Louisiana Barrier Island Comprehensive Monitoring Program (BICM) Phase 2 - 2016 Characterization of Surficial Sediments in the Western and Eastern Chenier Plain and Atchafalaya and Wax Lake Delta Regions: Part A - Data Collection, Sample Processing and Products

Ioannis Y. Georgiou, Mark A. Kulp, Michael Brown, Andrew Courtois
Pontchartrain Institute for Environmental Sciences,

James G. Flocks and Thomas Tuten
U.S. Geological Survey Florida Integrated Science Center,

Submitted to
Coastal Protection and Restoration Authority

Recommended Citation:

Georgiou, I.Y., Kulp, M.A., Brown, M., Courtois, A., Flocks, J.G., Tuten, T., 2017, Louisiana Barrier Island Comprehensive Monitoring Program (BICM) Phase 2 - 2016 Characterization of Surficial Sediments in the Western and Eastern Chenier Plain and Atchafalaya and Wax Lake Delta Regions: Part A - Data Collection, Sample Processing and Products. Prepared for Louisiana Coastal Protection and Restoration Authority (CPRA) by Pontchartrain Institute for Environmental Sciences, Baton Rouge, LA and New Orleans, LA, 15 p.

Table of Contents

Background

The Barrier Island Comprehensive Monitoring (BICM) Program was established in 2006 to provide long-term data on Louisiana’s barrier island systems for planning, design, evaluation, and maintenance of barrier islands restoration projects. The first phase of BICM was completed in 2012, culminating with a workshop on program successes, the initial development process, and lessons learned from data collection and analysis.

The overall goal of BICM is to provide long-term programmatic monitoring data for Louisiana’s barrier islands and inshore and coastal waters. This information will be used to plan, design, evaluate, and maintain current and future barrier island restoration projects.

Objectives:

1. Determine the elevation, longevity, and conservation of mass of the barrier islands.
2. Determine major habitat types and the distribution and quantity of each habitat over time on the barrier islands.
3. Determine geotechnical properties of sediments on the barriers to assess compatibility of the sediment and the sediment dispersal pattern to evaluate fill-performance.
4. Relate available data on environmental forces that affect the ecology and morphology of the barrier islands to other BICM data sets.
5. Determine species composition and diversity of vegetation within major habitat types on the barrier islands.

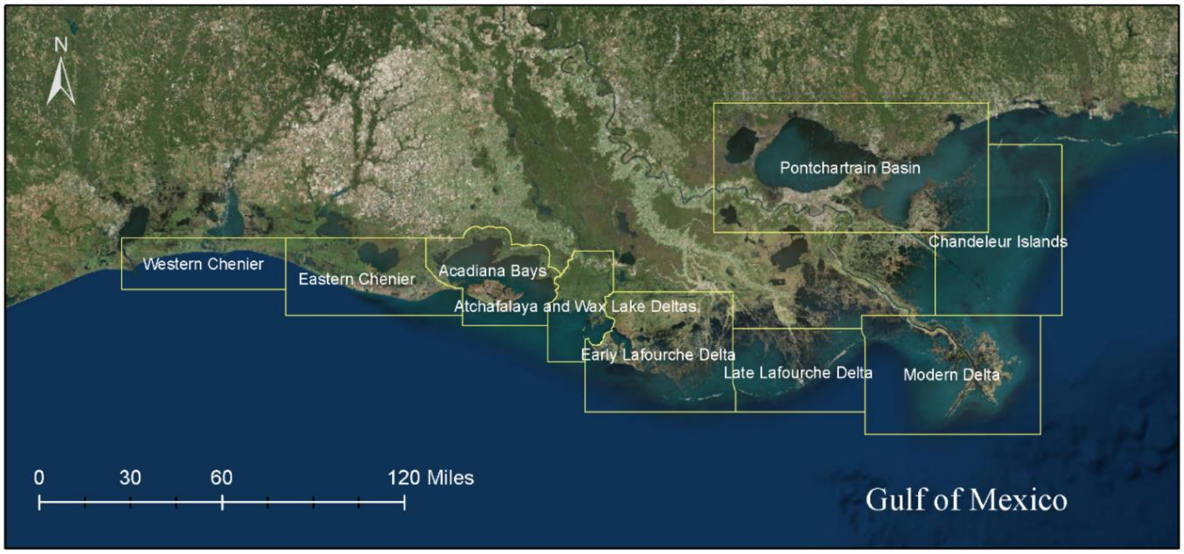

Figure 1. Base map depicting the 2015 Barrier Island Comprehensive Monitoring Program regions. Sediment sampling of this report took place across the sandy barriers of the Chandeleur Islands, Modern Delta, Late Lafourche Delta, and Early Lafourche Delta.

An understanding of grain-size characteristics of sediments within coastal zones provides an opportunity to evaluate the relationships between sediment transport patterns, alongshore variability in DoC (depth of closure), expected coastal system response to minor and major storms, and geotechnical properties that influence the development of shoreline nourishment and restoration approaches. Data contained within this volume of the Barrier Island Comprehensive Monitoring program provides a second phase of a system-wide surficial sediment dataset along the length Louisiana's Gulf shorelines. Shorelines sampled in this effort include the Western and Eastern Chenier Plain, and along Marsh Island in the Athcafalaya and Wax Deltas Regions. Only the Western Chenier Plain was previously sampled in 2008 (Kulp et al. 2011 A,B) which makes sampling in the Eastern Chenier Plain and along Marsh Island the first of its kind at this scale.

The result of this effort has been to build on previous sediment sampling results and continue with the development of a comprehensive sedimentary database for coastal Louisiana that spans the timeframe of nearshore and inshore change and the initiation of widespread coastal restoration projects such as are reported in the 2016 CPRA Annual Plan as well as planned in the 2007 and 2012 Louisiana Masterplans (CPRA 2007, 2012). Volume B of this project presents surficial sediment samples location maps.

Additional datasets of the BICM program that were collected and produced during a similar time frame as this sediment sampling effort included: 1) bathymetry, 2) topography, 3) shoreline change. A fundamental approach of BICM is to provide datasets that are collected during relatively similar spans of time so that each dataset provides an individual record of conditions and can be compared to other data collected during a similar time frame (e.g. dune textural characteristics and habitat distributions or elevations).

Approach

The cross-shore range of environments that were sampled within each geographic location included: 1) washover platforms, 2) back-barrier marsh, 3) dune, 4) beach berm, 4) upper shoreface at the mean low water (MLW), 5) middle shoreface and 6) base of the shoreface or DoC. The distribution of sediment samples for this effort generally followed the location of samples presented in Kulp et al. (2011A, B) and in regions sampled for the first time, an adaptive plan was employed, whereby an initial plan was developed following previous spacing used in the Western Chenier Plain, and sampling locations were adaptively adjusted (reduced or increased) depending on the sediment texture. A total of 675 samples were acquired from these regions.

Field Methods

Across the subaerial or shallow water environments samples were taken using hand scoops, whereas in subaqueous locations a Petite *Ponar* sampler was deployed manually from a boat to obtain a sample with a target amount of 500 grams. At each location of sampling a geographic coordinate was obtained from a Differential Geographic Positioning (DGPS) System and logged digitally within hand held units as well as field books. In order to cover the full extent of the area several field teams operated simultaneously and each field team had in their possession their own data logging equipment and consistent naming protocols. As each sample was acquired, it was placed in a plastic bag, labeled and sealed. Waterproof, sample ID tags were placed in the bags as well, in case labels on the outside became illegible. At the end of each day each field team returned to a common operating base, cross checked assignments, downloaded data, and quality controlled and assessed all information collected. On the basis of these debriefs the following day assignments were established.

Grain Size Analysis

At the completion of the field sampling effort each bag of sediment was opened and visually inspected to characterize the type of sediment (sand, mud, shells, etc.) and the percent abundance of detrital and organic sediment that was present. Size classification followed the Wentworth system (Wentworth, 1922). In order to remain consistent with the visual descriptions the same two technicians repeated this sediment characterization for all of the samples that were collected and all of the sedimentary interpretations were digitally entered and stored in a database. Visual sediment characterization included parameters such as percent sand, silt and clay, organics and shell content, sorting, and color according to a Munsell chart.

From the database of visual analyses the samples containing at least 70% sand were separated for quantitative analysis using a U.S. Geological Survey *Coulter LS200* particle size analyzer (methods in Appendix A). Due to the overall higher mud content of the Point au Fer and Oyster Bayou to Caillou Boca reaches, which had not been previously sampled, a visual estimate of 50% sand was the basis for determining the samples that would be analyzed with the *Coulter LS200* instrument. For these reaches this resulted in 46 samples for quantitative analysis but of those only 13 were suitable for grainsize analysis because of the abundance of shell particles which cannot readily be run through a *Coulter LS200*.

The *Coulter LS 200* particle size analyzer uses laser diffraction to measure the size distribution of sedimentary particles between 0.4 µm and 2 mm (fine clay to coarse sand). The measurement is accomplished by passing sediment, suspended in a solution of filtered water, between two narrow panes of glass in front of a laser. The laser is scattered by the particles into characteristic refraction patterns measured by photodetectors, this diffraction registers as intensity per unit area and is recorded as relative volume for 92 size-related channels. These channels can be binned into any number desired size classes.

The utility of the *Coulter LS200* is the high reproducibility of measurements, acquisition of results within less than ten minutes for each sample, ability to accurately and quickly provide quantitative measure of extremely small grain-size fractions, and customizable data output

Grain-size fractions were determined by classifying these channels according to the American Society for Testing and Materials (ASTM) Standard E11-04, which provides specifications for determining particle size using woven-wire testing sieves. The output of the Coulter analyses was in metric as millimeters in the form of spreadsheet. From each sample bag that was shipped to the U.S. Geological Survey six different samples were extracted and each one was processed through the *Coulter LS200* in two groups of three. For some samples more than six total runs were completed to decrease the deviation of the results. Samples that contained significant shell material (greater than 1mm) were first sieved through a 1mm size sieve to separate the shell material from the sample. This was done due to the fact that it could lead to clogging of the *Coulter LS200.*

A complete description of the procedures used in the analysis using the *Coulter LS200* is provided in Appendix A: Procedure for *Coulter* Grain Size Analysis.

Grain size output

The results of the analysis, in spreadsheet form, were then run through a free, widely available program called GRADISTAT (Blott and Pye, 2001). This program takes the coulter counter output and calculates the fraction of sediment from the samples in each size category (e.g. fine sand, coarse silt, etc.) to generate plots. An additional macro developed by the U.S. Geological Survey calculates the average and standard deviation of each sample set and then highlights repetitions that are 1.5 standard deviations outside the mean.

The resulting tables of the GRADISTAT statistical program were then examined manually as a quality assurance on the completeness of runs and data. The averaged data for each analyzed sample was transferred into a new, separate spreadsheet which was then modified to conform to the LASARD (Louisiana Sand Resource Database) format (Khalil et al., 2015) and maps were generated for Part B of this project.

Products

The products generated by this effort and available for use include the original field notebooks, physical samples, visual descriptions of each sample, LASARD point files, geodatabases (Appendix B), metadata, and maps (Georgiou et al., 2017B) showing the distribution of sediment samples that were collected. Figure 2 provides an example map showing the distribution of the entire Chenier Plain region including Marsh Island sediment samples.

Summary

This and past (e.g. 2011) sedimentary sample efforts of the Louisiana Coastal Zone, in conjunction with future sedimentary analyses, will result in a comprehensive assessment of sediment surface texture through multiple years. These sandy barrier sedimentary data provide a foundation for the development of restoration monitoring and planning, evaluating coastal processes, and developing a better understanding of sediment dispersal patterns within the Louisiana Coastal Zone.

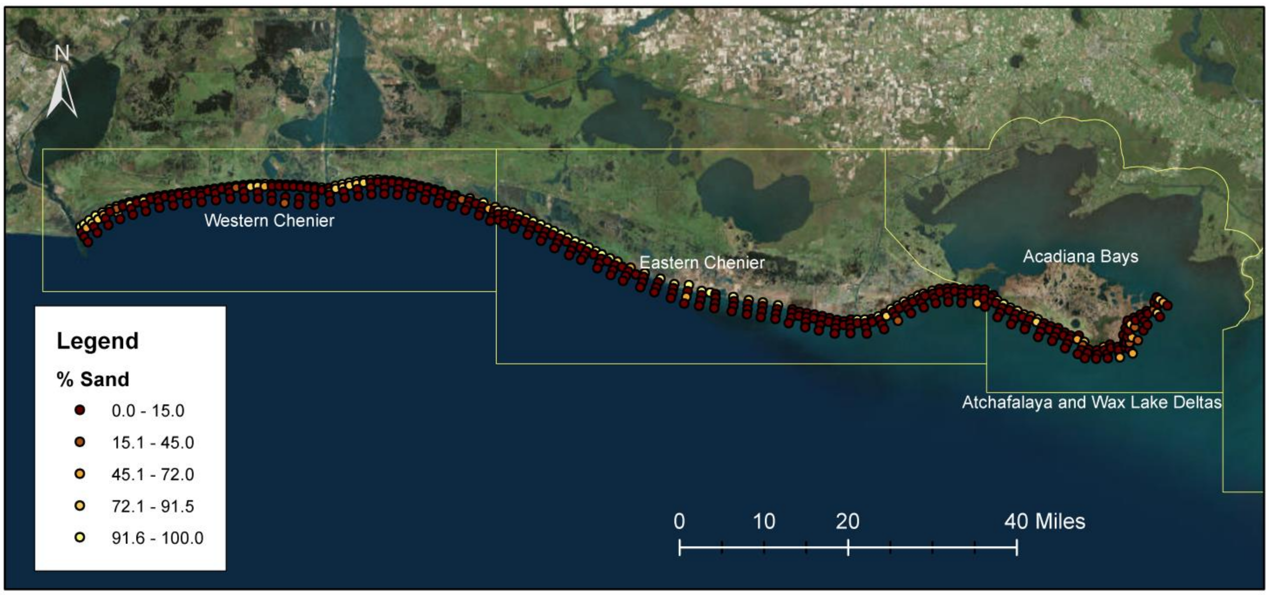

Figure 2. Base map showing the distribution of sediment samples within the Chenier Plain and Marsh Island region seaward of the Acadiana Bays as well as the results of the quantitative particle size analysis for samples that were visually determined to contain ≥70% sand. Samples with <70% sand, as determined by visual description, were not analyzed but the visual estimate of the percent sand is shown instead.

Acknowledgments

Funding for this project was from Coastal Protection and Restoration Authority (CPRA). Darin Lee and Syed Khalil (CPRA) provided much input and feedback for location selection and other aspects of the project. Field and laboratory assistance was provided by: Tara Yocum, Joe Frank, Brittany Kime, Timothy Nelson, and Joshua Flathers.

References

Blott, S.J., and Pye, K., 2001, Gradistat: A grain size distribution and statistics package for the analysis of unconsolidated sediments, Earth Surface Processes and Landforms, v. 26, p. 1237-1248.

Bernier, J., Kelso, K., Tuten, T., Stalk, C., and Flocks, J., 2017, Sediment data collected in 2014 and 2015 from around Breton and Gosier Islands, Breton National Wildlife Refuge, Louisiana, U.S. Geological Survey Data Series Report, in press.

Coastal Protection and Restoration Authority, 2007, Louisiana's Comprehensive Master Plan for a Sustainable Coast, Baton Rouge, La.

Coastal Protection and Restoration Authority, 2012, Louisiana's Comprehensive Master Plan for a Sustainable Coast, Baton Rouge, La.

Folk, R.L., 1954. The distinction between grain size and mineral composition in sedimentary rock nomenclature. Journal of Geology 62 (4), p. 344-359.

Folk, R.L., 1974, The petrology of sedimentary rocks: Austin, Tex., Hemphill Publishing Co., 182 p.

Khalil, S. M., Haywood, E. and Forrest, B. 2015. Standard Operating Procedures for Geo-scientific Data Management, Louisiana Sand Resources Database (LASARD), Coastal Protection and Restoration Authority of Louisiana (CPRA), 30pp. https://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=12362

Kulp, M.A., Miner, M., Weathers, D, Motti, J.P., McCarty, P., Brown, M., Labold, J., Boudreaux, A., Flocks, J., and Taylor, C., 2011A, Louisiana Barrier Island Comprehensive Monitoring Program (BICM) Volume 6, Part A: Characterization of Louisiana Coastal Zone Sediment Samples: Backbarrier through offshore samples of the Chenier Plain, South Central Barrier Island Systems and Chandeleur Islands, LA Coastal Protection and Restoration Authority, 10 pp.

Kulp, M.A., Miner, M., Weathers, D, Motti, J.P., McCarty, P., Brown, M., Labold, J., Boudreaux, A., Flocks, J., and Taylor, C. 2011B, Louisiana Barrier Island Comprehensive Monitoring Program (BICM) Volume 6, Part B: Characterization of Louisiana Coastal Zone Sediment Samples: Backbarrier through offshore samples of the Chenier Plain, South Central Barrier Island Systems and Chandeleur Islands, LA Coastal Protection and Restoration Authority, 39 pp.

Georgiou, I.Y., Kulp, M.A., Brown, M., Courtois, A., Flocks, J.G., Tuten, T., 2017B, Louisiana

Barrier Island Comprehensive Monitoring Program (BICM) Phase 2 - 2016 Characterization of Surficial Sediments in the Western and Eastern Chenier Plain and Atchafalaya and Wax Lake Delta Regions: Part B - Data Collection, Sample Processing and Products. Prepared for Louisiana Coastal Protection and Restoration Authority (CPRA) by Pontchartrain Institute for Environmental Sciences, Baton Rouge, LA and New Orleans, LA, 7 p

Poppe, L.J. and Eliason, A.E., 2008, A Visual Basic program to plot sediment grain-size data on ternary diagrams: Computers and Geosciences, v. 34, p. 561-565.

Schlee, John, 1973, Atlantic Continental Shelf and Slope of the United States sediment texture of the northeastern part: U.S. Geological Survey Professional Paper 529-L, 64 p.

Shepard, F.P., 1954, Nomenclature based on sand-silt-clay ratios: Journal Sedimentary Petrology, v. 24, p. 151-158.

Wentworth, C. K., 1922, A scale of grade and class terms for clastic sediments: Journal of Geology, v.30, p. 377-392.

Appendix A: Procedure for Coulter Grain Size Analysis

Coulter Operations (Startup)

1. Boot up the computer and turn on the Coulter machine
2. At the computer start the LS200 program (there is a desktop icon)
    a. Select **RUN** from the menu bar and then press **USE OPTICAL MODULE**
3. After, select **RUN → RUN CYCLE**
    a. Press **CLEAR ALL**, then select **AUTO RINSE** and allow to run twice
4. Select **PREFERENCES → LOAD PREFERENCES**
    a. Choose **JIMBOBMA.PRF** (in LS32/SOP folder)
5. Change the Save Folder to desired one
    a. **FILE → CHANGE FOLDER**
6. Press **RUN → RUN CYCLE**
    a. Enter **SAMPLE INFORMATION** (Example: Tom_55_A1_Run1)
        i. Tom_55 is sample number, found on bag
        ii. A1 is the aliquot, or how many times you are sampling from the same bag
        iii. Run1 is the run number of an aliquot through the machine, typically done 3 times
    b. Enter the **SAMPLE DEPTH** in the **COMMENT 1** box
    c. Enter the **SAMPLE SERIES** and **DATE** in the **COMMENT 2** box
    d. Press **FILE NAME**
        i. Make sure there are enough characters for the name
            1. If changing type the number of characters and press **USE EXAMPLE**, then **OKAY**
    e. Press **OKAY** to return to Run Cycle
    f. Press **RUN SETTINGS**
        i. Make sure **SCONICATE FOR 10 SECONDS** is checked (with no wait)
        ii. **RUN LENGTH IS 60 SECONDS** and check **SCONICATE DURING RUN** (Power Level 6)
    g. Press **EXPORT**
        i. Select **PRINTED REPORT TAB**
            1. Check **SAMPLE INFO** and **AVERAGED STATISTICS** (on Left)
            2. **MOVE SAMPLE INFORMATION** to the top of the list (on Right)
            3. Press **APPLY** and **OKAY** to return to Run Settings
            4. Press **OKAY** again to return to Run Cycle
    h. Run Cycle Page
        i. Press **NEW SAMPLE** (it will check most boxes)
        ii. Check **SCONICATE DURING LOADING** and Power Level 6 (must check and uncheck something to make it appear)
7. Press **START**

Sample Preparation

1. Start an entry in a log book for the sample
   a. Keep a separate book for each series/location (whatever makes sense)2. Enter the sample information into the Coulter machine as shown in the previous section and press run
3. Open sample bag to allow air in then reclose it
5. Using a scoopula, stir the sediment sample so it is homogenized
6. Take a clean 40 mL beaker and place clean 1 mm sized sieve on top
7. Place two scoopula full's on the sieve and rinse the sediment through sieve into beaker with tap water in a wash bottle
   a. The needed sediment amount will vary: very sandy samples take much more than clay rich samples
   b. If the sample has a significant portion of clay jump to the Clay-Rich Sample Section
   c. If the sample has a significant portion of shells jump to the Shell-Rich Sample Section (>1mm)
8. **NO SHELLS, MASSIVE ORGANICS, ROOTS OR ANYTHING OVER 1000µM ARE TO BE PUT IN THE COULTER TO BE RUN!** IF THIS OCCURS IT WILL CLOG THE CIRCULATION LINES AND DAMAGE THE GLASS PLATES THE SEDIMENT CIRCULATES THROUGH FOR THE LASER READING.
   a. IF YOUR SAMPLES CONTAIN A LARGE AMOUNT OF ORGANICS PLEASE DO THE FOLLOWING:
      i. Dissolve the organics using bleach or hydrogen peroxide. Make sure to rinse these chemicals from your sample before continuing to run on the Coulter. Procedures can be found on the USGS web site and some papers are included in this packet.

Sand rich Sediment Samples

1. The beaker should have more than 20 mL of sediment solution in it
2. Place sconicator wand in the beaker (without it touching the sides or the bottom)
3. Pulse the sconicator a few times (power level 8)
4. Wait until the machine is ready
5. Turn the sconicator to continuous (wear hearing protection)
6. Use bulb pipette to extract sample and place in the water tub of the machine
7. Machine should read between 8 and 11 % as ready a. Keep putting in sample until it reads that
   b. If you go above that, record that you went too high, cancel the run, and restart it
8. Press Done
   a. Machine will run for about a minute
   b. Record the starting time in a the log book (example below)

Time	Sample	Set	Run	Comments
830	HAR_55_A1_ Run1			Shells
831	2			
833	3			

9. Three runs are done for each of the two Sets

a. Once the instrument is done with the first run press Run and then Run Cycle information

i. Change the run number

b. Press Okay and Start

c. Once the Three Runs are done press Overlay button (left side next to Open)

10. Overlay
    a. Select the three just completed runs with the extension .$ls
        i. Use the control button to select multiple entries
    b. If there is a significant gap between some of the runs, do an extra run and note it in the comments, then recheck the overlay to see if it fits better.
11. Two sets of each sample are done sometimes for statistical purposes
    a. Process is the same, just change the set number (A1 to A2) and select New Sample
    b. Do three runs and check if the overlay is okay
12. Once an hour the offsets and alignment must be done
    a. Select these boxes in the Run Cycle Dialog, enter sample information, and press Run
    b. Go ahead and do this if you don't have enough time to complete a full sample run
13. Clean the scoopulas, sieves, mini bulb pipettes, and sonicator between each use.
    a. The sonicator can be wiped with a paper towel or cloth
    b. The others can be rinsed in tap water
        i. Use the sink closer to the entrance as it has a sediment catch

Clay Rich Samples

1. See Creating the *Sodium Hexametaphosphate* Solution section on page 6 to make the solution if none is available or the solution is cloudy (expired)
2. Sieve through as normal
3. While in beaker, mix one squirtful (from mini bulb pipette) of *Sodium Hexametaphosphate* (SHMP)
4. Let sit for 5 minutes
    a. Easiest if this is done while another sample is being run, and then do the SHMP right after pressing Start for the new Run Cycle
    b. If the sample is too hard to homogenize, put the sediment into a beaker with 10 ml of the SHMP solution and water, stir once initially, then let sit for up to 24 hour or until sample can be mixed.
5. Make a notation in the comment section
    a. Example SHMP ~ 5 minutes

Shell Rich Samples
(>1mm)

Preparation

1. Sieve through as normal and make notation in comments (★ Oven)
    a. Probably more than two scoops, but it depends on the sample
2. Take a little sample bag and write the sample number on it as well as the date
3. Put a few scoopfuls in the bag
4. Hang in the oven/dryer set at 45 C for several days

Processing

1. Once the sample is dried, break up the clumps
2. Turn on scale (one that closes off so air doesn't disturb reading)
3. Zero out a weigh boat
4. Place two or three scoops of sediment sample onto the weigh boat
5. Record the number of scoops and weight in the log book
6. Take a second weigh boat and place it under a 1mm sized sieve
7. Pour sample onto the sieve and shake it a little
8. Pour the remaining sample in the sieve onto another zeroed-out weigh boat and record the weight
9. Divide the >1mm weight by the total weight to get a percentage of sample greater than 1mm
10. Write the percentage on the bag and in the log book

Appendix B: Guide for Digital Files

Geodatabases were created using *ESRI ArcMap* following Louisiana State Data Management guidelines. All samples were included in the geodatabase. Quantitative analysis was performed for all samples containing 70% or greater sand content for all sampled regions, with the exception of the Point au Fer segment, where analysis was performed only on samples that were visually estimated to contain at least 50% sand. The geodatabase file was compressed to a zip archive file.