

Mon Louis Island Restoration 2019 Marsh Monitoring



Prepared for

Thompson Engineering, Inc.
2970 Cottage Hill Road
Mobile, AL 36606



Prepared by

Barry A. Vittor & Associates, Inc.
8060 Cottage Hill Road
Mobile, Alabama 36695



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1.0 INTRODUCTION

The Mobile Bay National Estuary Program funded the project entitled “Mon Louis Island Restoration 2018 Marsh Monitoring” through a grant provided by the National Fish and Wildlife Gulf Environmental Benefit Fund, to restore the erosion-impacted northern tip of Mon Louis Island. The project is located at the mouth of East Fowl River, on the western shore of Mobile Bay, Alabama (Figure 1).

The restoration project began in July 2016, and included restoration and armoring of the receding shoreline, placement of dredged material to re-create eroded land, and creation of 4.8 acres of tidal marsh habitat. A 1,400-foot continuous rock breakwater was constructed roughly along the 1995 footprint of the island, completed in early September 2016. Sandy material was hydraulically pumped from the Fowl River Open Water Disposal Area in Mobile Bay to provide a suitable substrate for marsh creation. A channel was then created to provide tidal inundation into the site.

The restored marsh was initially prepared in March-April 2017 by planting nursery-grown stock of smooth cordgrass (*Spartina alterniflora*), salt meadow cordgrass (*Spartina patens*), and black needlerush (*Juncus roemerianus*). Barry A. Vittor & Associates, Inc. conducted a qualitative survey of the restoration site in July 2017 and found that some areas of the site had suffered high transplant mortality, particularly the black needlerush. Additional transplants were obtained and installed. Based on an inspection of the re-planted areas in mid-September 2017, it was concluded that the planting was satisfactorily completed.

Thompson Engineering, Inc. sub-contracted Barry A. Vittor & Associates, Inc. to perform environmental monitoring of the Mon Louis Island restoration. The initial monitoring was performed in September 2018. This report provides Summer 2019 environmental survey data for Year 2 of the monitoring program.

2.0 METHODS

2.1 Sampling Plan

Sampling station locations are shown in Figure 1. The reference marsh is located on the north side of the mouth of East Fowl River, approximately 600 ft from the Mon Louis Island project site. Table 2-1 summarizes the number and types of samples collected during the June and July 2019 monitoring surveys.

Table 2-1. Number and type of samples collected at the Mon Louis Island restoration site and reference marsh, Summer 2019.					
Site (No. Stations)	Vegetation Quadrat	Nekton Lift Nets	Macroinfauna Hand cores	Epifauna Quadrats	Sediment Texture/ TOC
Mon Louis Island (4)	N = 118	N = 12	N = 12	N = 12	N = 4
Reference (2)	--	N = 6	N = 6	N = 6	N = 2



Figure 1. Location of the Mon Louis Island restoration project and faunal sampling stations.

2.2 Vegetation Coverage

Vegetation transects and quadrat locations are presented in Figure A-1 (Appendix A). Vegetation metrics were collected within standard 1-m² quadrats along 17 transects. The quadrat data collected included percent cover of individual species, average height of the vegetation, and an estimate of overall vegetative cover of vegetation. Typically, quadrat data were collected at the beginning of each transect and then approximately every 5 meters.

2.3 HGM Model Assessment

A detailed hydrogeomorphic (HGM) model methodology is presented in Appendix A. The HGM model is a collection of concepts and methods that uses mathematically derived indices to assess the capacity of wetlands to perform specific ecological, geochemical, and hydrological functions, in comparison to similar wetlands within the Mississippi/Alabama coast reference domain (Schafer et al., 2007). When an HGM model variable is within the range of conditions observed in reference standard wetlands a variable sub-index value of 1.0 is assigned. As the condition deviates from reference standards, the variable sub-index is assigned based on the observed relationship between model variable condition and functional capacity (on a scale of 0.0 to 1.0). HGM assessment metrics were measured in the field during July 2019.

2.4 Nekton

A bottomless nylon lift net (6-m² area) was installed on the vegetated marsh surface at each survey station to sample nekton during tidal inundation. Lift nets were raised near high tide, and trapped nekton collected with dip nets. Lift net samples were collected June 5, 6, and 7, 2019.

Lift net contents were fixed in the field with 10% formalin, and subsequently washed and transferred to containers with 70% isopropanol. Nekton were identified to lowest practical identifiable level (LPIL) and counted. The number of individuals and number of taxa are reported for each station in Appendix B.

Spatial patterns in the lift net data were examined using multivariate cluster analysis. The cluster analysis was performed on a similarity matrix constructed from a raw abundance data matrix consisting of taxa and samples. To weight the contributions of common and rare taxa, raw counts of each individual taxon in a sample (n) were transformed to logarithms [$\log_{10}(n+1)$] prior to similarity analysis. The similarity matrix was generated using the Bray-Curtis similarity index (Bray and Curtis, 1957). Species accounting for the observed nekton assemblage differences among sample groups and within sample groups were identified using SIMPER procedure. SIMPER determines the average contribution of each taxon to characterizing a sample group or discriminating between pairs of sample groups resolved by cluster analysis. These analyses (cluster analysis, SIMPER) were performed using PRIMER v6 package (Clarke and Gorely, 2006).

2.5 Macroinfauna

Three replicate samples for macroinfauna were collected at each station using a 4-inch diameter hand core (0.0079 m²), concurrent with lift net sampling. Sample contents were fixed in 10% formalin in the field. In the laboratory, samples were washed through a 0.5-mm sieve and transferred to containers with 70% isopropanol with rose Bengal stain. Macroinfauna were identified and counted to the LPIL and counted. The number of individuals in each taxon is reported for each station (Appendix C). Univariate summary statistics including number of taxa, number of individuals, density, Shannon's index of diversity (H') and Pielou's index of evenness (J') were calculated for each station.

Macroinfaunal data were analyzed using multivariate methods as described in Section 2.4.

In additions to hand core samples, three replicate 0.25-m² quadrats were assessed at each station to qualitatively document epibenthic macrofauna such as epibenthic snails not readily sampled with the hand core. Quadrats were haphazardly placed with blind, over-the-shoulder tosses. Quadrat data are reported in Appendix C.

2.6 Sediment Texture and Total Organic Carbon

One sediment sample (about 250 grams) for grain size analysis and percent total organic carbon (TOC) was collected with the hand core at each station, and stored on ice. Grain size analysis was conducted using combined sieve and hydrometer methods according to recommended American Society for Testing Materials (ASTM) procedures. Samples were washed in demineralized water, dried, and weighed. Coarse and fine fractions (sand/silt) were separated by sieving through a U.S. Standard Sieve Mesh No. 230 (62.5 μm). Sediment texture of the coarse fraction was determined at 0.5-phi intervals by passing sediment through nested sieves. Weight of materials collected in each particle size class was recorded. Boyocouse hydrometer analyses were used to analyze the fine fraction (<62.5 μm). Percentages of gravel, sand, silt, and clay were recorded for each sample.

TOC was measured using an EA 1112 Analyzer. For each sample, a silver sample capsule was tared on a microbalance, which was interfaced to the analyzer. Approximately 15-20mg of sample sediment was placed in the capsule and its weight recorded to 0.001 mg. Approximately 10 μl of concentrated nitric acid was added to the capsule and the sample was placed on a hot plate overnight at 80° C. The following day an additional 10 μl of concentrated nitric acid was added to the capsule and the sample was placed on a hot plate for at least one hour at 80° C, and then closed. A blank capsule was prepared for reference. Two standards of aspartic acid were weighed, and the sample and blank capsules were combusted with the chromatograph manually integrated to relate the instrument response to TOC concentration. After calibration, the percent carbon remaining in the sample was determined. Check standards and reference material were analyzed for quality control.

3.0 RESULTS

3.1 Vegetation Survey and HGM Model Analysis

A phylogenetic list of plant species and their percent cover in survey quadrats are presented in Appendix A. A total of 24 vascular plant species were identified. Vegetated coverage by all species was 57.3%. Smooth cordgrass (*Spartina alterniflora*) comprised an average of 36.4% of the vegetative over and occurred in 69% of the quadrats (Table 3-1). Salt meadow cordgrass (*Spartina patens*) was 9.2% of the coverage and occurred in 29% of the quadrats. Black needlerush (*Juncus roemerianus*) averaged 2.6% cover and was present in 21% of the sampled quadrats.

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Species	Average % Cover	No. of Quadrats (% of total)
<i>Spartina alterniflora</i>	36.40	80 (68)
<i>Spartina patens</i>	9.20	34 (29)
<i>Bolboschoenus robustus</i>	2.60	15 (13)
<i>Juncus roemerianus</i>	2.60	21 (18)
<i>Paspalum vaginatum</i>	1.60	8 (7)
<i>Panicum repens</i> †	1.30	12 (10)
<i>Phragmites mauritianus</i>	1.10	12 (10)
<i>Distichlis spicata</i>	0.60	5 (4)
<i>Sabatia stellaris</i>	0.30	7 (6)
<i>Schoenoplectus pungens</i>	0.30	5 (4)
<i>Solidago mexicana</i>	0.30	10 (9)
<i>Strophostyles helvula</i>	0.30	6 (5)

A number of obligate wetland plant species were recorded in 2019 that were not found in quadrats in the 2018 survey. These included the following:

- Southern Water Hemp (*Amaranthus australis*)
- Marsh Frimby (*Fimbristylis castanea*)
- Saltmarsh Mallow (*Kosteletzkya pentacarpos*)
- Narrowleaf Loosestrife (*Lythrum lineare*)
- Water Pepper (*Persicaria hydropiperoides*)
- Rose Of Plymouth (*Sabatia stellaris*)

Table 3-2 lists individual and average Functional Capacity Index (FCI) scores for the five ecosystem functions evaluated in the HGM model assessment for both 2018 and 2019. Except for Nekton Utilization Potential, which remained consistent since the 2018 assessment, FCI scores increased in 2019 due primarily to the increase in overall vegetative coverage. Compared to 2018, which had a low score (0.20) for Plant Community Composition / Structure, the site received an improved value of 0.60 in 2019.

HGM Function	2018 FCI	2019 FCI
Wave Energy Attenuation	0.62	0.67
Biogeochemical Cycling	0.53	0.77
Nekton Utilization Potential	0.92	0.92
Provide Habitat for Tidal Marsh Dependent Wildlife	0.72	0.80
Plant Community Composition / Structure	0.20	0.60
	Ave. 0.60	Ave. 0.75

The FCI score for Nekton Utilization potential (0.92) is highest of the five functions, due to the extent of aquatic edge along the tidal creek, and a V_{HYDRO} value (0.75) indicating adequate site accessibility for nekton. The average FCI in 2019 increased to 0.75, from 0.60 in 2018.

3.2 Nekton

A phylogenetic list of nekton collected in lift nets and the station taxa counts are presented in Appendix B. Table 3-3 presents lift net community statistics. Lift nets at Station ML1 yielded 13 total taxa, followed by ML4 (12 taxa), with means of 6.7 and 7.3, respectively. Stations R12 and R2 yielded the fewest total number of taxa, with 8 and 7, and 4.3 and 4.7 taxa per replicate, respectively.

Station	Total Number of Taxa	Mean Number of Taxa (Std. Dev.)	Mean Density (Individuals/m ²) (Std. Dev.)	Shannon Diversity (H')	Pielou Evenness (J')
ML1	13	6.7 (0.6)	8.9 (2.6)	0.83	0.32
ML2	11	6.0 (3.5)	8.3 (2.7)	0.85	0.35
ML3	9	6.3 (1.5)	14.5 (5.4)	0.63	0.29
ML4	12	7.3 (0.6)	8.2 (1.3)	1.17	0.47
R1	8	4.3 (0.6)	7.0 (1.9)	0.45	0.22
R2	7	4.7 (2.1)	20.1 (11.8)	0.42	0.22

Mean nekton densities per were greatest at Stations R2 (20.1 individuals/m²) and ML3 (14.5), while Station R1 had the lowest mean density (7.0). Diversity ranged from 1.17 at ML4 to 0.42 at R2. Taxa evenness, a measure of the distribution of overall abundance among the sampled taxa, ranged from 0.47 at ML4 to 0.22 at R1 and R2.

Table 3-4 lists the most abundant taxa collected in lift nets. Grass shrimp (*Palaemonetes*), blue crabs (*Callinectes sapidus*), Gulf killifish (*Fundulus grandis*), and white shrimp (*Litopenaeus setiferus*) were collected at all six stations. Grass shrimp were numerically dominant at all stations (Appendix Table B-2). Brown shrimp (*Farfantepenaeus aztecus*) were collected only at R1 and R2.

Taxonomic Name	Total Count	Station Occurrence
<i>Palaemonetes</i> (LPIL)	1034	ML1 ML2 ML3 ML4 R1 R2
<i>Callinectes sapidus</i>	38	ML1 ML2 ML3 ML4 R1 R2
<i>Fundulus grandis</i>	32	ML1 ML2 ML3 ML4 R1 R2
<i>Litopenaeus setiferus</i>	27	ML1 ML2 ML3 ML4 R1 R2
<i>Mugil</i> (LPIL)	13	ML1 ML2 ML3 ML4 R1
<i>Fundulus</i> (LPIL)	9	ML2 ML4
<i>Farfantepenaeus aztecus</i>	8	R1 R2
<i>Gambusia affinis</i>	7	ML1 ML2 ML3 R2

The SIMPER procedure identified the taxa accounting for the observed assemblage differences within and among the sample groups identified by cluster analysis (Table 3-5). ML stations clustered at 88% average similarity, with relatively high abundances of grass shrimp and Gulf killifish. Gulf killifish were less abundant at R stations, which

grouped together at 72% similarity. Lift nets at R stations also yielded brown shrimp, which were not collected at ML stations.

Table 3-5. Average abundance of nekton taxa accounting for at least 50% of within group similarity in lift nets. Numbers in bold represent the overall average similarity for each sample group. N = 3 for all stations.				
Group	Stations	Taxonomic Name	Average Abundance	Average Similarity
A	ML1, ML2, ML3, ML4	<i>Palaemonetes</i> (LPIL)	3.87	42.87
		<i>Fundulus grandis</i>	1.22	12.09
				87.79
B	R1, R2	<i>Palaemonetes</i> (LPIL)	4.19	47.01
				72.11

3.3 Macroinfauna

A phylogenetic list of macroinfauna collected in hand cores and the station taxa counts are presented in Appendix C. Table 3-6 presents macroinfauna community statistics. Station ML4 yielded 22 total taxa, followed by R1 (14 taxa), with a mean per sample of 11.3 and 7.7, respectively. Station ML4 had a mean of 7.3 taxa per replicate. Station ML1 yielded just 5 taxa, with a mean of 3.0 taxa per replicate.

Table 3-6. Macroinfaunal community statistics based on hand core contents at Mon Louis Island (ML) and reference (R) survey stations.					
Station	Total Number of Taxa	Mean Number of Taxa (Std. Dev.)	Mean Density (Individuals/m ²) (Std. Dev.)	Shannon Diversity (H')	Pielou Evenness (J')
ML1	5	3.0 (1.7)	1476.8 (861.6)	0.90	0.58
ML2	9	4.7 (1.5)	3038.0 (886.1)	1.17	0.44
ML3	12	6.0 (1.0)	1392.4 (334.9)	2.29	0.56
ML4	22	11.3 (4.9)	7468.4 (5949.4)	2.10	0.53
R1	14	7.7 (4.0)	5738.4 (2985.7)	1.57	0.59
R2	10	5.0 (2.6)	2827.0 (649.6)	1.31	0.57

Mean density was greatest at ML4 (7468.4 individuals/m²), while ML3 had the lowest mean density (1392.4 individuals/m²) (Table 3-6). Diversity ranged from 2.29 at ML3 to 0.90 at ML1. Taxa evenness was similar across all stations, ranging from 0.59 at R1 to 0.44 at ML2.

Table 3-7 lists the most abundant macroinfauna collected. Unidentified oloiochaetes (Naididae) and the polychaete *Laeonereis culveri* were collected at all six stations. Other relatively abundant polychaetes included *Mediomastus ambista* and *Capitella capitata*. *Capitella capitata* was collected at all four ML stations, but not at either R station (Table 3-7).

Table 3-7. Most abundant macroinfauna collected in hand cores at Mon Louis Island (ML) and reference (R) survey stations.

Taxonomic Name	Total Count	Station Occurrence
Naididae (LPIL)	124	ML1 ML2 ML3 ML4 R1 R2
<i>Chironomus</i> (LPIL)	81	ML3 ML4 R2
<i>Laeonereis culveri</i>	79	ML1 ML2 ML3 ML4 R1 R2
<i>Hargeria rapax</i>	74	R1 R2
<i>Mediomastus ambista</i>	29	ML3 ML4 R1 R2
<i>Capitella capitata</i>	28	ML1 ML2 ML3 ML4
<i>Uca pugnax</i>	14	ML2 ML3 ML4 R2
<i>Apocorophium louisianum</i>	13	R1 R2 ML4
<i>Streblospio benedicti</i>	13	ML4 R1

The SIMPER procedure identified the taxa accounting for the observed assemblage differences within and among the infaunal sample groups identified by cluster analysis (Table 3-8). The ML1 and ML2 stations (Group A) had relatively high abundances of Naidid oligochaetes. Group B stations (R1, R2) differed from Group A due to abundant *Laeonereis culveri*. In addition to *Laeonereis culveri* and Naidid oligochaetes, Stations ML3 and ML4 (Group C) yielded larval Ephydriidae (Diptera) and the polychaete *Mediomastus ambiseta*.

Table 3-8. Average abundance of macroinfauna accounting for at least 50% of within group similarity. Numbers in bold represent average similarity for each sample group.

Group	Stations	Taxonomic Name	Average Abundance	Average Similarity
A	ML1, ML2	Naididae (LPIL)	2.51	37.33 64.29
B	R1, R2	<i>Laeonereis culveri</i>	2.30	22.18
		Naididae (LPIL)	1.83	11.96 49.99
C	ML3, ML4	<i>Laeonereis culveri</i>	1.50	9.08
		Naididae (LPIL)	1.18	7.40
		Ephydriidae (LPIL)	0.69	5.23
		<i>Mediomastus ambiseta</i>	1.41	5.23 44.52

Epifauna quadrat data are presented in Appendix C. Stations R1 and R2 had numerous marsh periwinkles (*Littorina irrorata*) that were not present in quadrats sampled at the ML stations. Periwinkles were observed to be present in the restoration site.

3.4 Sediment Texture and Total Organic Carbon

Table 3-9 presents sediment texture and percent total organic carbon (TOC) data. ML stations had varying amounts of mud and sand, while R stations had mud and muddy sand mixed with gravel. There was a lower percent TOC at the ML stations compared to R stations.

Table 3-9. Sediment texture and % total organic carbon (TOC) at Mon Louis Island and reference survey stations.

Station	Sediment Texture			% TOC
	% Gravel	% Sand	%Fines	
ML1	0.1	86.4	13.5	0.107
ML2	0.3	86.4	13.3	0.238
ML3	0.3	67.5	32.2	0.416
ML4	0.6	61.1	38.3	0.554
R1	27.2	63.7	9.1	3.44
R2	17.9	13.7	68.4	2.24

4.0 CONCLUSIONS

Vegetated cover at the Mon Louis Island restoration site increased in 2019 to 57.3%, compared to 39.3% coverage in 2018. The planted species, including smooth cordgrass (*Spartina alterniflora*), salt meadow cordgrass (*Spartina patens*), and black needlerush (*Juncus roemerianus*), all increased their coverage compared to 2018. In addition, natural recruitment of native marsh plants is occurring at the site. The 2019 HGM model analysis indicates an increase in marsh functional capacity since the 2018 survey, with most of the improvement due to the increase in vegetative coverage.

Nekton community composition and abundance was similar at the restoration and reference stations, due primarily to high numbers of grass shrimp. Blue crabs (*Callinectes sapidus*), Gulf killifish (*Fundulus grandis*), and white shrimp (*Litopenaeus setiferus*) were also collected at all survey stations. Macroinfauna collected from the Mon Louis Island stations are common in northern Gulf estuaries. Differences in macroinfaunal community composition among the restoration and reference stations are likely due in part to variable sediment texture and soil organic content.

As in 2018, there was low percent TOC at the restoration site stations. TOC accumulation at the Mon Louis Island marsh is expected to increase as the marsh continues to mature.

5.0 REFERENCES CITED

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Appendix A – Vegetation Data and Hydrogeomorphic Model Analysis



Figure A-1. Vegetation transect and quadrat placement at Mon Louis Island, July 2019.

Plant Species List - July 2019 († = non-native, invasive exotic)

ORDER POALES

JUNCACEAE (RUSH FAMILY)

Juncus roemerianus Scheele —BLACK NEEDLE RUSH

CYPERACEAE (SEDGE FAMILY)

Bolboschoenus robustus (Pursh) J. Soják —STURDY BULRUSH

†*Cyperus rotundus* Linnaeus —PURPLE NUTGRASS

Fimbristylis castanea (Michaux) Vahl —MARSH FRIMBY

Schoenoplectus pungens (Vahl) Palla —COMMON THREE SQUARE

POACEAE (GRASS FAMILY)

Distichlis spicata (Linnaeus) Greene —SALT GRASS

†*Panicum repens* Linnaeus —TORPEDO GRASS

Paspalum vaginatum Swartz —SEASHORE PASPALUM

Phragmites mauritianus Kunth —MAURITIUS REED

Spartina alterniflora (Loiseleur) P. M. Peterson & Saarela —SMOOTH CORDGRASS

Spartina patens (Roth) P. M. Peterson & Saarela —SALT MEADOW CORDGRASS

ORDER FABALES

FABACEAE (LEGUME FAMILY)

Strophostyles helvula (Linnaeus) Elliott —TRAILING FUZZY BEAN

ORDER MYRTALES

LYTHRACEAE (LOOSESTRIFE FAMILY)

Lythrum lineare Linnaeus —NARROWLEAF LOOSESTRIFE, WAND LOOSESTRIFE

ORDER MALVALES

MALVACEAE (MALLOW FAMILY)

Kosteletzkya pentacarpos (Linnaeus) Ledebour —SALTMARSH MALLOW

ORDER CARYOPHYLLALES

POLYGONACEAE (BUCKWHEAT FAMILY)

Persicaria hydropiperoides (Michaux) Small —WATER PEPPER

AMARANTHACEAE (AMARANTH FAMILY)

Amaranthus australis (A. Gray) J.D. Sauer —SOUTHERN WATER HEMP

ORDER GENTIANALES

GENTIANACEAE (GENTIAN FAMILY)

Sabatia stellaris Pursh —ROSE OF PLYMOUTH

ORDER ASTERALES

ASTERACEAE (SUNFLOWER FAMILY)

Ambrosia artemisiifolia Linnaeus —ANNUAL RAGWEED

Baccharis halimifolia Linnaeus —EASTERN BACCHARIS, GROUNDSEL TREE

Heterotheca subaxillaris (Lamarck) Britton & Rusby —CAMPHOR WEED

Iva frutescens Linnaeus —BIGLEAF SUMPWEED, JESUIT'S BARK

Solidago mexicana (Linnaeus) Fernald —SOUTHERN SEASIDE GOLDENROD

Symphotrichum tenuifolium (Linnaeus) Nesom —PERENNIAL SALT MARSH ASTER

ORDER APIALES

ARALIACEAE (GINSENG FAMILY)

Hydrocotyle bonariensis Lamarck —LARGE-LEAF PENNYWORT

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Average percent cover of plants in quadrats - September 2019

Species	Average Cover	No. of Quadrats	% Occurrence
<i>Amaranthus australis</i>	< 0.1%	1	0.8
<i>Ambrosia artemisiifolia</i>	0.1%	4	3.4
<i>Baccharis halimifolia</i>	<0.1%	7	5.9
<i>Bolboschoenus robustus</i>	2.6%	15	12.7
<i>Cyperus rotundus</i>	< 0.1%	1	0.8
<i>Distichlis spicata</i>	0.6%	5	4.2
<i>Fimbristylis castanea</i>	< 0.1%	1	0.8
<i>Heterotheca subaxillaris</i>	0.2%	3	2.5
<i>Hydrocotyle bonariensis</i>	< 0.1%	2	1.7
<i>Iva frutescens</i>	< 0.1%	1	0.8
<i>Juncus roemerianus</i>	2.6%	21	17.8
<i>Kosteletzkya pentacarpos</i>	< 0.1%	1	0.8
<i>Lythrum lineare</i>	< 0.1%	2	1.7
<i>Panicum repens</i>	1.3%	12	10.2
<i>Paspalum vaginatum</i>	1.6%	8	6.8
<i>Persicaria hydropiperoides</i>	< 0.1%	1	0.8
<i>Phragmites mauritianus</i>	1.1%	12	10.2
<i>Sabatia stellaris</i>	0.3%	7	5.9
<i>Schoenoplectus pungens</i>	0.3%	5	4.2
<i>Solidago Mexicana</i>	0.3%	10	8.5
<i>Spartina alterniflora</i>	36.4%	80	67.8
<i>Spartina patens</i>	9.2%	34	28.8
<i>Strophostyles helvula</i>	0.3%	6	5.1
<i>Symphotrichum tenuifolium</i>	< 0.1%	1	0.8

Hydrogeomorphic (HGM) Model Analysis

Background

The Hydrogeomorphic (HGM) Approach is a collection of concepts and methods that uses mathematically derived indices to assess the capacity of a wetland to perform specific ecological, geochemical, and hydrological functions in comparison to similar wetlands within a geographic region. The HGM approach was originally developed to be used within the framework of the Federal Section 404 regulatory program permit review process to evaluate project alternatives, minimize project impacts, and determine compensatory mitigation requirements (Smith et al., 1995). Additional applications include the planning design and monitoring of habitat restoration projects outside the context of the Section 404 program.

The development of the HGM approach involves: 1) classification of wetlands within a defined region; 2) development of functional assessment models and indices, and 3) development and application of assessment protocols. The advantage of the HGM approach is that an individual site may be assessed for a suite of functions or a subset of functions, as determined by project management objectives. HGM is a rapid-assessment procedure designed to be implemented in a relatively short period of time at minimal expense (Shafer et al., 2007).

Classification

HGM classifies wetlands based on three separate criteria; geomorphic setting, water source, and hydrodynamics (Brinson, 1993). The classification criteria are used to group wetlands into five basic geomorphic classes at a continental scale (depressional, flat, slope, riverine and fringe wetlands). Flats can be further subdivided into organic and mineral flats, and fringe wetlands into lacustrine and tidal fringe. At a finer geographic scale, the three classification criteria are applied to identify regional wetland subclasses, which typically corresponds to existing, commonly recognized wetland types; for example oligohaline salt marsh along the Gulf of Mexico coastline (Shafer and Yozzo, 1998).

Reference Wetlands

In HGM, reference wetlands are sites selected to represent the variability that occurs within a regional wetland subclass. The reference domain is the geographic area represented by the reference wetlands. Ideally, the reference domain will mirror the geographic area encompassed by the regional wetland subclass; however, constraints on time, personnel, and fiscal resources, as well as agency jurisdictional boundaries often limit the size of a regional reference domain.

Reference wetlands establish the range and variability of conditions expressed by HGM model variables and provide data needed to calibrate HGM assessment models. Reference wetlands exhibiting the highest sustainable level of function across a suite of observed or documented functions are referred to as reference standard wetlands. When a model variable is within the range of conditions observed in reference standard wetlands a variable sub-index value of 1.0 is assigned. As the condition deviates from that observed in reference standard wetlands, the variable sub-index is assigned based on the observed relationship between model variable condition and functional capacity (on a scale of 0.0 to 1.0).

Assessment Protocol

The HGM assessment protocol is a series of tasks that allow the user to assess the functions of a particular wetland using the functional indices presented in a published Regional Guidebook. The first task in an HGM assessment is characterization, which involves describing the wetland and its surrounding landscape, describing the proposed project and its potential impacts, and identifying the wetland assessment areas (WAAs). The second task is collection of field data for model variables. The final task is analysis, which involves calculation of functional indices and units.

Models and Indices

An HGM assessment model is a simple representation of a wetland function. It defines the relationship among one or more wetland characteristics or processes (variables). Functional capacity is the ability of the wetland to perform a function relative the level of performance observed or measured in reference standard wetlands.

Variables are combined mathematically in a functional assessment model to produce a functional capacity index (FCI). The mathematical expressions used vary, depending on the type of interaction to be represented (e.g. fully or partially compensatory, cumulative, limiting, controlling, etc.). A complete discussion of variable interactions and model development is presented in Smith and Wakeley (2001). FCIs are multiplied by the wetland assessment area (typically in hectares) to produce functional capacity units (FCUs), which represent the “currency” used to determine mitigation ratios within the context of the Federal Section 404 regulatory program.

Mississippi/Alabama HGM Guidebook

The methodology employed in the data collection and HGM assessment generally follows the protocol described in the Mississippi/Alabama HGM Guidebook (Schafer et al., 2007). <http://el.erdc.usace.army.mil/wetlands/guidebooks.cfm>

METHODS

Field Data Collection

Field assessment of the Mon Louis Island site was conducted in September 2018. Transects were generally aligned perpendicular to the shoreline edge along the hydrologic gradient of decreasing elevation (following Schafer et al., 2007).

Vegetation metrics used in the HGM assessment were collected within meter-squared quadrats. Data recorded included the average height of vegetation (recorded in centimeters up to one meter), and the combined overall percent cover of native wetland vegetation occurring within the quadrat. Estimates of percent cover were made using cover class categories presented in **Table B-2** (modified from Schafer et al., 2007).

Table B-2. Cover classes and midpoint values for percent cover estimates in quadrats.		
Class	% Cover Estimate	Midpoint Value Assigned
1	<5	2.5%
2	5-25	15.0%
3	25-50	37.5%
4	50-75	62.5%
5	>75	87.5%

Desktop/GIS Assessment Variables

The HGM assessment procedure is twofold. First, site information is gathered and assessed in a GIS during the “desktop” component of the procedure. Wetland assessment areas (WAAs) are identified from maps and air photos (color infra-red is preferred, but high-quality true color air photos are acceptable, and were used in the current evaluations). A standardized scale is critical, and the methodology requires that all air photo work be conducted using a scale of 1:4800 (1 in. = 400 ft.). The following HGM variables were assessed during the desktop procedure:

V_{SIZE} (Wetland Patch Size): The size of the contiguous wetland patch within which the WAA occurs.

$V_{LANDUSE}$ (Adjacent Land Use): The proportion of the wetland perimeter occupied by various land use types.

V_{WIDTH} (Mean Marsh Width): The distance (m) that wind and vessel-generated waves must travel across intervening tidal fringe wetland (distance from the shoreline)

V_{EXPOSE} (Wave Energy Exposure): A qualitative classification of the potential for a wetland to attenuate wind and vessel-generated wave energy based on geomorphic setting and fetch distance – unitless.

V_{EDGE} (Aquatic Edge): The length (m) of vegetated tidally connected marsh/water interface or edge expressed as a proportion of total WAA area (ha).

V_{HYDRO} (Hydrologic Regime): The degree of alteration to the normal tidal hydrology typical of the subclass – unitless.

Field Assessment Variables

The HGM approach also incorporates site-specific information on vegetation metrics and habitat diversity collected in the field. The field assessments generated data on the following HGM variables:

V_{NHD} (Nekton Habitat Diversity): A measure of the heterogeneity of the site, based on comparison of the number of habitats actually present at a site relative to the number of possible habitats known to occur in the regional subclass.

V_{WHD} (Wildlife Habitat Diversity): A measure of the occurrence of habitat types known to support selected marsh-dependent wildlife species within the WAA.

V_{COVER} (Mean Percent Cover Emergent Marsh Vegetation): The mean total percent cover of native non-woody plant species with a wetland indicator status of OBL or FACW

V_{HEIGHT} (Vegetation Height): The most frequently occurring height of the plants within the tallest zone of the emergent marsh plant community.

V_{EXOTIC} (Percent Cover of Invasive or Exotic Species): The proportion of the site that is covered by non-native or invasive plant species.

V_{WOODY} (Percent Cover by Woody Plant Species): The proportion of the site that is covered by shrub-scrub or other woody plant species.

V_{WIS} (Wetland Indicator Status): The ratio of percent cover of FAC and FACU plants to the cover of emergent herbaceous wetland (OBL or FACW) plants.

Ecosystem Functions (FCIs and FCUs)

The data collected during the desktop and field assessments (i.e., the thirteen variables listed above) are combined using various mathematical expressions to estimate five ecosystem functions attributed to tidal fringe wetlands in the AL/MS Gulf coast reference domain (Schafer et al., 2007):

Wave Attenuation: Ability of a wetland to attenuate wind and vessel-generated wave energy based on geomorphic setting and fetch distance

Biogeochemical Cycling: The ability of a tidal wetland to receive, transform, and export various elements and compounds through natural biogeochemical processes.

Nekton Utilization: The potential utilization of a marsh by resident and seasonally occurring non-resident adult or juvenile fish and macrocrustacean species.

Provide Habitat for Tidal Marsh Dependant Wildlife: The capacity of a tidal marsh to provide critical life requisites to selected components of the vertebrate wildlife community.

Maintain Characteristic Plant Community Structure: The ability of a tidal marsh to support a native plant community of characteristic species composition and structure.

Calculation of FCIs

A Microsoft Excel file provided by USACE-ERDC was used to facilitate data entry and to calculate FCIs for each of the functions assessed. Formulas used to calculate FCIs were:

Functional Capacity Equations	
Wave Energy Attenuation	$FCI = [(3V_{WIDTH} + V_{COVER}) / 4 \times V_{EXPOSE}]^{1/2}$
Biogeochemical Cycling	$FCI = [V_{HYDRO} \times V_{COVER} \times V_{LANDUSE}]^{1/3}$
Nekton Utilization Potential	$FCI = (V_{EDGE} + V_{HYDRO} + V_{NHD}) / 3$
Provide Habitat for Tidal Marsh Dependent Wildlife Species	$FCI = [V_{SIZE} \times \{(V_{HEIGHT} + V_{COVER}) / 2\} \times \{(V_{EDGE} + V_{WHD}) / 2\}]^{1/3}$
Maintain Plant Community Composition and Structure	$FCI = (\text{Minimum } (V_{COVER} \text{ or } V_{EXOTIC} \text{ or } V_{WIS} \text{ or } V_{WOODY}))$

**FCI and FCU Calculations for the Tidal Fringe HGM Regional Subclass
in the North Central Gulf of Mexico (Version of 04/2007)**

Project:	Mon Louis Island		
WAA		Area (ha):	1.95

Variable	Metric Value	Units	Subindex
V_{COVER}	54.2	%	0.600
V_{EDGE}	High	Qualitative	1.000
V_{EXPOSE}	Moderate	NA	0.600
V_{EXOTIC}	2.4	%	1.000
V_{HEIGHT}	90	cm	0.750
V_{HYDRO}	Minor	NA	0.750
V_{LANDUSE}	100%	%	1.000
V_{NHD}	7	EA	1.000
V_{SIZE}	1.95	ha	0.750
V_{WIS}	0.7	%	1.000
V_{WOODY}	0.2	%	1.000
V_{WHD}	4	EA	1.000
V_{WIDTH}	50.7	m	0.800

Function	Functional Capacity Index (FCI)	Functional Capacity Units (FCU)
Wave Energy Attenuation	0.67	1.308
Biogeochemical Cycling	0.77	1.494
Nekton Utilization Potential	0.92	1.788
Provide Habitat for Tidal Marsh Dependent Wildlife Species	0.80	1.554
Maintain Plant Community Composition and Structure	0.60	1.170
Overall Average	0.75	7.314

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Appendix B – Nekton Data

Table B-1. Lift Net Taxa List

Class	Order	Family	Taxon Name
Malacostraca	Decapoda	Palaemonidae	<i>Palaemonetes</i> (LPIL)
Malacostraca	Decapoda	Penaeidae	<i>Farfantepenaeus aztecus</i>
Malacostraca	Decapoda	Penaeidae	<i>Litopenaeus setiferus</i>
Malacostraca	Decapoda	Portunidae	<i>Callinectes sapidus</i>
Malacostraca	Decapoda	Sesamidae	<i>Armases cinereum</i>
Actinopterygii	Atheriniformes	Atherinopsidae	<i>Menidia beryllina</i>
Actinopterygii	Beloniformes	Belonidae	<i>Strongylura marina</i>
Actinopterygii	Cyprinodontiformes	Fundulidae	<i>Fundulus</i> (LPIL)
Actinopterygii	Cyprinodontiformes	Fundulidae	<i>Fundulus grandis</i>
Actinopterygii	Cyprinodontiformes	Fundulidae	<i>Fundulus jenkinsi</i>
Actinopterygii	Cyprinodontiformes	Fundulidae	<i>Fundulus pulvereus</i>
Actinopterygii	Cyprinodontiformes	Fundulidae	<i>Fundulus xenicus</i>
Actinopterygii	Cyprinodontiformes	Fundulidae	<i>Lucania parva</i>
Actinopterygii	Cyprinodontiformes	Poeciliidae	<i>Gambusia affinis</i>
Actinopterygii	Cyprinodontiformes	Poeciliidae	<i>Poecilia latipinna</i>
Actinopterygii	Perciformes	Gobiidae	Gobiidae (LPIL)
Actinopterygii	Perciformes	Gobiidae	<i>Gobiosoma robustum</i>
Actinopterygii	Perciformes	Mugilidae	<i>Mugil</i> (LPIL)
Actinopterygii	Perciformes	Sparidae	<i>Lagodon rhomboides</i>
Actinopterygii	Syngnathiformes	Syngnathidae	<i>Syngnathus</i> (LPIL)

¹LPIL = lowest possible identification level

Table B-2. Lift Net Taxa Counts

Station ML1

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Palaemonetes</i> (LPIL)	61	39	33	133
<i>Fundulus grandis</i>	1	3	3	7
<i>Armases cinereum</i>	4	0	0	4
<i>Litopenaeus setiferus</i>	2	1	0	3
<i>Callinectes sapidus</i>	1	2	0	3
<i>Mugil</i> (LPIL)	1	1	0	2
<i>Gambusia affinis</i>	1	0	0	1
<i>Fundulus jenkinsi</i>	0	0	1	1
<i>Fundulus pulvereus</i>	0	0	1	1
<i>Fundulus xenicus</i>	0	0	1	1
<i>Poecilia latipinna</i>	0	0	1	1
<i>Lucania parva</i>	0	0	1	1
				160

Table B-2. Lift Taxa Counts (Cont'd)

Station ML2

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Palaemonetes</i> (LPIL)	27	60	35	122
<i>Callinectes sapidus</i>	1	2	4	7
<i>Litopenaeus setiferus</i>	3	0	1	4
<i>Fundulus grandis</i>	1	0	3	4
<i>Fundulus</i> (LPIL)	0	1	3	4
<i>Mugil</i> (LPIL)	0	0	3	3
<i>Menidia beryllina</i>	0	1	0	1
<i>Lucania parva</i>	0	0	1	1
<i>Poecilia latipinna</i>	0	0	1	1
<i>Gambusia affinis</i>	0	0	1	1
				149

Station ML3

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Palaemonetes</i> (LPIL)	48	71	107	226
<i>Fundulus grandis</i>	2	5	4	11
<i>Callinectes sapidus</i>	2	2	4	8
<i>Litopenaeus setiferus</i>	1	1	3	5
<i>Mugil</i> (LPIL)	0	4	0	4
<i>Gambusia affinis</i>	0	1	0	1
<i>Syngnathus</i> (LPIL)	0	1	0	1
<i>Gobiosoma robustum</i>	0	0	1	1
				261

Station ML4

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Palaemonetes</i> (LPIL)	38	31	39	108
<i>Fundulus grandis</i>	3	3	2	8
<i>Callinectes sapidus</i>	4	0	2	6
<i>Litopenaeus setiferus</i>	3	0	2	5
<i>Fundulus</i> (LPIL)	3	0	2	5
<i>Gobiosoma robustum</i>	2	1	1	4
<i>Mugil</i> (LPIL)	0	3	0	3
<i>Armases cinereum</i>	1	0	0	1
<i>Fundulus xenicus</i>	0	1	0	1
<i>Poecilia latipinna</i>	0	1	0	1
Gobiidae (LPIL)	0	1	0	1
				148

Table B-2. Lift Net Taxa Counts (Cont'd)

Station R1

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Palaemonetes</i> (LPIL)	50	37	28	115
<i>Litopenaeus setiferus</i>	1	1	1	3
<i>Farfantepenaeus aztecus</i>	2	0	1	3
<i>Fundulus grandis</i>	1	0	0	1
<i>Callinectes sapidus</i>	0	1	0	1
<i>Strongylura marina</i>	0	1	0	1
<i>Syngnathus</i> (LPIL)	0	0	1	1
<i>Mugil</i> (LPIL)	0	0	1	1
				126

Station R2

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Palaemonetes</i> (LPIL)	194	87	49	330
<i>Callinectes sapidus</i>	0	7	6	13
<i>Litopenaeus setiferus</i>	2	1	4	7
<i>Farfantepenaeus aztecus</i>	2	0	3	5
<i>Gambusia affinis</i>	2	0	2	4
<i>Fundulus grandis</i>	0	0	1	1
<i>Lagodon rhomboides</i>	0	0	1	1
				361

Appendix C – Macroinfaunal Data

Table C-1. Macroinfaunal Taxa List

Phylum	Class	Order	Family	Taxonomic Name
Annelida	Clitellata			Hirudinea (LPIL)
Annelida	Oligochaeta	Tubificida	Lumbriculidae	Lumbriculidae (LPIL)
Annelida	Oligochaeta	Tubificida	Naididae	Naididae (LPIL)
Annelida	Polychaeta	Phyllodocida	Nereididae	<i>Laeonereis culveri</i>
Annelida	Polychaeta	Phyllodocida	Nereididae	<i>Nereis succinea</i>
Annelida	Polychaeta	Scolecida	Capitellidae	<i>Capitella capitata</i>
Annelida	Polychaeta	Scolecida	Capitellidae	<i>Mediomastus</i> (LPIL)
Annelida	Polychaeta	Scolecida	Capitellidae	<i>Mediomastus ambiseta</i>
Annelida	Polychaeta	Spionida	Spionidae	<i>Dipolydora socialis</i>
Annelida	Polychaeta	Spionida	Spionidae	<i>Polydora cornuta</i>
Annelida	Polychaeta	Spionida	Spionidae	<i>Streblospio benedicti</i>
Annelida	Polychaeta	Terebellida	Ampharetidae	<i>Hobsonia florida</i>
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogonidae (LPIL)
Arthropoda	Insecta	Diptera	Chironomidae	<i>Chironomus</i> (LPIL)
Arthropoda	Insecta	Diptera	Chironomidae	<i>Dicrotendipes</i> (LPIL)
Arthropoda	Insecta	Diptera	Chironomidae	<i>Dicrotendipes fumidus</i>
Arthropoda	Insecta	Diptera	Chironomidae	<i>Dicrotendipes simpsoni</i>
Arthropoda	Insecta	Diptera	Chironomidae	<i>Polypedilum</i> (LPIL)
Arthropoda	Insecta	Diptera	Chironomidae	<i>Polypedilum illinoense</i> grp.
Arthropoda	Insecta	Diptera	Chironomidae	<i>Polypedilum scalaenum</i> grp.
Arthropoda	Insecta	Diptera	Chironomidae	<i>Rheotanytarsus</i> (LPIL)
Arthropoda	Insecta	Diptera	Chironomidae	<i>Tanytarsus</i> (LPIL)
Arthropoda	Insecta	Diptera	Chironomidae	<i>Tvetenia</i> (LPIL)
Arthropoda	Insecta	Diptera	Dulichopodidae	<i>Rhaphium</i> (LPIL)
Arthropoda	Insecta	Diptera	Ephydriidae	<i>Ephydra</i> (LPIL)
Arthropoda	Insecta	Diptera	Ephydriidae	Ephydriidae (LPIL)
Arthropoda	Insecta	Diptera	Tabanidae	Tabanidae (LPIL)
Arthropoda	Insecta	Diptera	Tipulidae	Tipulidae (LPIL)
Arthropoda	Insecta	Diptera		Diptera (LPIL)
Arthropoda	Malacostraca	Amphipoda	Aoridae	<i>Grandidierella bonnieroides</i>
Arthropoda	Malacostraca	Amphipoda	Corophiidae	<i>Apocorophium louisianum</i>
Arthropoda	Malacostraca	Decapoda	Ocypodidae	<i>Uca pugnax</i>
Arthropoda	Malacostraca	Decapoda	Palaemonidae	<i>Palaemonetes pugio</i>
Arthropoda	Malacostraca	Tanaidacea	Leptocheliidae	<i>Hargeria rapax</i>
Mollusca	Gastropoda	Mesogastropoda	Hydrobiidae	Hydrobiidae (LPIL)
Mollusca	Gastropoda	Neritopsina	Neritidae	<i>Neritina usnea</i>
Nemertea				Nemertea (LPIL)

LPIL = Lowest practical identification level

Table C-2. Macroinfaunal Station Data

Station ML1

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
Naididae (LPIL)	11	12	1	24
<i>Capitella capitata</i>	3	2	3	8
<i>Rhaphium</i> (LPIL)	1	0	0	1
<i>Palaemonetes pugio</i>	1	0	0	1
<i>Laeonereis culveri</i>	1	0	0	1
				Total 35

Station ML2

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
Naididae (LPIL)	25	15	7	47
<i>Capitella capitata</i>	4	2	8	14
Ceratopogonidae (LPIL)	3	0	0	3
<i>Uca pugnax</i>	0	1	1	2
<i>Laeonereis culveri</i>	0	2	0	2
Diptera (LPIL)	0	0	1	1
Ephydriidae (LPIL)	0	0	1	1
Tipulidae (LPIL)	0	0	1	1
<i>Dicrotendipes</i> (LPIL)	0	1	0	1
				Total 72

Station ML3

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Laeonereis culveri</i>	2	1	4	7
Naididae (LPIL)	2	2	1	5
<i>Capitella capitata</i>	0	4	1	5
<i>Mediomastus ambiseta</i>	0	3	0	3
Ephydra (LPIL)	2	0	0	2
<i>Uca pugnax</i>	1	0	1	2
<i>Grandidierella bonnieroides</i>	0	0	2	2
<i>Dipolydora socialis</i>	0	0	2	2
<i>Chironomus</i> (LPIL)	0	0	2	2
Ephydriidae (LPIL)	0	1	0	1
<i>Dicrotendipes fumidus</i>	1	0	0	1
<i>Dicrotendipes simpsoni</i>	0	1	0	1
				Total 33

Table C-2. Macroinfaunal Station Data (Cont'd)

Station ML4

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Chironomus</i> (LPIL)	1	77	0	78
<i>Mediomastus ambiseta</i>	20	2	0	22
<i>Laeonereis culveri</i>	5	9	1	15
<i>Streblospio benedicti</i>	2	9	0	11
Naididae (LPIL)	4	2	3	9
<i>Uca pugnax</i>	8	0	1	9
Hydrobiidae (LPIL)	6	0	0	6
<i>Grandidierella bonnieroides</i>	0	3	0	3
Ceratopogonidae (LPIL)	1	0	2	3
Ephydriidae (LPIL)	2	0	1	3
<i>Dicrotendipes</i> (LPIL)	1	2	0	3
<i>Tvetenia</i> (LPIL)	2	0	1	3
<i>Polydora cornuta</i>	2	0	0	2
Diptera (LPIL)	0	0	2	2
<i>Capitella capitata</i>	0	1	0	1
<i>Nereis succinea</i>	1	0	0	1
<i>Hobsonia florida</i>	1	0	0	1
Tabanidae (LPIL)	0	1	0	1
<i>Rhaphium</i> (LPIL)	1	0	0	1
<i>Tanytarsus</i> (LPIL)	1	0	0	1
<i>Apocorophium louisianum</i>	0	0	1	1
<i>Rheotanytarsus</i> (LPIL)	1	0	0	1
				Total 177

Station R1

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Hargeria rapax</i>	33	12	27	72
<i>Laeonereis culveri</i>	17	7	5	29
<i>Apocorophium louisianum</i>	6	0	4	10
Naididae (LPIL)	3	0	4	7
<i>Nereis succinea</i>	1	3	0	4
<i>Mediomastus ambiseta</i>	2	1	0	3
<i>Streblospio benedicti</i>	2	0	0	2
Hirudinea (LPIL)	2	0	0	2
<i>Neritina usnea</i>	1	0	1	2
Nemertea (LPIL)	0	0	1	1
<i>Palaemonetes pugio</i>	0	0	1	1
Lumbriculidae (LPIL)	1	0	0	1
<i>Polypedilum scalaenum</i> group	1	0	0	1
<i>Polypedilum illinoense</i> group	1	0	0	1
				Total 136

Table C-2. Macroinfaunal Station Data (Cont'd)

Station R2

Taxonomic Name	Rep 1	Rep 2	Rep 3	Total
<i>Hargeria rapax</i>	33	12	27	72
<i>Laonereis culveri</i>	17	7	5	29
<i>Apocorophium louisianum</i>	6	0	4	10
Naididae (LPIL)	3	0	4	7
<i>Nereis succinea</i>	1	3	0	4
<i>Mediomastus ambiseta</i>	2	1	0	3
<i>Streblospio benedicti</i>	2	0	0	2
Hirudinea (LPIL)	2	0	0	2
<i>Neritina usnea</i>	1	0	1	2
Nemertea (LPIL)	0	0	1	1
				Total 67

Table C-3. Quadrat Data

Station ML1

Taxonomic Name	Common Name	N1-1	N1-2	N1-3	Total
<i>Uca</i> (LPIL)	Fiddler crab	2	0	0	2

Station ML2

Taxonomic Name	Common Name	N2-1	N2-2	N2-3	Total
<i>Uca</i> (LPIL)	Fiddler crab	0	1	0	1

Station ML3

Taxonomic Name	Common Name	S-1	S-2	S-3	Total
<i>Uca</i> (LPIL)	Fiddler crab	4	0	0	4

Station ML4

Taxonomic Name	Common Name	R1-1	R1-2	R1-3	Total
		0	0	0	0

Station R1

Taxonomic Name	Common Name	R2-1	R2-2	R2-3	Total
<i>Littorina irrorata</i>	Marsh periwinkle	2	6	3	11

Station R2

Taxonomic Name	Common Name	R2-1	R2-2	R2-3	Total
<i>Littorina irrorata</i>	Marsh periwinkle	14	8	11	33