BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

BOEM OCS Region: Gulf of Mexico

Planning Area: Central

Title: Forcing Functions Governing Salt Transport Processes in OCS Navigation Canals and the Surrounding Wetland Landscape, Utilizing Houma Navigation Canal (HNC) as a Surrogate Canal (GM-10-01)

Total Cost: $278,532.00 **Period of Performance:** FY 2010-2012

Conducting Organization: U.S. Geological Survey, National Wetlands Resource Center

BOEM Contact: Arie Kaller

Description:

Background: BOEM (formerly MMS) has funded and completed several studies dealing with the canal widening and land loss issues. The first study entitled "The Outer Continental Shelf (OCS) – Related Pipelines and Navigation Canals in the Western and Central Gulf of Mexico: Relative Impacts on Wetland Habitats and Effectiveness of Mitigation" was completed in 2007. This was a comparative study that basically identified localized loss rates and patterns within the vicinity of OCS pipeline and navigation canals and compared them to regional loss patterns in various sub areas (Chenier plain, Delta plain etc.) of the central and western planning areas and how they responded over time with and without mitigation.

A second study entitled "Influence of the Houma Navigation Canal on Salinity Patterns and Landscape Configuration in Coastal Louisiana" was completed in 2008 and evaluated the extent that OCS activity on waterways and navigation canals have contributed to changes in salinity and wetland landscape patterns in coastal Louisiana. This study examined the patterns of marsh deterioration as a function of hydrological connectivity to higher salinity waters. No direct relationship was established due to variability of marsh loss adjacent to HNC (3KM buffer), lack of current data and models. While there may be some influence on marsh degradation from the canal the degree and distance of the influence was not detectible. While both studies provide insight and perspective into the salinity/land loss relationship both studies relied on old empirical data and photo and thematic mapper satellite imagery comparisons to piece together the salinity and land loss correlations. Detailed salinity and current velocity data collected over a wide range of runoff and tidal conditions in navigation channels that convey OCS-related traffic are currently lacking. These data can shed light on circulation and mixing dynamics that occur in these channels, and how those dynamics interact with freshwater inputs, tidal processes, and shelf salinities to govern saltwater intrusion in the channel. These data can also be used to develop improved analytical and numerical models that can better predict the behavior of navigation channels over a wider range of conditions.

The basic understanding of processes that govern saltwater intrusion, and how they vary through time and space, is essential if we are to understand how OCS vessel traffic modulates salt transport processes through these channels.

Objectives: The primary study objective is to document the behavior of the salt wedge in the canal, characterize its spatial and temporal extent and determine how external factors (tidal variability, freshwater inputs, and vessel traffic) influence its movements.

The secondary objectives would be to determine the degree to which hydrologic connectivity with the HNC may influence salinities in the surrounding marshes, and also to examine the degree to which OCS vessel traffic on the HNC may directly augment the channel's influence on surface water salinities in the surrounding marshes.

The final objective is to prepare a data synthesis and analysis that can be utilized to determine if 1) channel induced salinity increases occur in the adjacent wetlands and 2) if these salinity increases occur, are they significantly higher than salinities experienced under normal weather and tidal events in these areas.

Methods: Three approaches will be used to determine the extent of the salt wedge and the dispersion and mixing dynamics that cause it to form and dissipate. First, acoustic doppler current profilers (ADCPs) will be deployed in the bottom of the canal at up to three different locations along the length of the canal.

Second, synoptic (hourly) measurements of current velocity and salinity vertical profiles will be taken over individual tidal cycles (25 hours) during combinations of a) high freshwater inputs/low tidal stirring, b) high freshwater inputs/high tidal stirring, c) low freshwater inputs/low tidal stirring, and d) low freshwater inputs/high tidal stirring. Current velocity profiles will be made with a bottom-tracking, boat-mounted ADCP, and salinity profiles will be obtained with a conductivity-temperature-depth (CTD) profiler.

Third, casting of CTD profilers at numerous (~20) locations along the length of the channel will be conducted approximately monthly over the course of at least one year. In addition to the CTD profiles described above, influences of vessel traffic on salinity stratification will be assessed by obtaining CTD profiles immediately prior to OCS vessel passages, and repeated CTD (approximately every 2 minutes) casts will be made after passage for 30 minutes to determine the degree that vertical mixing driven by vessel passage may occur, and timescale and degree to which re-stratification may occur. In addition to the CTD profiles described above, influences of vessel traffic on salinity stratification will be assessed by obtaining CTD profiles immediately prior to OCS vessel passages, and repeated CTD (approximately every 2 minutes) casts will be made after passage for 30 minutes to determine the degree that vertical mixing driven by vessel passage may occur, and timescale and degree to which re-stratification may occur.

Two approaches will be used to examine the relationship of salinity in the HNC with surface water salinity in fringing marshes. First, salt flux between the HNC and fringing marshes that occurs through breaches in the HNC channel banks will be monitored by

taking hourly measurements of salinity and velocity with logging acoustic doppler velocimeters (ADVs) and CT probes.

A second approach to understanding HNC channel influences on fringing marshes will involve examining variability of fringing marsh surface water salinity variability in relation to salinity variations in the HNC. Hourly time series of salinity will be obtained in the channel and at multiple (3-5) sites in the fringing marsh along a transect of increasing distance from breaches in the channel bank that are suspected conduits for saltwater intrusion.

To date findings indicate current velocity data at HNC station near the Gulfward end of the canal exhibits two dominant modes of variability – a depth-independent barotropic mode and a depth-dependent flow where outflow occurs near the surface and inflow occurs near the bottom. This depth-dependent flow is likely baroclinic estuarine circulation driven by a horizontal density gradient present in the system. Salinity stratification at site two occurs over two dominant time scales. First, over roughly fortnightly (13.6 days) timescales, brief episodes of stratification tend to occur. These episodes are short-lived (1-2 days), and always coincide with equatorial tides, when tidal stirring power is minimal. Also, over diurnal timescales, very brief (1-2 h) episodes of stratification tend to develop during tropical tides when tidal stirring power is at its maximum. These events occur immediately after the slack tide, when tidal currents, and hence stirring power, are minimal. Transects along the length of the channel indicate that the HNC tends to be more stratified during equatorial tides. Relationships between salinity structure along the HNC and Atchafalaya River discharge may exist, but are not apparent yet as little variability in Atchafalaya River discharge has occurred to date in this study. We anticipate encountering this variability in the coming months in the spring, as we are beginning the typical high-flow period for the river.

Products: Quarterly Reports, Technical Summary, Final Report, Digital Copies of Reports

Importance to BOEM: To accurately determine the affect of OCS activities (specifically vessel traffic) on canal widening and its contribution to wetland loss in the coastal zone. Baseline salinity behavior must be established in these canals in order to determine if OCS activities alter this behavior in a way that may induce canal widening and eventual wetland loss.

Current Status: Awarded December 17, 2009. The original timeline outlined in the subject Interagency Agreement stated that all data collection would be completed by March 31, 2011. Due to weather and various issues in the field (equipment malfunction, stations destroyed by vessel traffic, etc), the researcher was unable to complete all data collection by the original March 2011 target. The time-series data collection for the project was just recently completed (September 2011), and there is still some remaining sampling to conduct related to the effects of large vessel wakes on salt transport through side channels that connect the HNC to the surrounding marshes. This sampling is scheduled December, 2011. To ensure that sufficient time exists for data analysis and

report preparation, there is a no-cost extension of the study, from the original date of December 31, 2011 to September 30, 2012.

Final Report Due:	September 2012
Publications:	none
Affiliated WWW Sites:	none
Revised date:	December 2011
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