecasting non-linear hydrologic time series such as groundwater levels. For instance, a previous study demonstrated that an ANN with 2 hidden layers, 100 time delays and Bayesian Regularization training algorithm had the best model architecture that provided predictions of daily groundwater levels up to three months ahead. The effectiveness of ANN in forecasting daily groundwater levels depends on different input datasets as well as on the network learning capacity. An important step in the ANN development process is the evaluation of significant input variables, given that not all of them are powerful predictors of the model output. In this study, the performance of an ANN trained with a Bayesian Regularization algorithm and different input variable combinations was evaluated to determine the optimal model that can simulate groundwater trends up to three months in a USGS monitoring well located in Sunflower County, Mississippi. Nine years of daily groundwater level measurements were collected and partitioned into training and validation data sets. At the same time, input time series such as daily evapotranspiration rates, calculated by the Priestly-Taylor method, and daily precipitation were also partitioned into training and validation sets. The evaluation of the model performance under different input variables was based on the Mean Square Error (MSE) and correlation statistic estimations. The use of ANN with significant input variables provides useful information for the management of water withdrawals either per well or on a regional level in order to implement different conservation practices.

Groundwater Levels in the Mississippi River Valley Alluvial Aquifer

Stiles, M.

The Yazoo Mississippi Delta Joint Water Management District (YMD) collects water level information from the Mississippi River Valley Alluvial Aquifer (MRVA) twice each year, once in April and again in October. These months are used to allow staff to obtain water levels before and after the groundwater irrigation season. Measurements are gathered from a network of 550 survey wells located throughout the entire Mississippi delta. Tablet computers configured with custom software are used by field staff to assist with data entry and quality control. The information gathered from each water level survey is incorporated into the YMD geographic information system (GIS). After the field work is completed for each water level survey, YMD uses GIS to create water level surface maps. These surface maps serve as the primary datasets used by YMD to create short and long term aquifer water level change maps. Additionally, GIS is used to create aquifer water volume changes. These changes are calculated annually from Spring to Spring and Fall to Fall. Additional changes are calculated for fall to spring representing aquifer recovery and spring to fall representing water withdrawals. The aquifer water volume changes are calculated then entered into a spreadsheet for graphing.

Assessment of tailwater recovery system and on-farm storage reservoir efficacies: Quantity issues

Czarnecki, J.; Omer, A.

In the State of Mississippi, the USDA via the Natural Resource Conservation Service has provided financial assistance for ~200 tailwater recovery systems (TWR) with and without the addition of an on-farm storage reservoir (OFS); over half of these systems are located within Sunflower County, overlying the cone of depression. The objective of this study was to quantify capture and use of TWR (and OFS, where available). In order to understand the water quantity benefits of TWR and OFS, it was necessary first to determine how much water these systems captured over the course of the year and how much water was lost from these systems due to natural processes. Working with agency partners, a list of TWR and OFS was compiled and 30 sites (18 TWR/12 OFS) were selected for study. Each site was instrumented with a water level logger. Loggers were set to capture data at 15-minute intervals. Loggers were deployed for at least a year in most systems. Dimensions and build specifications for each system were obtained to convert depth measurements into volumes. Incremental changes in volume and surface area were calculated for the span of the data collection effort. Considerations for evaporation and infiltration were made using best available models and methods to quantify these losses. These resultant values can then be weighed against the potential levels of capture, re-use, and loss, and the conservation contribution of TWR and OFS can be quantified. It is intended that these values will provide insight for agency personnel to determine if the benefit justifies the cost relative to other, alternative best management practices.

Water Resource Management in the Mississippi Delta

Dean Pennington *(Yazoo-Mississippi Delta Joint Water Management District)*	Water Resource Planning and Solution Implementation in the Mississippi Delta: YMD Joint Water Management District
Leighton Janes *(Yazoo-Mississippi Delta Joint Water Management District)*	Pecan Bayou: A Pilot-Scale Comprehensive Conservation Watershed Proposal
Taylor Bowling *(Yazoo-Mississippi Delta Joint Water Management District)*	The Benefits and Potential for Well Fields in the Mississippi Delta
David Kelley *(Yazoo-Mississippi Delta Joint Water Management District)*	Crop Water Use in the Mississippi Delta

Water Resource Planning and Solution Implementation in the Mississippi Delta: YMD Joint Water Management District

Pennington, D.

The YMD Joint Water Management District was created in 1989 to develop and implement solutions to many of the Delta's water supply and quality problems. Heavy use of groundwater by agriculture has resulted in declining groundwater levels which are not sustainable and also contribute to loss of stream base flows. YMD has always recognized that efficient use of existing water supplies (conservation) and the development of new water supplies were the only non-regulatory solutions available to address the Delta's water supply problems. A simple spreadsheet model has been developed to provide 50 year scenario analysis of different conservation and water supply plans. The primary variables of the model are levels of conservation implementation, new water supplies and irrigation expansion. Results of the model indicate that, individually, conservation or new water supply will not have sufficient capacity to create a balanced water budget in the Delta. Both conservation and new water supplies will be needed if we continue to expand irrigated acres at historic rates. Following presentations in the session will go into greater detail about some of YMD's major efforts to collect water resources information to support planning efforts and our activities related to on-the-ground solutions.

Pecan Bayou: A Pilot-Scale Comprehensive Conservation Watershed Proposal

Janes, L.; Bowling, T.; Pennington, D.

Over the last 30 years, withdrawals from the Mississippi River Valley Alluvial Aquifer (MRVA) have exceeded the aquifers natural ability to recharge resulting in a significant decline in the groundwater table in the Mississippi Delta. In an effort to decrease the overdraft of the MRVA, the Yazoo Mississippi Delta Joint Water Management District (YMD) has proposed implementing the Pecan Bayou Comprehensive Conservation Watershed to develop new water sources for irrigation water supply coupled with utilization of available conservation and management practices. Pecan Bayou is also a pilot planning component of a feasibility study with the USACE to import water into the Quiver River to enhance aquatic habitat and provide surface water for irrigation. This project has the potential to convert approximately 3000-5000 acres from groundwater to surface water irrigation and potentially offset the calculated overdraft within the project footprint. The project would consist of a re-lift station on the Quiver River to import approximately twenty-five (25) cubic feet per second (cfs) of surface water into the system for irrigation purposes. Imported surface water will be distributed through a network of improved natural channels and constructed zero-grade, lateral ditches. Weirs and water control structures will be constructed to divert and retain water in the system. The excavated channels and water control structures will not only provide water distribution and storage but also provide runoff recovery, improved drainage, and water retention. YMD also plans to implement available conservation practices, per landowner approval, to maximize the benefits of the system. YMD envisions the Pecan Bayou Comprehensive Conservation Watershed becoming a pilot-watershed to act as a blue-print for managing the natural resources of the Mississippi Delta.

The Benefits and Potential for Well Fields in the Mississippi Delta

Bowling, T.; Janes, L.; Pennington, D.

Over the last 30 years, withdrawals from the Mississippi River Valley Alluvial Aquifer (MRVA) have exceeded the aquifers natural ability to recharge resulting in a significant decline in the groundwater table in the Mississippi Delta. As water levels in the aquifer begin to drop, the dry season stream flows also begin to decline because less water is flowing from the aquifer into the streams. The portion of the aquifer underlying lands in close proximity to the Mississippi River are influenced by the fluctuations of water levels of the river system. During high and normal river stages, the Mississippi River can assist recharge of the groundwater aquifer near the river. During low river stages, groundwater from the aquifer can actually be lost by flowing back into the river. The Yazoo Mississippi Delta Joint Water Management District (YMD) has implemented and operated a working well field near Friar's Point, MS to better utilize Mississippi River recharged groundwater. Since 2005 YMD has used Mississippi River influenced groundwater to augment flows in the Sunflower River. Groundwater is extracted from a series of 11 wells and discharged into a tributary of Swan Lake. Water then flows through a water control structure at the Swan Lake outlet into a series of tributaries before joining the Sunflower River north of Clarksdale, MS. Pumps are operated in order to maintain a 50 cubic foot per second flow rate at the Sunflower, MS river gauge. Since 2012, YMD has monitored wells along the Mississippi River to develop a dataset in order to determine the extent of the Mississippi River's influence on the MRVA. By installing extraction wells in areas where the Mississippi River is in direct contact with the MRVA, well fields have the potential to capture clean, filtered Mississippi River water without adversely affecting the MRVA. Captured Mississippi River water can then be conveyed inland to aid in times of low flow to assist aquatic ecosystems and provide an abundance of surface water irrigation opportunities for the Mississippi Delta.

Crop Water Use in the Mississippi Delta

Kelly, D.

The Yazoo Mississippi Delta Joint Water Management District (YMD) has conducted water use surveys for the past thirteen years to determine the amount of groundwater used from the Mississippi River Valley Alluvial Aquifer (MRVA). These surveys focused on cotton, soybeans, corn, rice, and catfish. Each year begins with roughly 180 sites for investigation. In an effort to determine the most efficient ways to irrigate these crops, irrigation methods for each site are recorded along with the total amount of groundwater used. Additionally, a cost analysis is performed for each site. Electric single crop wells are targeted for this study. Flow rates are obtained throughout the year. Total kilowatts from the electric meter are collected from the sites at least once each month giving YMD a total hours of well operation and cost factors. After an average amount of water per acre by crop is determined, YMD uses a Geographic Information System (GIS) to apply these estimates across the entire delta.

Agricultural Water Management

Agricultural Water Management

Mary Love Tagert *(Mississippi State University)*	Enhancing Agricultural Water Management Through Soil Moisture Monitoring and Irrigation Scheduling
Derek R. Faust *(Mississippi State University)*	Understanding Nitrogen and Organic Carbon Contents of Agricultural Drainage Ditches in the Lower Mississippi Alluvial Valleys
Ritesh Karki *(Mississippi State University)*	Assessment of On-Farm Water Storage System (OFWS) for Design and Nutrient Variability in the Mississippi Delta and East Mississippi
John J. Ramirez-Avila *(Mississippi State University)*	Evaluating Analytic and Risk Assessment Tools in Agricultural Fields of Mississippi

Enhancing Agricultural Water Management Through Soil Moisture Monitoring and Irrigation Scheduling

Rawson, J.; Linhoss, A.; Tagert, M.; Sassenrath, G.; Kingery, W.

Increasing reliance of crop producers on water for irrigation coupled with expansion of irrigated acreage has resulted in the overdraft of the Mississippi River Valley alluvial aquifer (MRVA). As water resources continue to decline, there is an immediate need for more efficient water management and greater implementation of water conservation practices. Mississippi's Natural Resource Conservation Service (NRCS) has been working with farmers to increase voluntary implementation of water conservation practices, but these systems often require financial input from the grower and take time to install and manage. The Mississippi Irrigation Scheduling Tool (MIST) uses a "checkbook" water balance calculation and offers producers a free online irrigation management tool that indicates a need for irrigation when the soil water available to the plant falls below the level needed for crop growth. The overall objective of this study has been to evaluate and refine data requirements and inputs needed to calibrate and validate of the model for testing on corn and soybean fields with differing management and soil types. Data collection has been ongoing since May of 2011. Watermark 200SS sensors and dataloggers have been used to continually measure and record soil moisture at six-inch depth increments to three feet at various sites throughout the growing season of each year. Soil water retention curves were generated for each field from detailed soil testing at each depth increment and used to convert soil tension data to actual soil water balance, which was then compared to the MIST-calculated soil water balance. In addition, comparisons were done between sets of soil moisture readings within the same field to characterize the precision of the measurements. Next Generation Radar's (Nexrad) four-kilometer precipitation data were used along with farm irrigation data to calibrate the model for a soybean field under pivot irrigation and a cornfield under furrow irrigation.

Understanding nitrogen and organic carbon contents of agricultural drainage ditches in the Lower Mississippi Alluvial Valley

Faust, D.; Kroger, R.; Rush, S.

Agricultural fertilizer applications have resulted in excessive nitrogen loading to agricultural drainage ditches, contributing to the Gulf of Mexico hypoxic zone. The purpose of this study was to assess relationships between organic carbon and nitrogen content of drainage ditches and evaluate the spatial scope in which organic carbon amendments may be used in remediating nutrient loading throughout the Lower Mississippi Alluvial Valley. Water and sediment samples were obtained from agricultural drainage ditches in Missouri, Arkansas, Mississippi, and Louisiana. Nitrate, nitrite, ammonia, and total nitrogen concentrations were determined in overlying and pore water, along with characterizing dissolved organic carbon aromaticity (spectral absorbance at 254 nm) and molecular weight (ratio of spectral absorbance at 254:365 nm). Concentrations of ammonia and nitrate nitrogen and total organic carbon in overlying and pore waters were variable, with ranges of 0.0117 to 20.4 mg L^{-1}, 0.05 to 17.0 mg L^{-1}, and 0.0 to 17.0 mg L^{-1}. However, concentrations of nitrogen species and dissolved organic carbon were generally higher in the pore water compared to those in overlying water. Pore waters generally had lower molecular weight character of dissolved organic carbon than overlying water, although this trend was dependent on the state and site from which the sample was collected. The results of this study show that there is spatial variability in nitrogen species and organic carbon throughout the Lower Mississippi Alluvial Valley and demonstrate the importance of evaluating where organic carbon may be limiting nitrogen removal in agricultural drainage ditches.

Assessment of On-Farm Water Storage System (OFWS) for design and nutrient variability in the Mississippi Delta and East Mississippi

Karki, R.; Tagert, M.; Paz, J.

Irrigation can help increase crop yields, decrease risk, and provides an avenue for crop diversification in Mississippi. In the Mississippi Delta, where groundwater is the primary source of water for irrigation, the Mississippi River Valley alluvial aquifer is being mined at an average of 3,00,000 acre-feet per year and the amount of withdrawal exceeds the recharge rate leading to a reduction in groundwater levels. Nutrient loading from irrigation tail water is another major concern in the Mississippi Delta. It has been estimated that about 1.5 million metric tons of nitrogen are being transported to the Gulf of Mexico every year from the Mississippi River Basin resulting in eutrophic conditions that has led to the development of hypoxic zones. An On-Farm Water Storage (OFWS) system, which consists of a tail water recovery ditch and a water storage pond, is a constructed BMP that has a primary goal of water conservation by capturing surface runoff from excess rainfall and irrigation tail water. This paper will describe an OFWS design and discuss the differences in OFWS establishment in the Mississippi Delta and East Mississippi based on irrigation techniques and tail water recovery systems. Preliminary findings on the difference in nutrient content of the storm water runoff and storage pond will also be discussed.

Evaluating analytic and risk assessment tools in agricultural fields of Mississippi

Ramirez-Avila, J.; Oldham, J.; Ortega-Achury, S.; Gallardo-Estrella, R.; Baker, B.; Alexander, K.; Locke, M.; Read, J.

Nutrient and sediment runoff from agricultural fields is a critical problem associated with impairment of waterbodies in Mississippi and has generated a need to identify best nutrient management practices that minimize sediment and nutrient losses from fields, mitigating their contribution to a low-oxygen environment in the Gulf of Mexico. Environmentally safe and cost-effective implementation of quantified nutrient load reductions would require analysis of site-specific monitored water quality data that help producers to identify the most appropriate conservation practices for protecting or improving water quality. But lack of information in many regions regarding edge of the field and watershed monitoring for water quality and quantity and their associated costs, has promoted the use of qualitative and quantitative risk assessment models or tools to explore actions and policy alternatives for managing both water quality and quantity from intensive agricultural fields. National, regional and State nutrient reduction initiatives have indicated that the evaluation and selection of analytical tools (or risk assessment models) needs to be included as one of the strategies for designing, siting and assessing potential reductions from multiple management practices implemented within the Mississippi Delta, and subsequently, the Mississippi Upland and Mississippi Coastal regions. A Conservation Innovation Grant (CIG) project is being conducted to determine the existent need to assess and enhance the ability of existing risk assessment tools for improved cost-effectiveness of conservation practices, and enhance stakeholder's ability to make appropriate resource conservation decisions supported through such tools. This project supports specifications in the recently revised USDA-NRCS nutrient management standard (590) and state nutrient criteria. Preliminary results are presented on research to test and validate five quantitative (APEX, NTT, APLE, N-Index, and RUSLE2) and three qualitative (P-Index, N Leaching Index, WQ Index) risk assessment tools in fields from the Mississippi Delta and the poultry production area in South Mississippi.

Agricultural Water Management

Jack Appleton *(Jackson State University)*	Policy Considerations for the Restoration of Mississippi's Rivers, Future Water Quality, and Environmental Management with Consideration for the Future Inpact of Increasing Ambient Temperatures
Jason Barrett *(Mississippi State University)*	The Effect of Government Structure and Size on the Performance of Mississippi Community Water Systems

Policy Considerations for the Restoration of Mississippi's Rivers, future Water Quality, and Environmental Management with Consideration for the Future Inpact of Increasing Ambient Temperatures

Appleton, J.

Considering the projects that are the result of the Gulf Coast Restoration Act (GCRA), continued and on-going concerns with regards to water quality, agricultural and forestry activities, and the predicted impact of future warming on the rivers and streams of Mississippi, policy makers should consider a broad agenda of not simply providing water for future use and need, but these projects as the foundation of a new approach to the management of the states flowing water resources. These streams and rivers should not merely be considered for restoration, but for on-going mitigating management and development. In essence, in the context of warming temperatures, these resources are not and cannot be restored in the narrow sense, but can be managed in the dynamic sense. Such management should not be limited to, but could include wider civic participation in both the managerial goal setting, and in the care of the rivers and streams themselves. The rivers and steams should be evaluated with consideration for their ecosystems services, mitigation of the effects of a warming climate, and as the backbones of green corridors. Consideration should not include just the water itself, but the riparian ecology, the watershed, the management and perhaps the expansion and/or reintroduction of a range of species. The overall goal of future policies should be the provisioning and protection of water resources as part of a larger effort of environmental protection, and warming mitigation and adaptation.

The Effect of Government Structure and Size on the Performance of Mississippi Community Water Systems

Barrett, J.

Mississippi has an abundant supply of underground aquifers which are utilized by community water systems as their source for drinking water. As the demand for water increases through the increasing population and the influx of industries, there is a need to manage the consumption and distribution of this valuable resource. The initial management forms created with the constructing of Mississippi's water supplies have experienced peaks and valleys of performance. Since their inception, the Mississippi drinking water industry has spawned new regulations, new management options, and creative ideas to promote a safer more efficient community water system. Over the past 15 years, Mississippi has seen several centralization efforts occur, where a municipality, utility district, or a rural water association merges with one or multiple adjoining or close proximity community water systems. This results in one of the three legal structures of a community water systems increasing in size in an effort to heighten performance. It will be valuable to see which of the consolidating government structures has been able to achieve optimal performance. This research analyzes the size (population) and government structures of Mississippi community water systems and will determine if economies of scale and economies of scope exist. This study will reveal the affect that size and government structure have on the overall performance of Mississippi community water systems.

Methodologies

Methodologies

Heather Welch *(U.S. Geological Survey)*	Comparison Among Three Methods for Suspended-Sediment Sampling of the Mississippi River at Vicksburg, Mississippi
Dean Pennington *(Yazoo-Mississippi Delta Joint Water Management District)*	Use of Small Unmanned Aerial Vehicle in Agricultural Research

Comparison among three methods for suspended-sediment sampling of the Mississippi River at Vicksburg, Mississippi

Welch, H.

Depth- and- width- integrated isokinetic sampling techniques have been used to collect suspended-sediment samples in the Mississippi River by the U.S. Geological Survey (USGS) since the early 1970s as part of the National Stream Quality Accounting Network program. Collecting water-quality samples is critical in order to measure and understand chemical and sediment transport, but sampling can be challenging in terms of logistics, cost, and safety. The USGS has established suspended- sediment sampling protocols to ensure that samples are collected in a consistent and uniform way in streams across the country for data comparability and interpretation. However, variants of the traditional method have evolved to account for possible loss of equipment, improved safety to personnel, and potential loss of samples “contaminated” with bed material. Questions have recently arisen regarding the comparability of suspended-sediment data at selected water-quality stations along the lower Mississippi River. Three methods of sample collection have been used since the early 1980s. They include the traditional method, in which the sampler is lowered to the bottom of the channel, and two variants of that method, which consist of either lowering the sampler to 90% of the total stream depth or lowering the sampler to 2 feet from the bottom of the channel. From April through August 2013, the USGS collected suspended-sediment samples along a transect of the Mississippi River above Vicksburg, Mississippi using the three different methods. The collected data will be used to assess if: (1) sample collection techniques are reproducible, (2) data collected using the three different methods are comparable, and (3) the traditional method biases the suspended-sediment sample toward the sand-size fraction.

Use of Small Unmanned Aerial Vehicle in Agricultural Research

Pennington, D.

Recent development in electronic and software systems have made the use of small unmanned aerial vehicles (UAVs) practical for a wide range of applications. In the research presented here, an electric powered, 5 lb, 66 inch wing span, foam fixed wing model airplane was fitted with a 3D Robotics, APM 2.6 autopilot for guidance and two point-and-shoot Canon cameras for imagery collection. One camera is a 1.2 MP RGB camera and the filter in the second camera was changed to allow the red band to receive and record intensity of near infra-red electromagnetic energy. Programmed flight missions were flown over 3 different fields at 100 meters above ground level or less. The same missions were flown over each field on several dates. The total number of individual images collected for each field ranged from 80 images for small plot areas to 325 images for a 65 acre production soybean field. Individual georeferenced tagged images were stitched into a single georeferenced orthophotograph mosaic for each field using the Dronemapper data system available commercially through the internet. Yield data was collected from the plot areas using conventional plot harvesting methods. Yield data from two production fields were obtained from yield data collected during harvest with combines fitted with yield monitoring systems. The remotely sensed imagery data and the spatial yield data were compared and analyzed with QGIS (free GIS software) and spreadsheets. Comparisons of spatial imagery and yield data are being made and the results of those analysis will be presented. Operational experience of a UAV system will also be discussed.