

BOGUE INLET SALTMARSH MONITORING REPORT



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BOGUE INLET SALTMARSH MONITORING REPORT

1.0 INTRODUCTION

The following report serves to document baseline (2003) conditions of saltmarsh communities in support of an Environmental Impact Statement for the Bogue Inlet Channel Erosion Response Project. This report documents pre-construction conditions and is the first report of a monitoring study that will provide information on coastal marsh habitats that may be directly or indirectly affected by the project. This monitoring study was developed in coordination with the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, National Marine Fisheries Service, the North Carolina Department of Environment and Natural Resources, the North Carolina Division of Marine Fisheries, and the North Carolina Wildlife Resources Commission.

Sampling efforts concentrated on representative areas of potential impact where biota and physical conditions may be directly or indirectly affected by the project. Sampling took place in September 2003 to observe effects of perturbation on vegetative conditions at the end of the growing season.

2.0 METHODOLOGY

Saltmarsh monitoring transects were established at the following locations: 1) north of Bogue Inlet on the east side of the main channel, 2) on the east side of Dudley Island, and 3) on the north side of Bear Island (Figure 1). Transects are 300 feet long and located within saltmarsh vegetation dominated by smooth cordgrass (*Spartina alterniflora*). Each monitoring and sampling station includes similar vegetation and tidal conditions. The Bear Island transect serves as the control site for the other transects since project-related impacts are not expected at this location. Monitoring parameters include: *Spartina* sp. stem density, mature (>30 cm in height) *Spartina* sp. stem density, percent organic content of surface substrate, sedimentation rate, and wildlife utilization. This information will be used to characterize any changes in the marsh edge.

2.1 Marsh Monitoring

Five one – meter square quadrats were established on 4 September 2003 at 5, 50, 100, 150, and 300 feet away from the marsh edge along each permanent transect (Figure 2). The marsh edge represents the boundary between vegetated and unvegetated portions of intertidal flats, found between mean low and mean high water tides. A Trimble ProXR GPS unit (submeter accuracy) was used to record the location of each transect and quadrat (Table 1).



LEGEND



MONITORING TRANSECT
LOCATIONS



**MARSH MONITORING TRANSECT LOCATIONS
SEPTEMBER 2003**

BOGUE INLET

SCALE: AS SHOWN	APPROVED BY: <i>DL</i>	DRAWN BY: TLJ
DATE: 12/24/03		FILE: 1937-FIG1

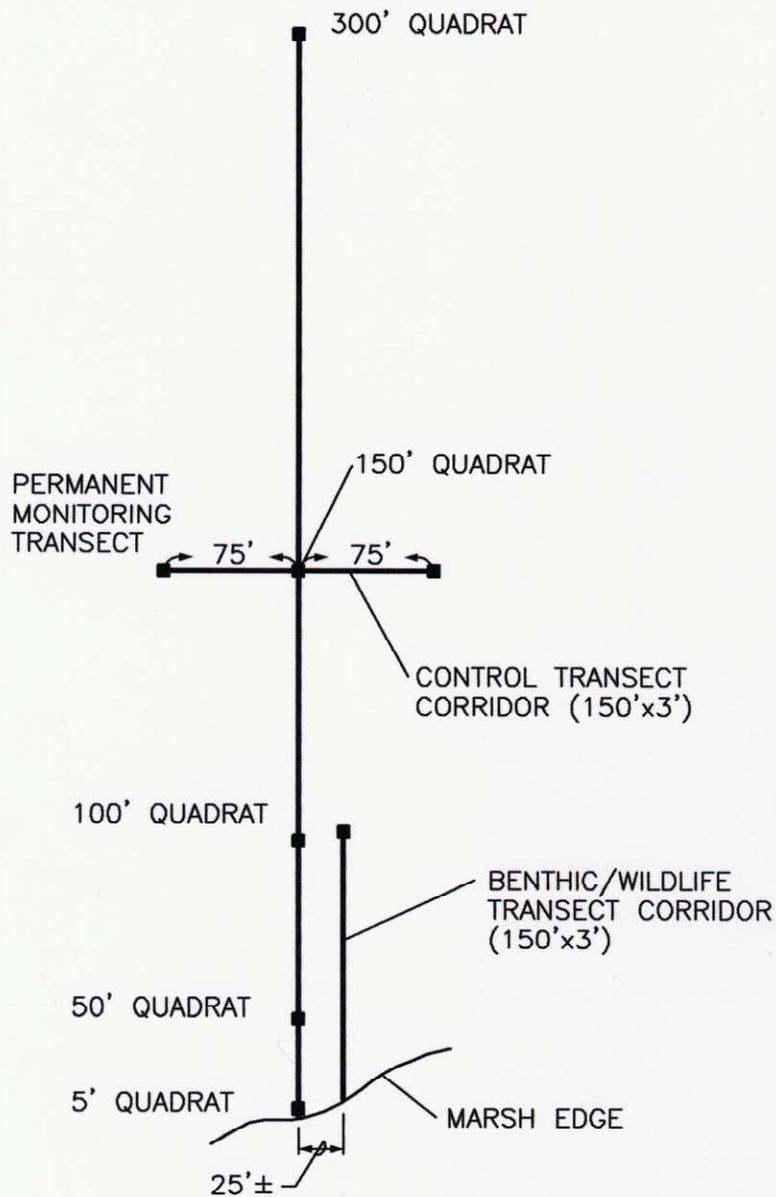


4709 COLLEGE ACRES DRIVE
SUITE 2
WILMINGTON, NORTH CAROLINA 28403
TEL 910/392-9253
FAX 910/392-9139

CP#1937.01

FIGURE 1

SOURCE: AERIAL IMAGES WERE FLOWN JUNE 2003 BY EMERGE AND APPLIED GEO TECHNOLOGIES, INC. AND PROVIDED BY COASTAL PLANNING AND ENGINEERING.



LEGEND

- SITE OF ONE SQUARE METER QUADRAT: SAMPLING OF *Spartina* AND SEDIMENTS AND PVC SEDIMENTATION POLE.

SAMPLING DESIGN SCHEME FOR SALTMARSH MONITORING TRANSECTS

BOGUE INLET

SCALE: AS SHOWN

APPROVED BY:

DRAWN BY: TLJ

DATE: 12/23/03

DMC

FILE: 1937FIG2



4708 COLLEGE ACRES DRIVE
SUITE 2
WILMINGTON, NORTH CAROLINA 28403
TEL 910/392-9253
FAX 910/392-9139

CP# 1937.01

FIGURE 2

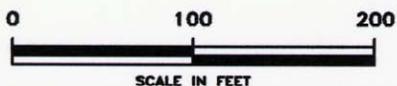
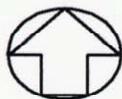


Table 1. Locations of Bogue Inlet, Dudley Island, and Bear Island saltmarsh monitoring transects and sampling quadrats within the Bogue Inlet Study Area.

Transect	Quadrat distance from marsh edge (ft)	Northing^a	Easting
Bogue Inlet	0	3836780.268	307980.986
Bogue Inlet	5	3836781.456	307981.896
Bogue Inlet	50	3836791.887	307990.776
Bogue Inlet	100	3836802.879	308000.78
Bogue Inlet	150	3836814.776	308010.551
Bogue Inlet	300	3836849.077	308040.525
Dudley Island	0	3837228.038	307027.231
Dudley Island	5	3837228.645	307025.963
Dudley Island	50	3837235.937	307015.181
Dudley Island	100	3837244.95	307003.296
Dudley Island	150	3837253.956	306990.02
Dudley Island	300	3837281.32	306952.881
Bear Island	0	3835856.189	304749.83
Bear Island	5	3835856.189	304749.83
Bear Island	50	3835852.946	304733.843
Bear Island	100	3835849.711	304719.241
Bear Island	150	3835846.992	304704.394
Bear Island	300	3835836.958	304658.939

^a Coordinate system is UTM, 18N, NAD83, meters as collected with Trimble Pro XR GPS unit.

Each quadrat was sampled for stem density and mature height of *Spartina* sp. Stem density was quantified by tallying stems of *Spartina* sp. located within the boundaries of each quadrat. Dead stems of *Spartina* sp. were not tallied. The number of stems below the mature (<30 cm in height) *Spartina* sp. stem height were tallied and then subtracted from the total stem density to quantify mature stems of *Spartina* sp. Percent mature stems of *Spartina* sp. were calculated for each quadrat. Estimated percent cover was also recorded for each quadrat.

2.2 Sediments

Surface sediments were collected from the 5, 50, 100, 150, and 300-foot quadrat locations along each transect to determine percent organic content. Samples were collected to a depth of 15cm (10cm in diameter) and then placed in standard soil sample bags. Samples were placed on ice within 4 hours of collection and shipped to Coastal Planning and Engineering on 11 September 2003. Samples were analyzed by a certified testing laboratory (GFA International) for percent organic content.

Analysis of percent organic content required preparing a 100g representative sample taken from a thoroughly mixed portion of the material and dried in an oven at 230°F ($\pm 9^\circ$ F) to constant temperature. The sample was removed from the oven, placed in a desiccator, and allowed to cool. A sample weighing approximately 10 to 40g was placed into an evaporating dish and weighed. The dish was then placed into a muffle furnace for 6 hours at a temperature of 833°F ($\pm 18^\circ$ F). The sample was removed, allowed to cool, and then weighed. The organic content is expressed as a percentage of the mass of the oven dried soil and was calculated as follows:

Percent Organic Content = $(A-B/A-C) \times 100$, where:

A = mass of evaporating dish and oven dried soil before ignition

B = mass of evaporating dish and oven dried soil after ignition

C = mass of evaporating dish

In addition to collection of sediment samples, graduated PVC piping was installed at each quadrat during September 2003 to serve as a tool for evaluating sediment deposition and/or erosion through the course of the project. Six-foot sections of PVC piping were installed to expose 3 to 4 feet of the pole above the existing surface substrate. Total pole length above the surface substrate was measured and permanent graduated notches were made on the pole every 6 inches beginning at current substrate surface (Table 2).

2.3 Wildlife Utilization

Direct visual observations and indirect evidence, such as fiddler crab burrows, were used to document the presence of epibenthic macroinvertebrates and wildlife along separate transect corridors. Each transect corridor was three feet wide and extended 150 feet from the edge of the marsh, roughly perpendicular to the channel and parallel to the

Table 2. Measurements of PVC pole length above existing surface substrate for Bogue Inlet, Dudley Island, and Bear Island saltmarsh monitoring transects and sampling quadrats.

Transect	Distance from marsh edge (ft)	Above ground pole length (in)
Bogue Inlet	5	36.5
Bogue Inlet	50	49.5
Bogue Inlet	100	37
Bogue Inlet	150	34
Bogue Inlet	300	41
Dudley Island	5	37.25
Dudley Island	50	42
Dudley Island	100	37
Dudley Island	150	41.25
Dudley Island	300	38
Bear Island	5	58
Bear Island	50	36.75
Bear Island	100	36.5
Bear Island	150	37.5
Bear Island	300	36.5

saltmarsh vegetation/sedimentation monitoring transect. Separate control transect corridors (150 feet by 3 feet) were established parallel to the channel and intersect the 150-foot quadrat location (Figure 2). Representative epibenthic macroinvertebrate samples were collected in the field and later identified in the lab.

3.0 RESULTS

3.1 Marsh Monitoring

The only species of *Spartina* encountered within the three saltmarsh monitoring transects was *Spartina alterniflora*. Other species such as, *Spartina patens*, *Borrchia frutescens* and *Salicornia* sp. also occur in the vicinity of the transects where elevations are slightly higher.

Spartina sp. stem density (number of stems per square meter) within the transects ranged from 24 individual stems at Bogue Inlet to 200 stems at Dudley Island (Table 3). Percent mature stems were the highest at the Bear Island (control site) monitoring transect, with 100% mature stems at two quadrats. The largest percentage of *Spartina* cover within a sampling quadrat occurred at both Bogue Inlet and Dudley Island with 90% vegetation cover.

Bogue Inlet saltmarsh monitoring transect contained two small estuarine channels, one at the 100-ft quadrat and the other at the 300-ft quadrat. Quadrat sampling resulted in an increase in stem density away from the marsh edge with 79 stems (92% mature) within the 5-ft quadrat to 123 stems (93% mature) within the 50-ft quadrat and then a subsequent decrease in stem density with 24 stems (67% mature) at the 100-ft quadrat (Table 3). Stem density is augmented in the 150-ft quadrat with 75 stems (91% mature). The 300-ft quadrat occurs at the edge of an estuarine channel where 32 stems (20% mature) are present. Percent vegetation cover was high within the 5-ft and 50-ft quadrats, with 90% and 85% respectively, and then decreased to 40% within the 100-ft quadrat close to the estuarine channel. The 150-ft quadrat contained 70% cover and the 300-ft quadrat adjacent to the channel, contained less *Spartina* with a 20% cover.

Dudley Island transect showed a distinct pattern different from the Bogue Inlet transect in that stem density and percentage of mature stems were relatively constant along the monitoring transect except at the 300-ft quadrat adjacent to an estuarine channel that intersects between the 150-ft and 300-ft quadrats. Stem density increased from the marsh edge with 120 stems (98% mature) at the 5-ft quadrat to 142 stems (75% mature) at the 50-ft quadrat, to 200 stems (64% mature) at the 100-ft quadrat (Table 3). Stem density decreased slightly at the 150-ft quadrat with 155 stems (0% mature). The 300-ft quadrat declined in density with 91 stems (100% mature). Percent vegetation cover followed a similar pattern as stem density with 50% at the 5-ft quadrat, 70% at the 50-ft quadrat, 90% at the 100-ft quadrat, 75% at the 150-ft quadrat, and 50% at the 300-ft quadrat.

Table 3. Stem density, mature stems, percent mature stems and percent vegetation cover of *Spartina alterniflora* and percent organic content in soils from Bogue Inlet, Dudley Island, and Bear Island saltmarsh monitoring transects during September 2003.

Quadrat distance from marsh edge (ft)	5			50			100			150			300		
Transect	Bogue	Dudley	Bear	Bogue	Dudley	Bear	Bogue ^a	Dudley	Bear	Bogue	Dudley	Bear	Bogue ^a	Dudley ^a	Bear ^a
Stem density (<i>Spartina alterniflora</i>)	79	120	80	123	142	90	24	200	70	75	155	68	32	91	50
Mature stems (#of stems>30 cm)	73	118	80	114	107	90	16	128	64	68	0	63	19	91	49
Percent mature stems	92	98	100	93	75	100	67	64	91	91	0	93	59	100	98
Percent cover	90	50	75	85	70	85	40	90	70	70	75	75	20	50	60
Percent organic content in soils ^b	14.1	14.3	12.0	15.6	10.0	12.1	12.4	9.9	9.6	19.0	12.9	11.9	13.8	17.5	15.1

^a Quadrat near small estuarine channel.

^b Analyzed by GFA International.

Bear Island, which serves as a control transect, followed a similar pattern to the Dudley Island transect. Stem density and percent mature stems were relatively constant along the monitoring transect except at the 300-ft quadrat adjacent to an estuarine channel that intersects between the 150-ft and 300-ft quadrats. The 5-ft quadrat contained 80 stems (100% mature), 90 stems (100% mature) within the 50-ft quadrat, 70 stems (91% mature) within the 100-ft quadrat, 68 stems (93% mature) within the 150-ft quadrat and 50 stems (98% mature) within the 300-ft quadrat. Vegetation cover was similar throughout the transect, however, it declined in the 300-ft quadrat, adjacent to a small estuarine channel, with 60% cover (98% mature).

3.2 Sediments

Sediment samples were analyzed for percent organic content ranging from 9.6% organics at the Bear Island transect to 19.0% at the Bogue Inlet transect. Average percent organic content from each transect was 15.04 at Bogue Inlet, 12.92 at Dudley Island, and 12.14 at Bear Island. Results of the soils analysis are found in Table 3.

In addition to collection of sediment samples, PVC piping was installed prior to construction to evaluate sediment deposition and/or erosion over time for each plot or quadrat. The surface substrate will be compared to pole measurements during the next sampling period in order to compare and evaluate sediment deposition or erosion.

3.3 Wildlife Utilization

Epibenthic macroinvertebrate species as well as evidence of wildlife were observed during the sampling period in September 2003 for each saltmarsh monitoring transect. Seven epibenthic macroinvertebrate species were noted and identified among the three transects (Table 4). The same species, except for the striped hermit crab, were noted from both sampling corridors at each transect.

Five species of epibenthic macroinvertebrates were identified within the Bogue Inlet transects; striped hermit crab (*Clibanarius vittatus*), American oyster (*Crassostrea virginica*), Atlantic ribbed mussel (*Geukensia demissa*), marsh periwinkle (*Littorina irrorata*), and wharf crab (*Sesarma cinereum*). Wharf crab burrows were the most numerous in the transect perpendicular to the channel and decreased in number in the control. Population density of the marsh periwinkle was scattered. An abundant oyster and mussel strata occurs at the marsh edge to approximately 50 to 75 feet into the marsh. Estuarine channels provide habitat for blue crabs (*Callinectes sapidus*) as well as juvenile fish species. The striped hermit crab was collected within the control transect. Bird species noted included clapper rail (*Rallus longirostris*) snowy egret (*Egretta thula*), great egret (*Casmerodius albus*), and great blue heron (*Ardea herodias*).

Four species of epibenthic macroinvertebrate were identified within the Dudley Island transect, American oyster, Atlantic ribbed mussel, marsh periwinkle and sand fiddler crab (*Uca pugilator*). Fiddler crab burrows were abundant. Sand fiddler crabs

Table 4. List of epibenthic macroinvertebrate species noted (x) from Bogue Inlet, Dudley Island, and Bear Island sampling transects during September 2003.

Species Name	Common Name	Bogue Inlet		Dudley Island		Bear Island	
		Transect	Control	Transect	Control	Transect	Control
<i>Clibanarius vittatus</i>	Striped hermit crab	-	x	-	-	-	-
<i>Crassostrea virginica</i>	American oyster	x	x	x	x	x	x
<i>Geukensia demissa</i>	Atlantic ribbed mussel	x	x	x	x	x	x
<i>Ilyanassa obsoleta</i>	Mud snail	-	-	-	-	x	x
<i>Littorina irrorata</i>	Marsh periwinkle	x	x	x	x	x	x
<i>Sesarma cinereum</i>	Wharf crab	x	x	-	-	-	-
<i>Uca pugilator</i>	Sand fiddler crab	-	-	x	x	x	x

and marsh periwinkle snails were observed feeding on the marsh sediment and *Spartina* leaf blades along the entire corridor. There were very few to scattered oyster, mussel, and non-living scallop shells. Juvenile fish species and mummychugs (*Fundulus heteroclitus*) were observed in the small estuarine channel adjacent to the 150-ft quadrat. Various bird species such as the clapper rail, snowy egret, great egret, and great blue heron were also noted in the vicinity of this transect.

Five species of epibenthic macroinvertebrate were identified within the Bear Island transect; American oyster, Atlantic ribbed mussel, mud snail (*Ilyanassa obsoleta*), marsh periwinkle, and sand fiddler crab. Few fiddler crabs and burrows and marsh periwinkle snails were observed due to the high percentage of mature stems and density of *Spartina*. Mussels and oysters were observed throughout each transect, however, were more abundant in the estuarine channel adjacent to the 150-ft quadrat. Blue crabs and juvenile fish species were observed. Various bird species such as the clapper rail, snowy egret, great egret, and great blue heron were also noted in the vicinity of this transect.

4.0 SUMMARY

4.1 Marsh Monitoring

The Bogue Inlet and Bear Island transects were dominated by tall-form *Spartina alterniflora* (1-2m tall) which is typical of marsh areas that are flooded daily by tides. A higher percentage of mature stems were found in portions of the transects that appeared to be exposed to higher tidal amplitudes. Dudley Island is co-dominated by the short-form *S. alterniflora* (<0.5m tall) which is typical of higher tidal heights. Evidence of sand overwash was observed during the sampling period which may contribute to higher elevations and smaller flooding depths. The type of *S. alterniflora* form appears to affect stem density, percent of mature stems, and vegetation cover for each plot which appear to be influenced by various factors such as flooding and elevation. Estuarine channels also appear to be a factor in stem density and vegetation cover due to the amount of sediment deposition from receiving waters.

4.2 Sediments

Sediments within the Bogue Inlet study area are dominated by soils such as Carteret (Typic Psammaquent) and Bohicket (Typic Sulfaquent) (Soil Conservation Service 1978 and 1992). Collection of sediment samples during the next sampling period will provide organic content percentages which will aid in yearly comparisons.

Coupled with rising sea level, tidal sedimentation contributes to a rise in the marsh surface and landward migration of the marsh (Shafale and Weakley 1990). The Bogue Inlet and Dudley Island monitoring stations are in close proximity to Bogue Inlet and may receive higher tidal fluctuations which may contribute to a dynamic fluctuation in sedimentation and/or erosion. Bear Island serves as a control due its geographical

location behind the protection of Hammocks Beach State Park and may not receive as much tidal fluctuation and therefore less sediment availability.

4.3 Wildlife Utilization

Numerous species of benthic and epibenthic macroinvertebrate species may be observed within saltmarsh habitats. Mobile species, such as crabs, fish, snails and birds are difficult to observe and enumerate. Additional collection and identification during the next sampling period may supplement the species list.

5.0 REFERENCES

Soil Conservation Service. 1978. Soil survey of Carteret County, North Carolina. U.S. Department of Agriculture.

Soil Conservation Service. 1992. Soil survey of Onslow County, North Carolina. U.S. Department of Agriculture.

Shafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina, 3rd Approximation. North Carolina Natural Heritage Program Division of Parks and Recreation, NC Department of Natural Resources