Assessment and Evaluation of Soil Physical and Chemical Properties of Dredged Material in Constructed Wetland

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Introduction

The use of dredge materials for marsh creation has proven to be a sound and economical approach for coastal restoration capable of restoring large areas of deteriorated marsh. In the absence of any soil contamination, the success of created marshes to meet or exceed their targeted objectives is primarily a function of project design, physical and chemical properties of dredged material and the restored marsh surface elevations. The rapidity of vegetative establishment following restoration is generally governed by availability of in-situ foundation plant materials that serve as nursery plants and also whether introduced planting of foundation materials is included in the restoration effort.

Coastal restoration using sediment mined from relic soil-banks, sediment landfills, or near-shore dredged sediments have become increasingly more common in marsh restoration construction. However, there is inadequate information on the physical and chemical properties and vegetative performance of dredged sediments, particularly as related to plant recruitment, productivity, and near-term sustainability. A limited understanding of how sediment depth and elevation can affect the hydrologic and edaphic environments is a major constraint to successful plant establishment and natural plant recruitment. Too little sediment may have no beneficial effect, while too much sediment may detrimentally modify the hydrology-soil-vegetative dynamics essential for maintenance, self-regulation, and sustainability of these systems. Only with a better understanding of the hydrologic and edaphic environments, that control successful wetlands sustainability, will restoration of deteriorating wetlands using dredge sediments be predictable.

Currently, there is an accelerated initiative to restore Louisiana's barrier islands, deltaic and cheniere ridges, as well as bay islands and near-shore interior marshes. Marshes and swamps being the major wetland type in coastal Louisiana. Marshes convert to open water due to many factors, including sea-level rise, sediment starvation, subsidence, salinity and change in hydrology and soil chemistry. Conversion of wetlands for agricultural and industrial uses have also played a major role in the wetland loss (Coleman et al., 2008). Fresh water and sediment input are critical factors for use in combating coastal marsh loss (Day et al., 2000). Accumulation of organic matter is also important with maintaining marsh elevation (Nyman et al., 2006; Craft, 2007).

Regional long-term processes, such as down-warping because of sedimentary loading and global sea-level rise, along with regional short-term processes (i.e. the change in location of delta formation, compaction, dewatering, and oxidation of coastal fine-grained and organic-rich sediments) in addition to human modification of the riverine system also contribute to wetland loss. Local short-term processes including those of a catastrophic nature (hurricanes), those of a biologic nature, and human nature also contribute to losses. Many researchers have noted the complex physical and biogeochemical processes governing wetland loss (Turner and Cahoon, 1987). Increasing salinity associated with salt water intrusion is one major cause for wetland loss. Salt water extending into the brackish and fresh marshes impacts vegetation resulting in collapse of the organic peat layer (DeLaune et al., 1994) creating more open water (Craig et al., 1979; Van Sickle et al., 1976, Gagliano et al., 1970).

Management of salt-affected soils

The table below provides information that is helpful in evaluating problems with salt-affected soils and in identifying appropriate management practices. Having long-term data on how the soil has changed over time is essential to making well-informed decisions about irrigation water management, rates and types of soil amendments, and the probability of positive economic returns from managing salt-affected soils. Once the necessary soil test and field history has been collected and assessed, the next step is to identify economical options for reclamation. Salt-affected soils will need management and careful monitoring to achieve reclamation.

Table 1. Typical characteristics of saline, sodic and saline-sodic soils

Classification	Electrical Conductivity (millimhos/cm or mS/cm)	Soil pH	Exchangeable Sodium percentage (%)	Sodium Absorption Ratio	Soil Physical Condition
Saline	>4.0	<8.5	<15	<13	Normal
Sodic	<4.0	>8.5	>15	>13	Poor
Saline-Sodic	>4.0	<8.5	>15	>13	Normal

Source: NDSU Extension Service; Managing Saline Soils in North Dakota, Revised, David Franzen, 2007.

In soils suspected as being saline or affected by sodium, the extent of the problem and its management are difficult to determine unless the soil is analyzed using laboratory procedures. Soil salinity can be diagnosed by measuring the salt concentration in soil water (solution) by analyzing it for Electrical Conductivity (EC). EC is the ability of a material to transmit electrical current, which in the case of a soil is the result of salt concentration.

The extent of soil sodicity is measured either through its Exchangeable Sodium Percentage (ESP) or Sodium Adsorption Ratio (SAR). Both measure the sodium content of the soils in relation to calcium and magnesium using specific mathematical formulas. Sodic soils are low in total soluble salts but high in exchangeable sodium, which tends to disperse soil particles and destroys soil structure (Management of Saline and Sodic Soils, Kansas State University, 1992). A soil will be interpreted as sodic if it has an Exchangeable Sodium Percentage of 15 or more or have Sodium Adsorption Ratio of 13 or more. Sodic soils often have a pH level of 8.5 or more in carbonate-rich soils, such as in northeastern North Dakota, but may also have very low pH, perhaps as low as 4.0 in southeastern North Dakota in soils with no carbonates. Soils having both salinity and sodicity problems are considered as saline-sodic soils and will have the characteristics of both.

In order to better understand the relationship of plant establishment, growth and development under specific environmental conditions, the physical and chemical properties of dredge material used in marsh restoration must be examined.

OBJECTIVES

The objectives of this research were to: 1) assay and interpret the physical and chemical analyses of all soil samples previously completed by A&L laboratory in 2011; and 2) assist BTNEP project managers in the implementation and analysis of the incomplete 2012, 2013, and 2014 soil sample series. Assessments for both Objectives 1 and 2 included interpreting the physical and chemical property of dredged materials as they relate to plant species selection, establishment, and near-term sustainability.

Study objectives were to complete the two primary tasks conducted over a 12-month period. The LSU AgCenter completed all soil testing using the Soils Testing and Wetland Soil Characterization Laboratories. The Barataria-Terrebonne National Estuary Program (BTNEP) was responsible for collecting soil samples and costs associated with the laboratory analyses.

METHODOLOGY

The total of 264 soil samples that were collected in 2011-2014 were analyzed at the LSU Agricultural Center's Soils Testing and Wetland Soil Characterization Laboratories. The samples were collected from different locations i.e. MA (Mitigation Area), OR (Old Ridge), MR (Middle Ridge) and FR (Far Ridge) (Appendix Table 2-13). The analyses included pH, electrical conductivity (EC), salinity, macro- and micronutrients. Salinity, conductivity, soluble salts, and pH were analyzed using a ratio of 1:2 for dry soil and distilled water. Electrical conductivity measures the ability of soluble salts to conduct electricity in water. The macro and micro nutrients including phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), sodium (Na), iron (Fe), copper (Cu), and zinc (Zn) were analyzed from the water soluble extract of the 1:2 soil and water ratio, and the element concentration was determined using ICP (Inductively Couple Plasma spectrophotometer). Cation Exchange Capacity (CEC) and Sodium Absorption Ratio (SAR) were calculated based on the element analyses. SAR is defined as the ratio of sodium to calcium plus magnesium. The calculations are based on molecular weight of each of the three elements and their respective valence and expressed as milliequivalent (meq). For example, low sodium content in soil or sediment would yield a low SAR value, with a SAR value of less than 13 being desirable. In addition to soil analysis, the test results from the LSU Lab were also compared to the test results of 212 samples that were tested by the A&L Lab for the samples collected from 2008 to 2011. The soil analysis package from the A&L lab included organic matter, cation exchange capacity, pH, soluble salts, and extractable elements i.e. P, K, Ca, Mg, S, Na Zn, Mn, Fe, Cu, boron (B), and nitrate (NO_3^-). Mehlich III (an acid extractant with the mixture of 0.2*N* CH_3COOH + 0.25*N* NH_4NO_3 + 0.013*N* HNO_3 +0.015*N* NH_4F + 0.001*M* EDTA) was used to determine the concentration of extractable elements. The correlation and comparison of the results from both labs were analyzed by averaging the data over 6 different sampling times at the same sampling sites and same parameters. There were only 44 sites that have completed for the analysis in both labs. Graphs were plotted for each important parameter using results from both labs including the correlation coefficient value.

RESULTS

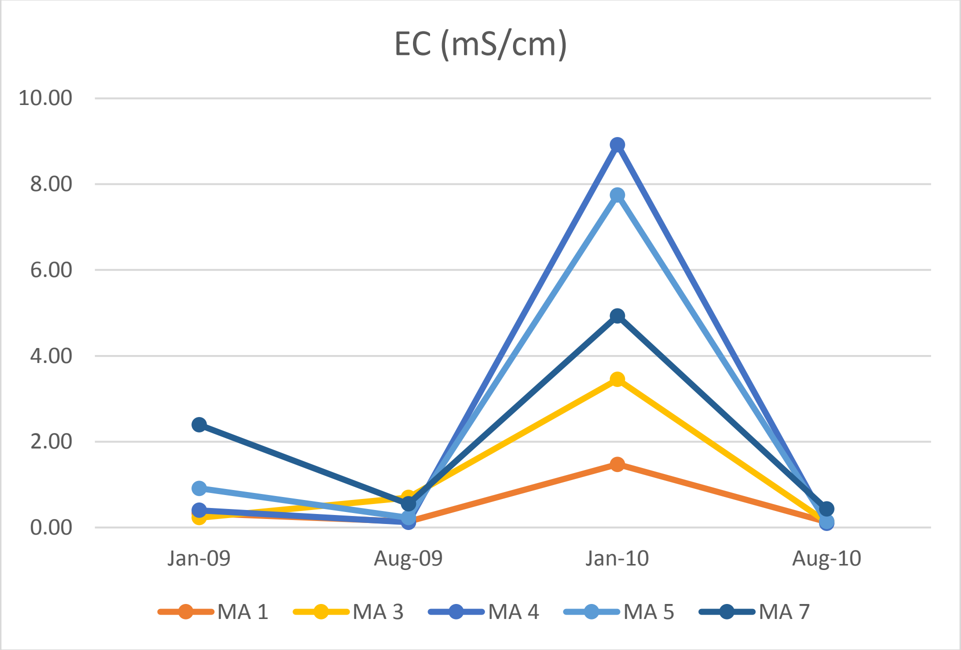
1. **Soil test results from A&L Laboratory for the samples collected from May 2008 to February 2011 (Mehlich III Extraction)**

Soil test package offered from the A&L lab covered most of the important factors for agricultural soil basis i.e. electrical conductivity (EC) organic matter, pH, pH buffer, soluble salts, cation exchange capacity, macronutrient and micronutrient content. Six sampling times were collected from four locations namely; MA, OR, MR, and FR from May 2008 to February 2011. A summary of the soil test results for each sampling date are in Table 2 for the samples collected in May 2008, Table 3 for the samples collected in January in 2009, Table 4 for the samples collected in August 2009, Table 5 for the samples collected in January 2010, Table 6 for the samples collected in August 2010, and Table 7 for samples collected in February 2011. In May 2008 and February 2011, soil samples were collected only from OR and MR locations. In addition to the results in the tables that attached at the end of the report, graphs below show the results of the important elements from Mehlich III extraction. The additional 2 parameter; EC and pH, which were measured in the mixture of soil and water slurry to show the level of salinity in each location.

1.1 Mitigation Area (MA1-MA10), Ten samples were collected from this area. The site is a created marsh initially pumped with sediment in 2001. The samples were collected from 3 landforms: Low ridge (MA1, MA3, MA4, MA5, and MA7); Low Ridge Slope (MA2, MA6, and MA8); and Marsh (MA9 and MA10).

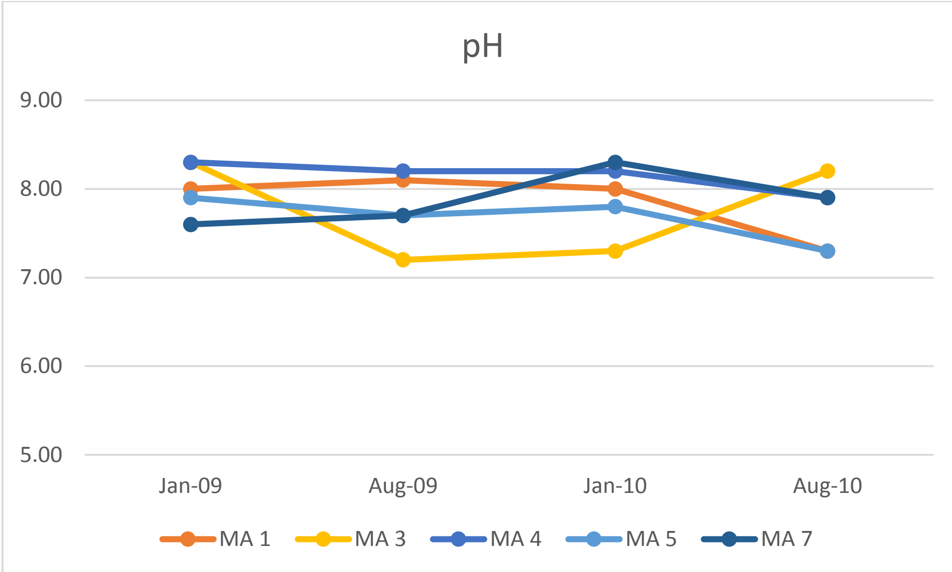
1.1.1 Low Ridge (MA1, MA3, MA4, MA5, and MA7)

1.1.1.1 Electrical conductivity (mS/cm)



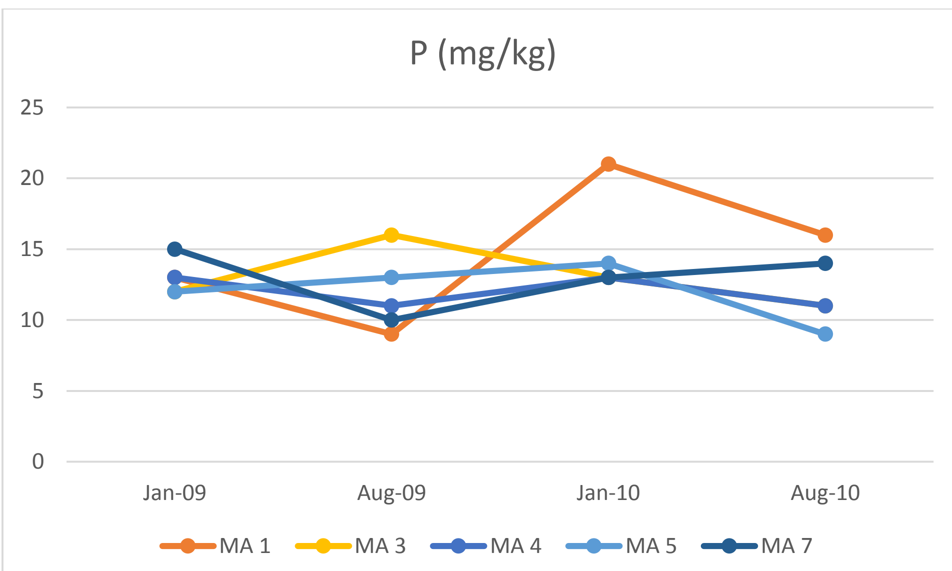
Electrical conductivity for the low ridge ranged from 0.14 to 8.92 milliSiemens/cm (mS/cm). EC for the samples collected in January 2010 were increased significantly as compared to other sampling dates that might be due to weather condition before sampling (such as major hurricanes or long drying period).

1.1.1.2 pH



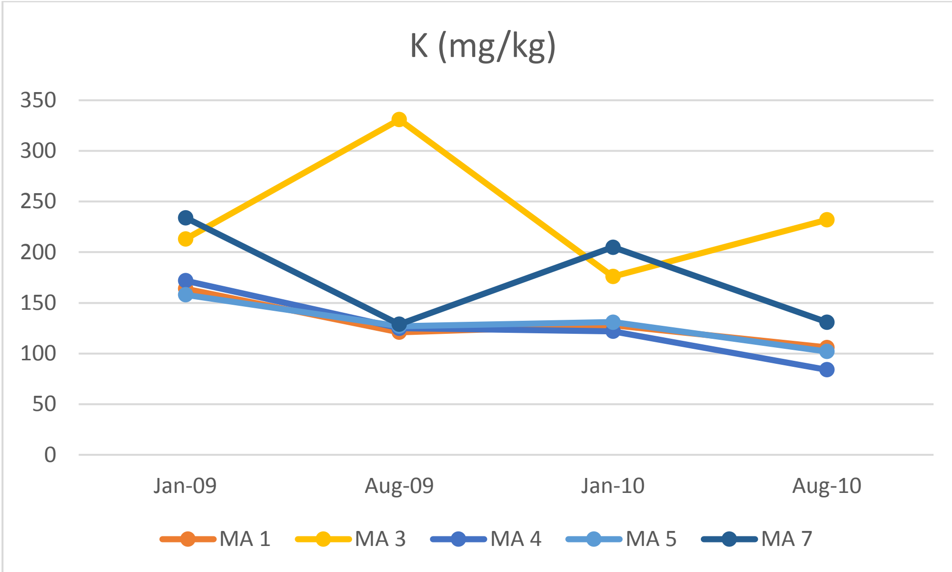
pH was also measured in the soil slurry. It ranged from 7.2 to 8.3, which is common in the saltmarsh area.

1.1.1.3 Extractable P (mg/kg)



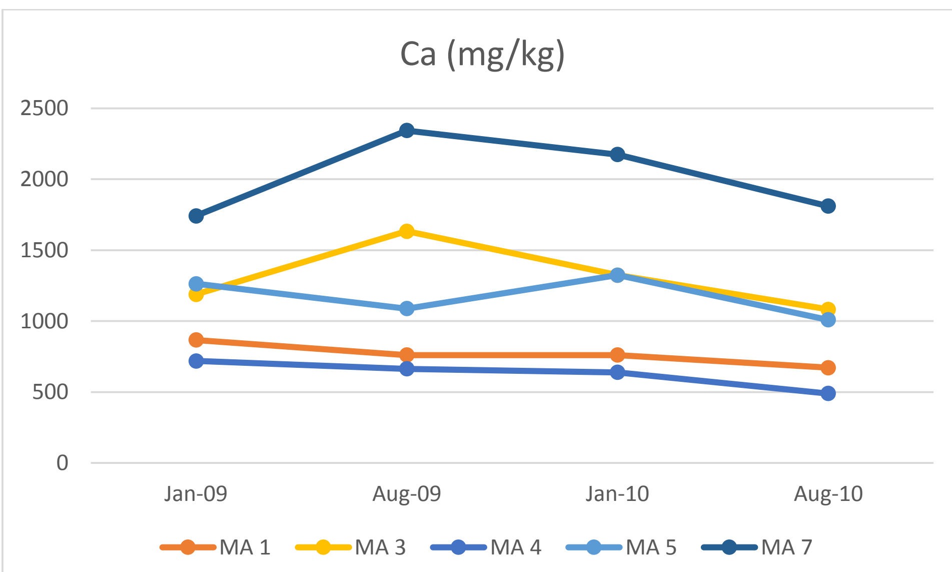
Extractable P was extracted by Mehlich III solution ranged from 9-23 mg/kg.

1.1.1.4 Extractable K (mg/kg)



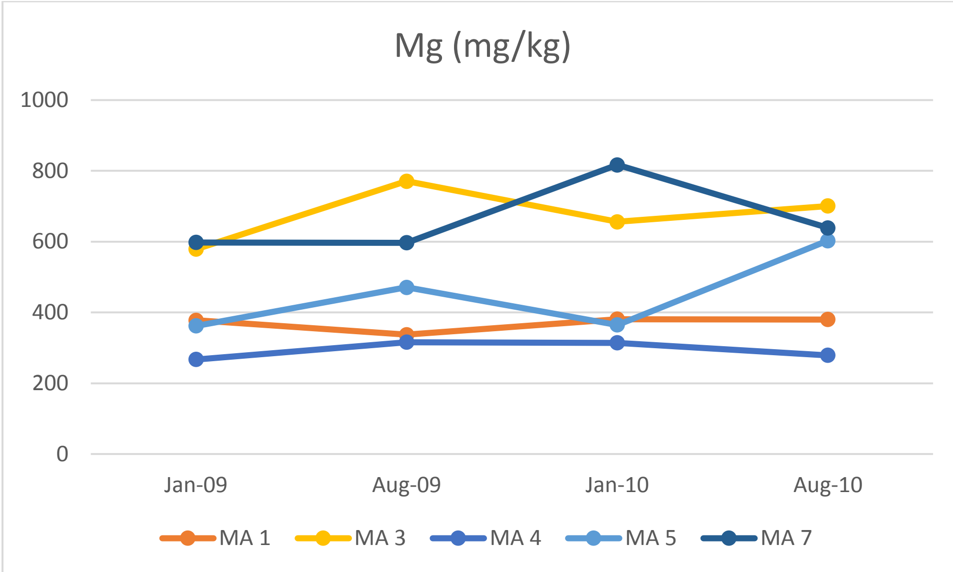
Extractable K ranged from 84 to 331 mg/kg. The lowest was observed in MA4 and the highest was in MA3.

1.1.1.5 Extractable Ca (mg/kg)



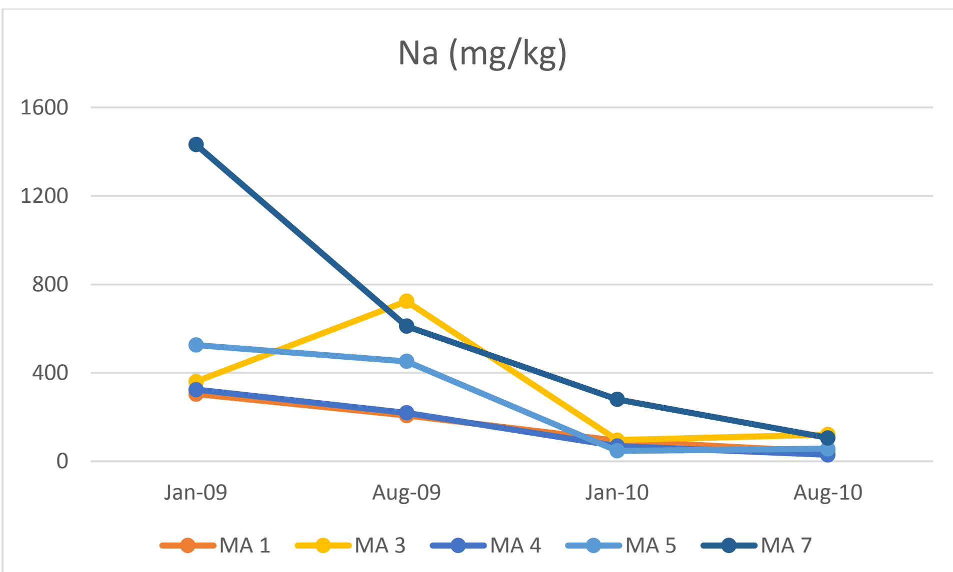
Ca was a dominant cations as compared to K, Mg, and Na for this location. The lowest concentration was found in MA4 and the highest was in MA7. The Ca concentration was influenced by oyster shell at the sites.

1.1.1.6 Extractable Mg (mg/kg)



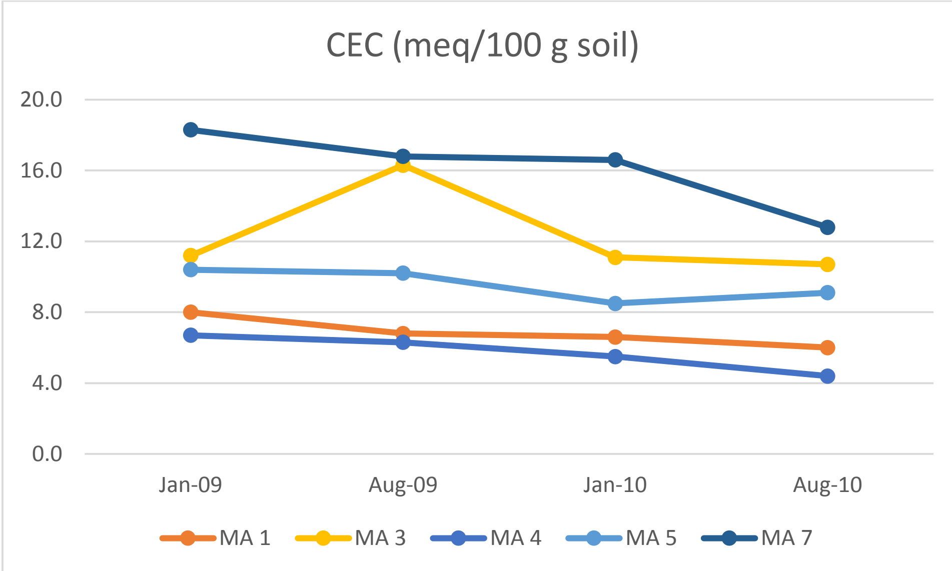
Mg was also similar trend with Ca but in lower level. The lowest was found in MA4 for 267 mg/kg and the highest at MA7 for 817 mg/kg.

1.1.1.7 Extractable Na (mg/kg)



Na usually is a major cation in the soil collected from high salinity environment like saltmarsh. However, at this location the amount of Na was lower than Ca because of the high amount of oyster shell.

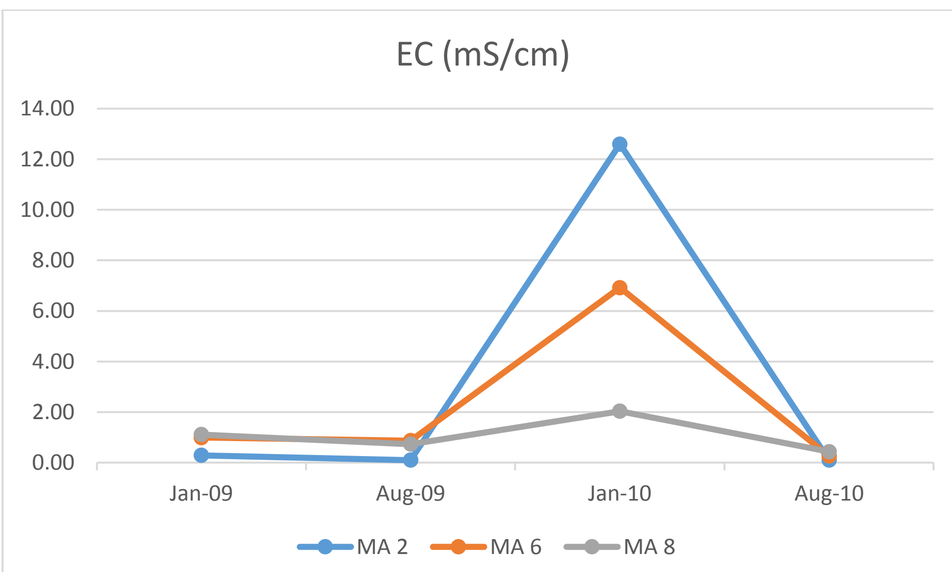
1.1.1.8 Cation exchange capacity (meq /100 g soil)



CEC was highly influenced by the amount of Ca, which was the highest cation concentration in the sites.

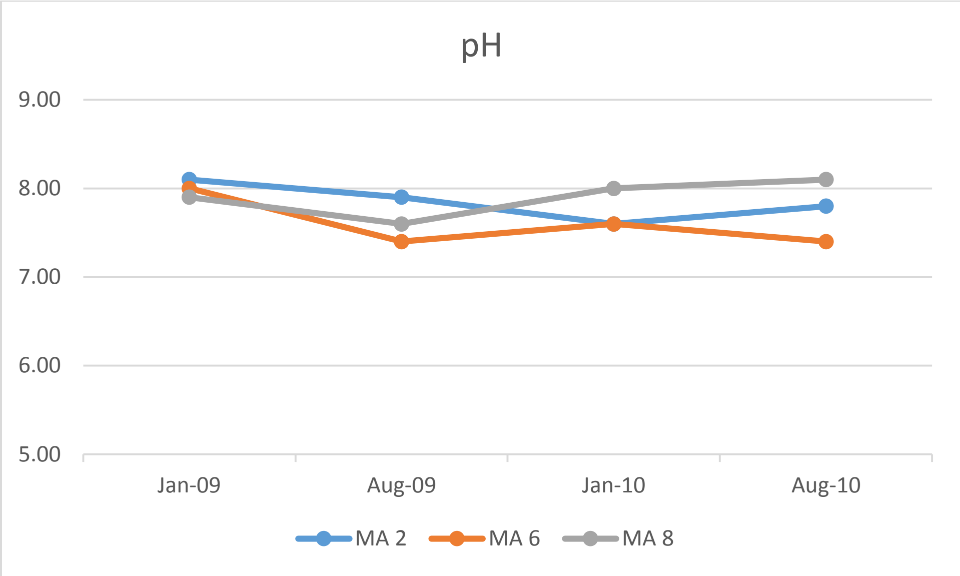
1.1.2 Low Ridge Slope (MA2, MA6, and MA8). The elevation of these three sites were lower than "Ridge Top".

1.1.2.1 Electrical conductivity (mS/cm)



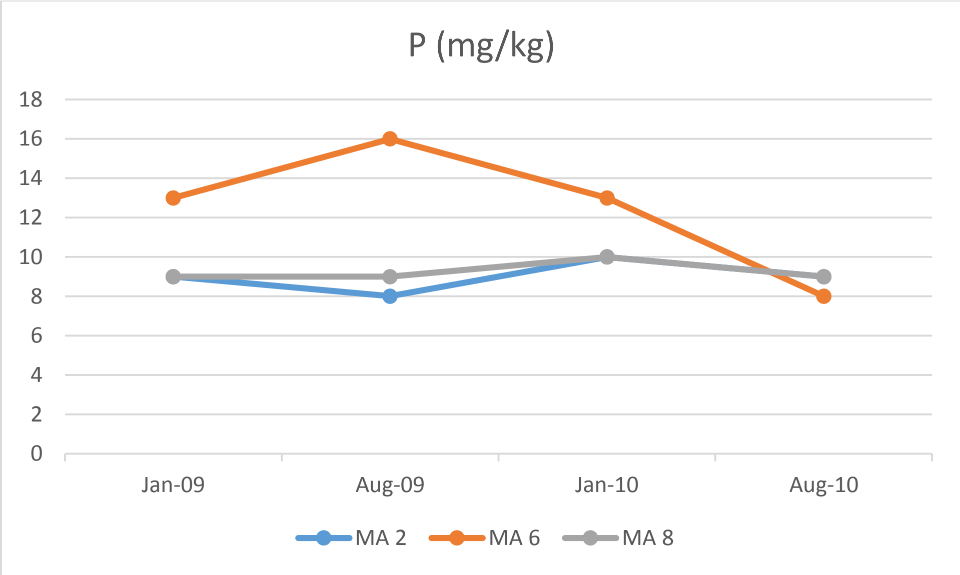
EC for the samples collected in January 2009, August 2009, and August 2010 were lower than 2 mS/cm but it jumped up for the sampling in January 2010 that might be because of weather as described above.

1.1.2.2 pH



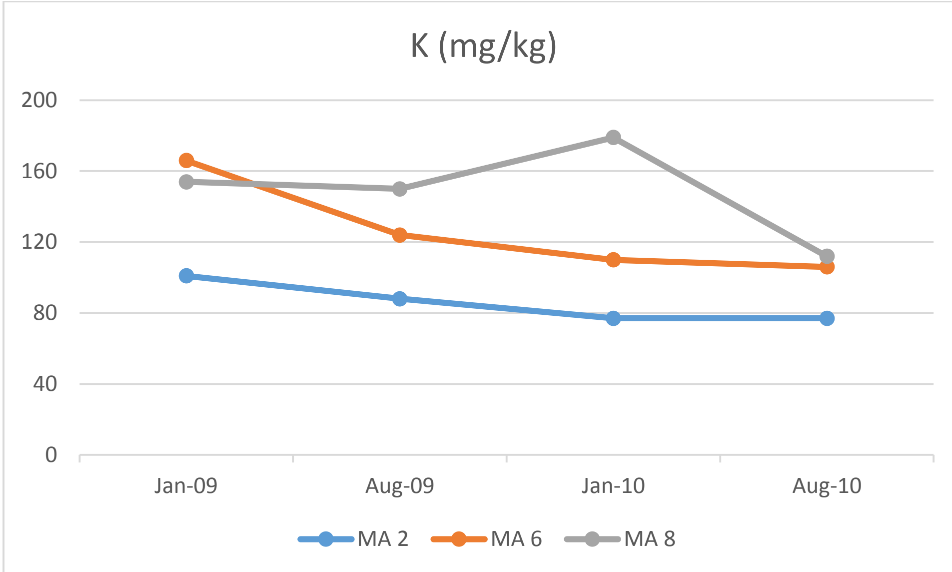
The average pH of these 3 sites was almost same with the Ridge Top. The lowest pH was 7.4 and the highest was 8.1.

1.1.2.3 Extractable P (mg/kg)



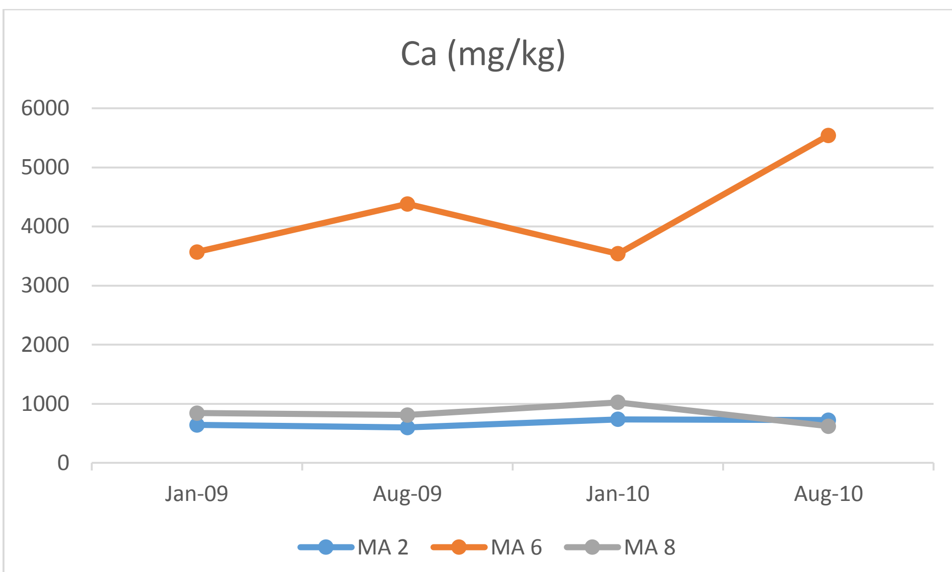
Extractable P ranged from 8 to 16 mg/kg. It was not different between the sampling times for MA2 and MA8 but it was varied by the sampling times in the MA6.

1.1.2.4 Extractable K (mg/kg)



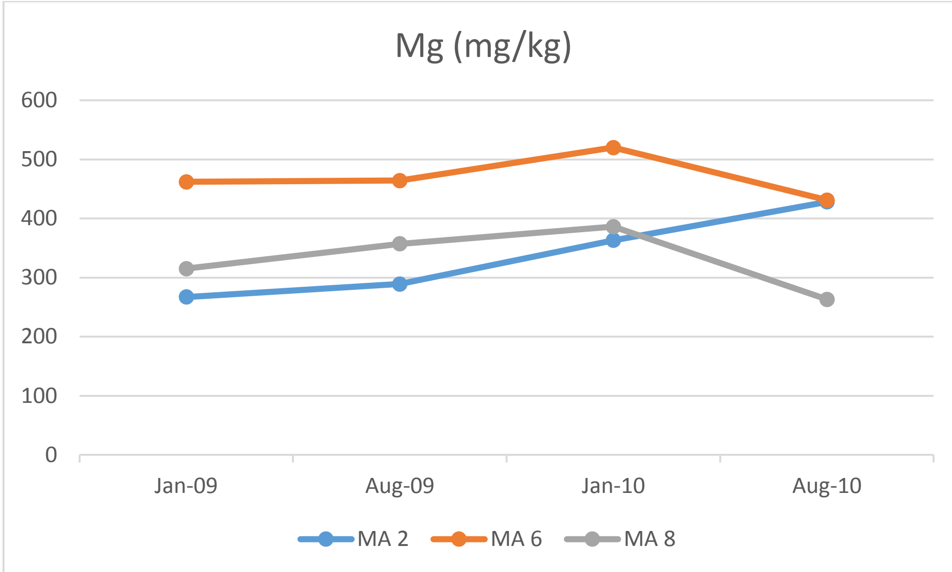
Extractable K ranged from 77 to 179 mg/kg. It was lower than the Ridge Top location.

1.1.2.5 Extractable Ca (mg/kg)



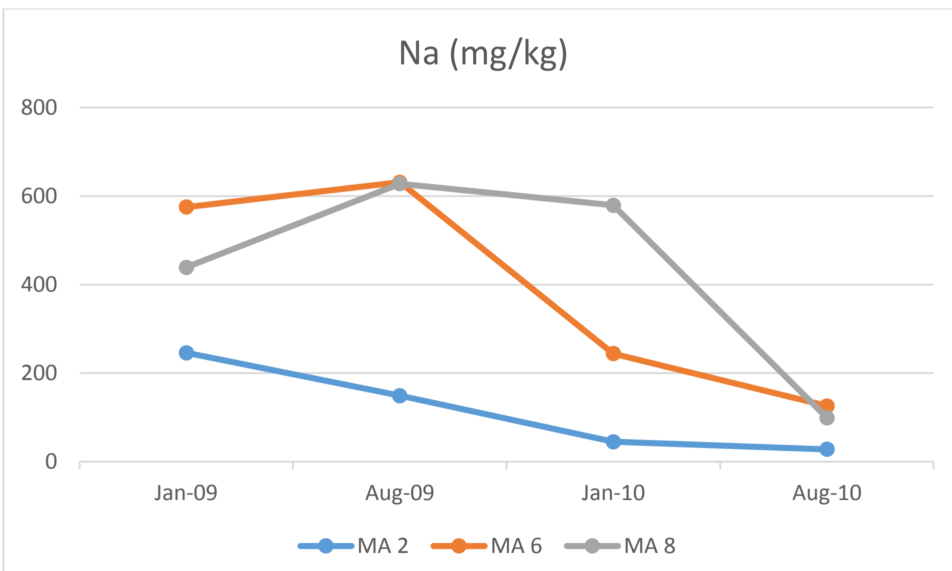
Ca was also high particularly in the MA6 that might be because of the oyster shell in the sample.

1.1.2.6 Extractable Mg (mg/kg)



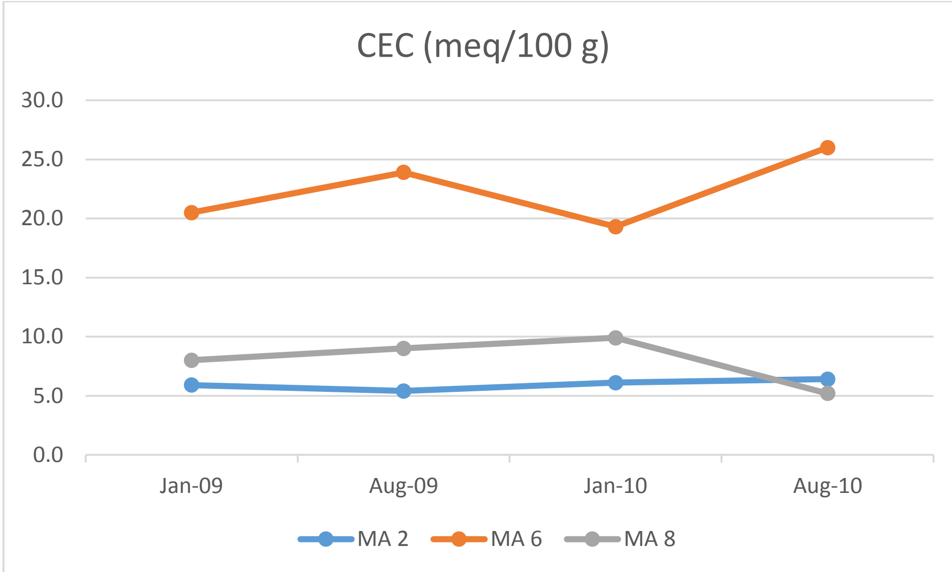
Mg ranged from 263 to 520 mg/kg. The highest concentration was observed in the MA6.

1.1.2.7 Extractable Na (mg/kg)



Na was dropped by time. The lowest was 28 mg/kg in MA2 and the highest was 631 mg/kg in MA6.

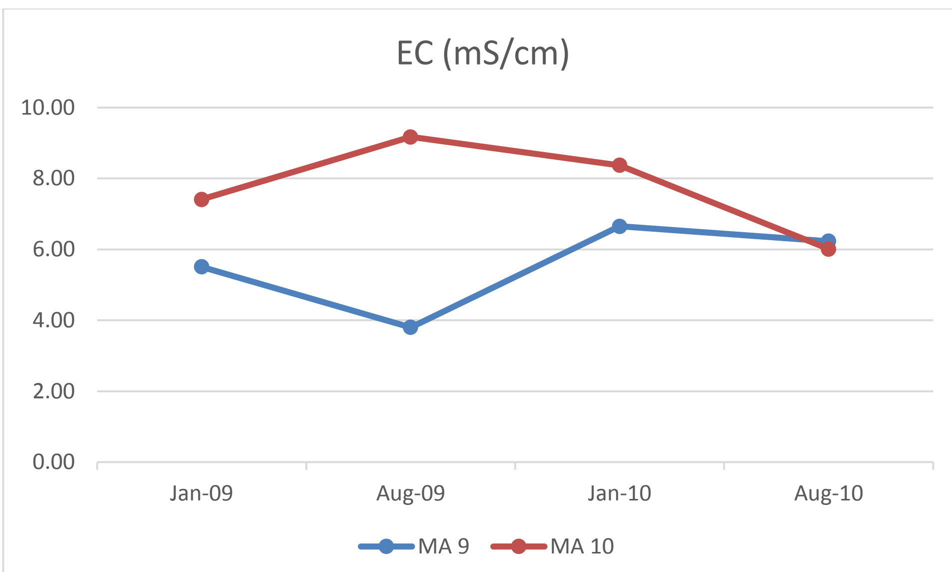
1.1.2.8 Cation exchange capacity (meq/100g soil)



CEC was highly affected by the concentration of Ca which was the highest concentration of the cations in this area.

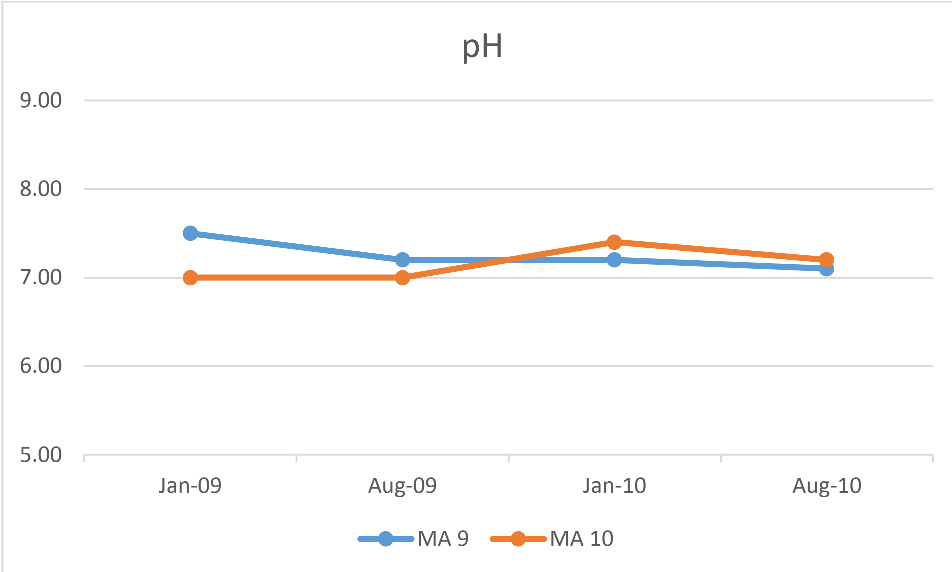
1.1.3 Marsh (MA9 and MA10)

1.1.3.1 Electrical conductivity (mS/cm)



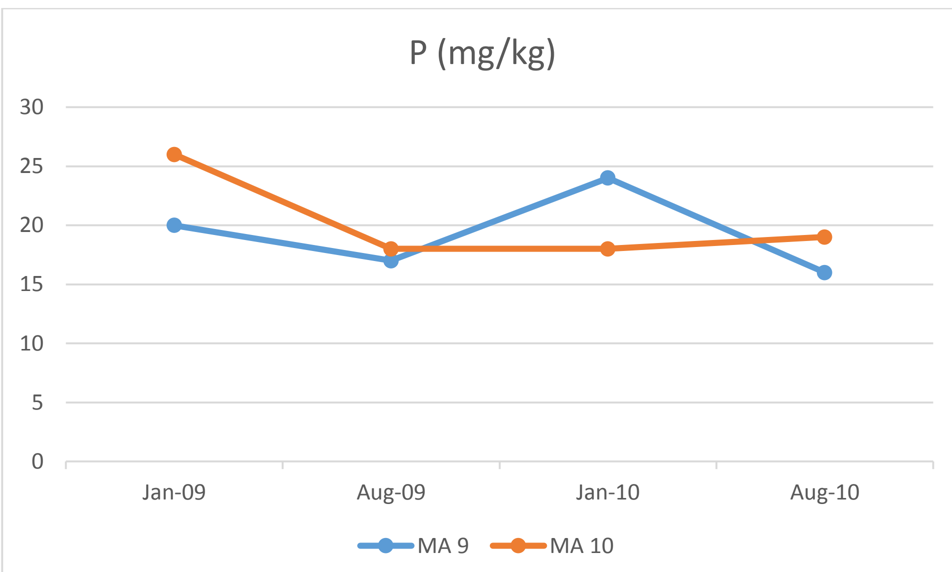
EC in the marsh area were slightly differ from the two sites. The value for MA9 was dropped in August 2009. That might be an error from the measurement. The EC in these two sites should not different.

1.1.3.2 pH



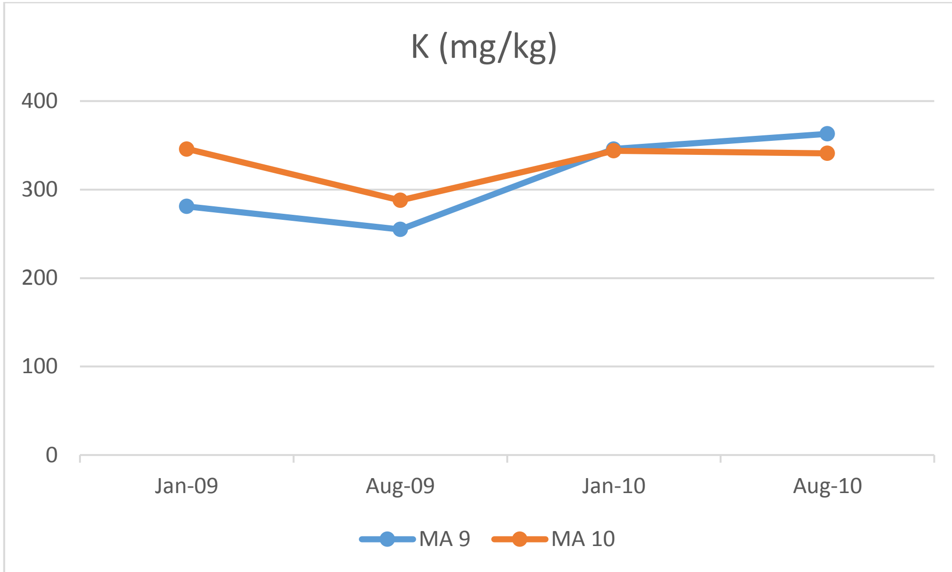
Soil pH of these two sites were not deferent. It ranged from 7.0 – 7.5.

1.1.3.3 Extractable P (mg/kg)



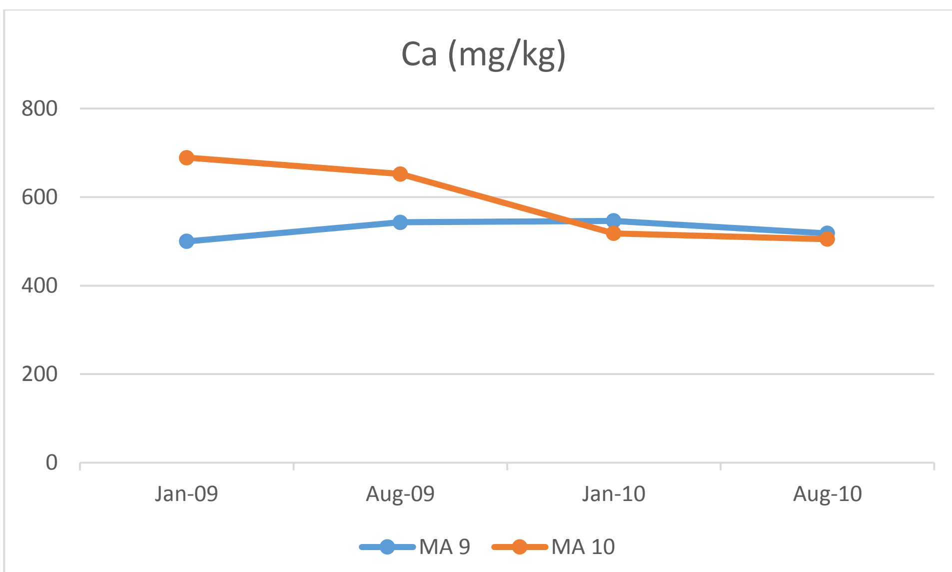
Extractable P from the two sites were not different. It ranged from 16 – 26 mg/kg.

1.1.3.4 Extractable K (mg/kg)



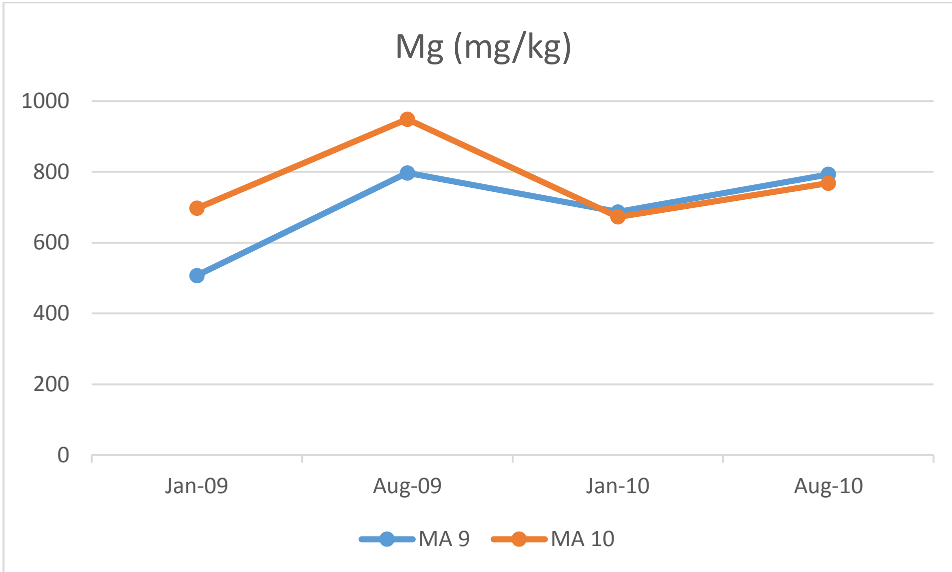
Extractable K ranged from 225 to 263 mg/kg. the values from both sites were not much different.

1.1.3.5 Extractable Ca (mg/kg)



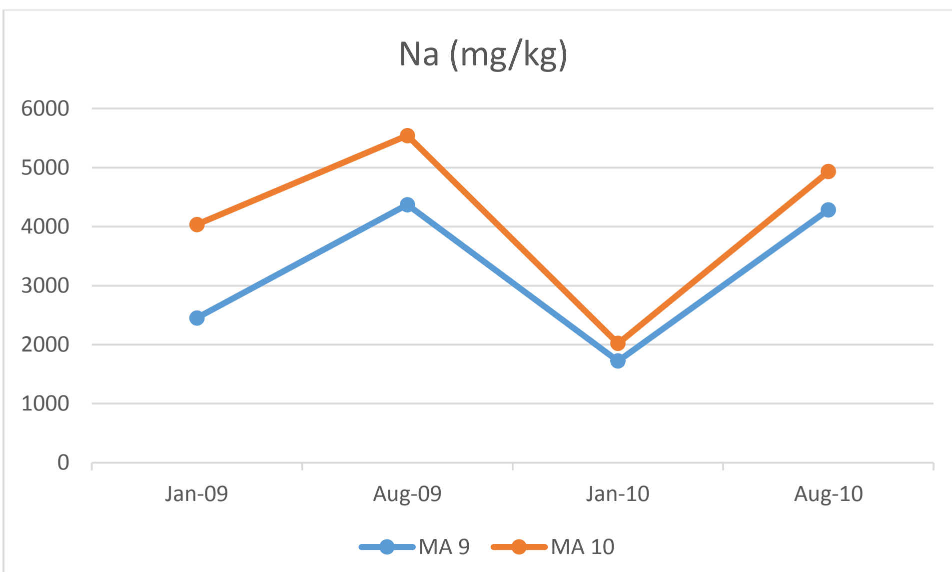
Ca ranged from 500 to 689 mS/cm. By the average, the value of the MA10 was higher than the MA9.

1.1.3.6 Extractable Mg (mg/kg)



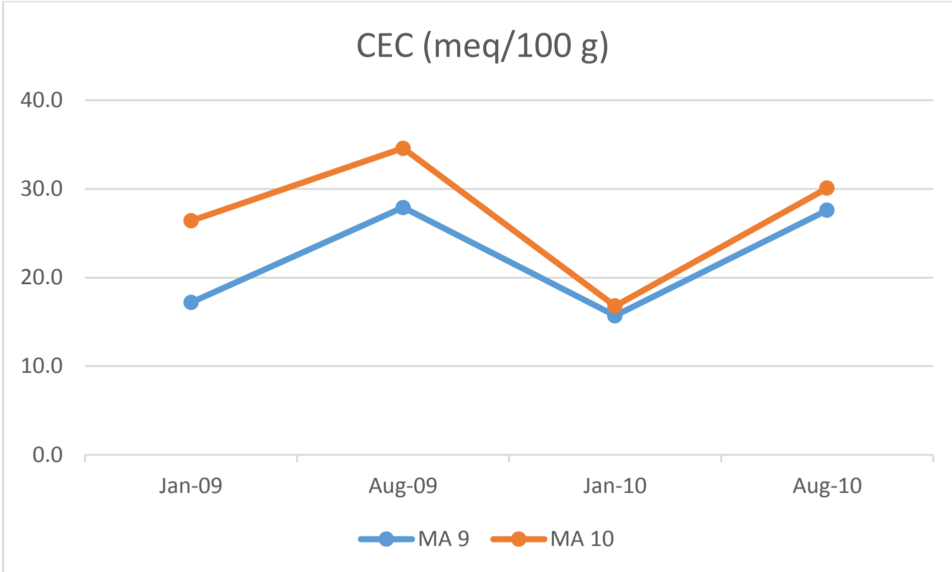
Mg was increased at the August 2009 sampling. The average for MA10 was higher than MA9.

1.1.3.7 Extractable Na (mg/kg)



Extractable Na were fluctuated by time of sampling with the lowest was 1,723 mg/kg of MA9 and the highest was 5,540 mg/kg in MA10.

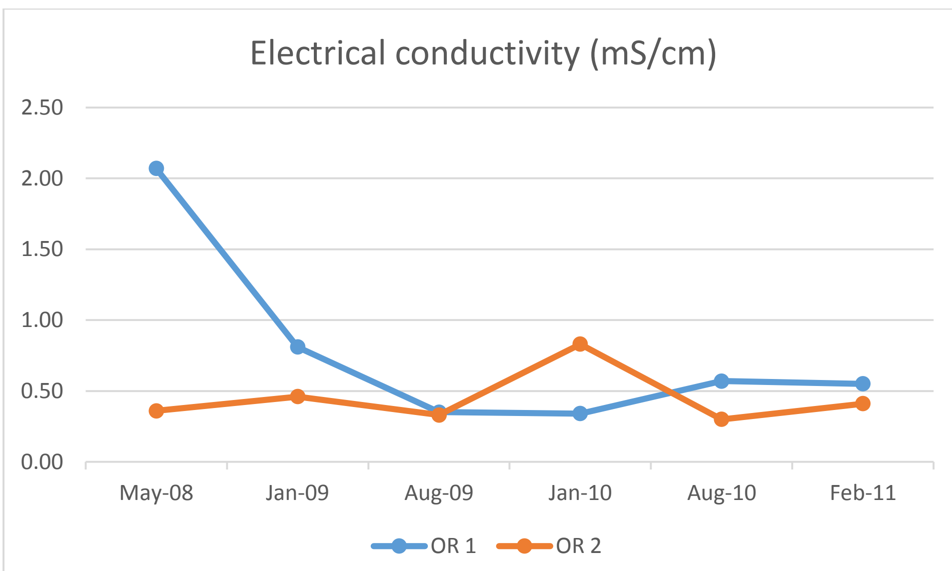
1.1.3.8 Cation exchange capacity (meq/100 g soil)



CEC were highly related to amount of Na content, which was the highest cation concentration as compared to K, Ca, and Mg.

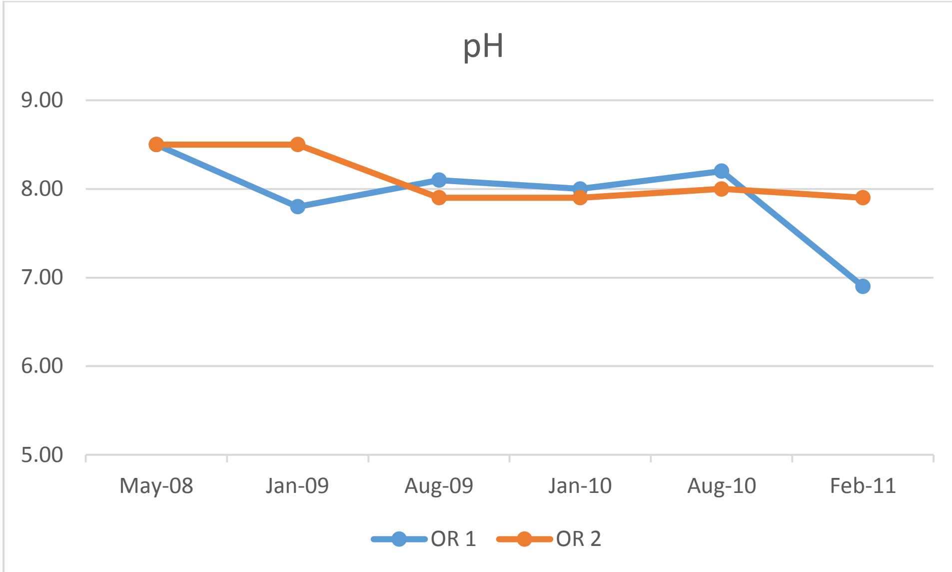
1.2 Old Ridge (OR1 and OR2), this site was created in 2003. Only two samples were collected from the Old Ridge site. The samples were collected 6 different times (May 2008, January 2009, August 2009, January 2010, and February 2011). Electrical conductivity appeared to be the lowest as compared to other locations and would likely not impact plant growth.

1.2.1 Electrical conductivity (mS/cm)



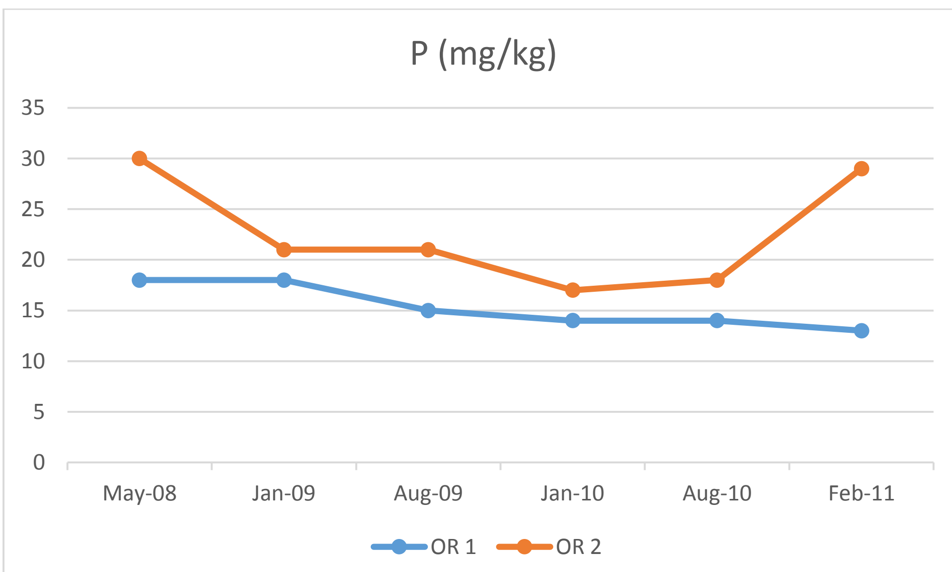
Electrical conductivity was lower than the samples collected from MA area. The highest was 2.07 mS/cm at the first sampling in May 2008 for the OR1. Most of the results were lower than 1.0 mS/cm.

1.2.2 pH



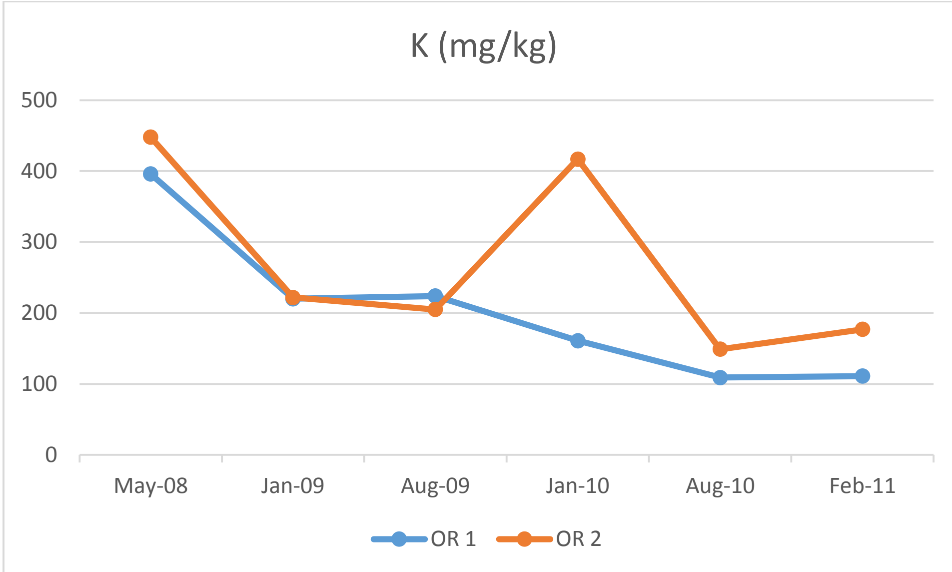
Soil pH ranged from 6.9 to 8.5 and it was slightly higher than the MA samples, except the sample collected in February 2011 that significantly dropped to below 7.

1.2.3 Extractable P (mg/kg)



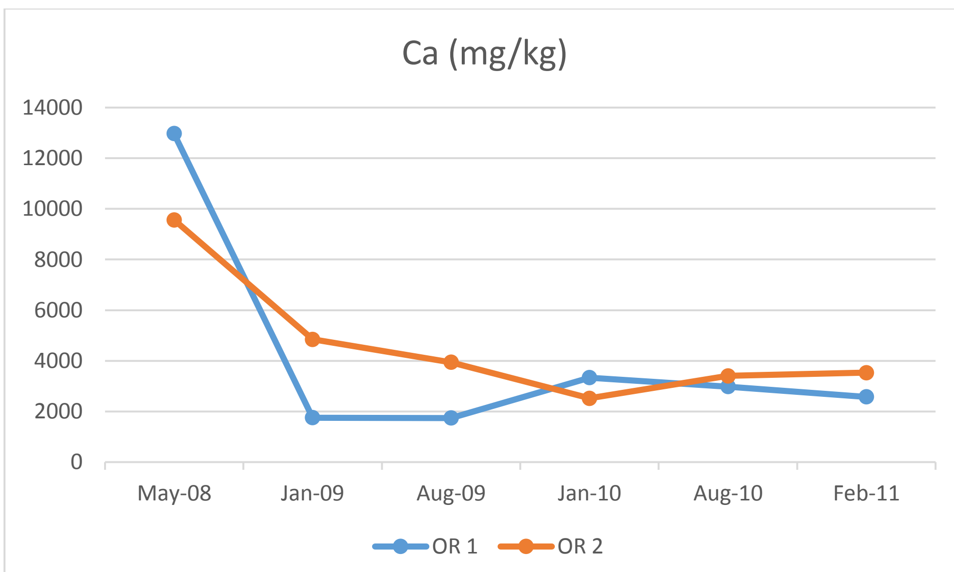
Extractable P ranged from 13 to 30 mg/kg. The highest concentration was observed in OR 2 for the sampled in February 2011.

1.2.4 Extractable K (mg/kg)



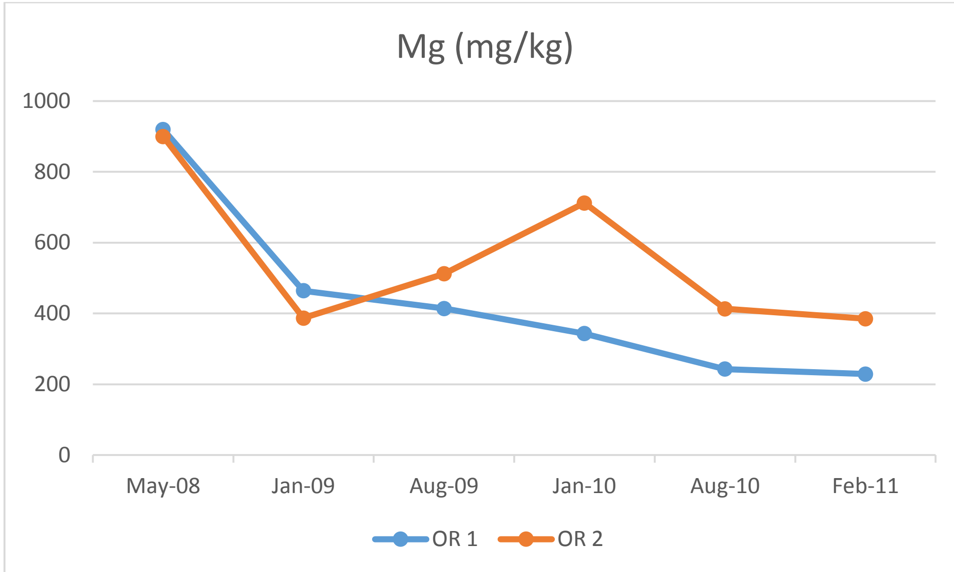
Extractable K were higher at the first sampled in May 2008 (396-448 mg/kg) and dropped afterward to the lowest at 111 mg/kg for the OR1. However, fluctuation P concentration was observed in the OR2.

1.2.5 Extractable Ca (mg/kg)



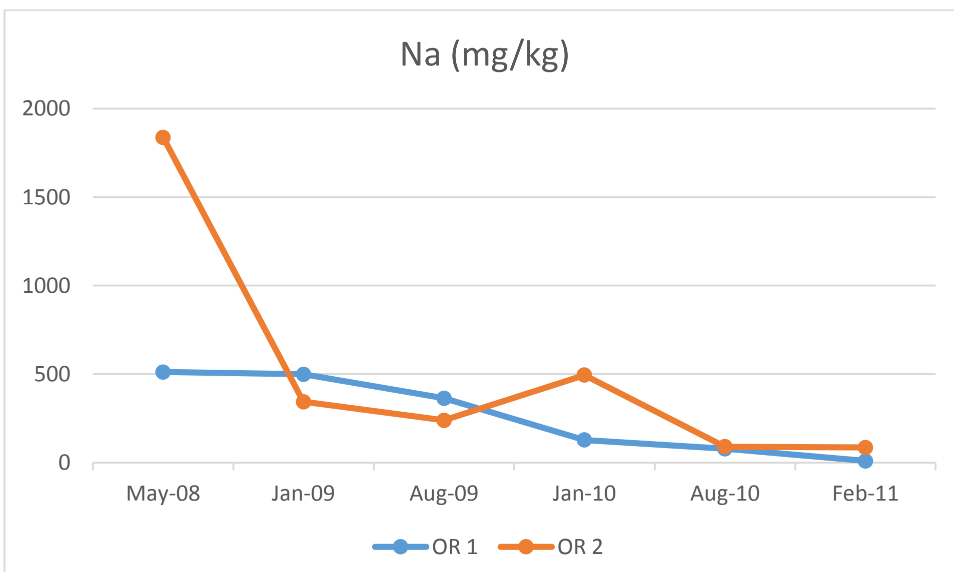
Extractable Ca were extremely high (12,970 mg/kg for OR1 and 9,562 mg/kg for OR2) at the first sampling date (May 2008) and subsequently were significantly decreased to 2,579 mg/kg for OR1 and 3,531 mg/kg for OR2 in February 2011.

1.2.6 Extractable Mg (mg/kg)



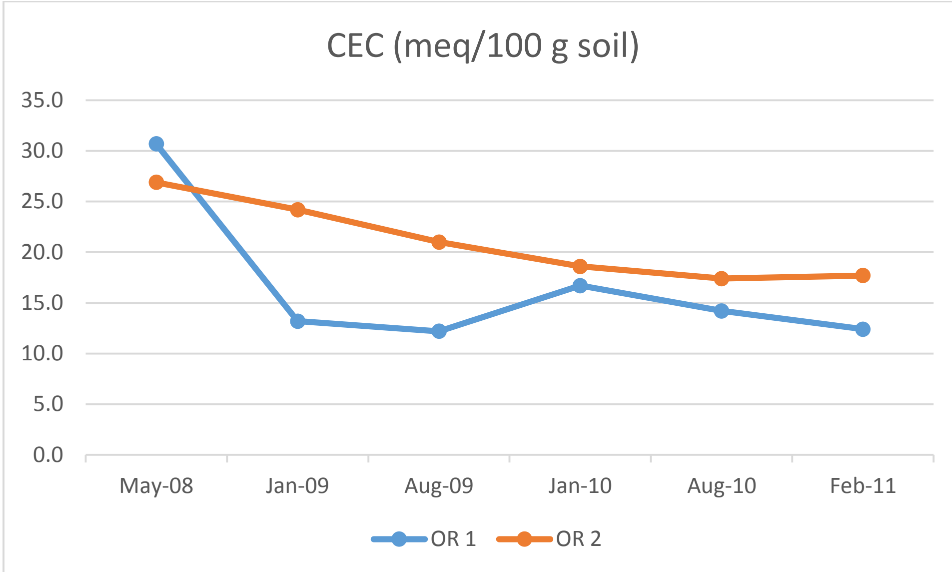
Extractable Mg ranged from 229-920 mg/kg. Effect of sampled dates on the concentration of extractable Mg was observed. The latest sampling date in February 2011 has the lowest concentration as compared to the other sampling dates.

1.2.7 Extractable Na (mg/kg)



Extractable Na has similar trend with Na. For the OR1, the concentration dropped from 1,838 mg/kg (May 2008) to 85 mg/kg (February 2011).

1.2.8 Cation exchange capacity (meq/100 g soil)

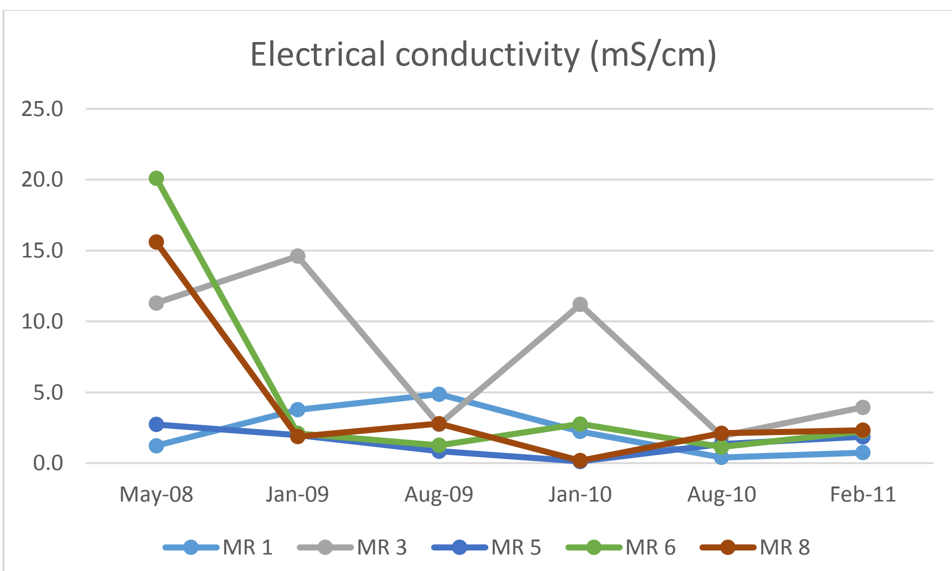


CEC for this site was relatively low as compared to other sites and the values were decreased by time. That might be because of the leaching of cations from the upper soil layers.

1.3 Middle Ridge (MR1-MR10) was formed in summer of 2005. The 10 samples were collected from 6 different times (May 2008, January 2009, August 2009, January 2010, August 2010, and February 2011) and are broken down into 3 landforms: Ridge top (MR1, MR3, MR5, MR6, and MR8), Ridge slope (MR10), and Marsh (MR2, MR4, MR7, and MR9).

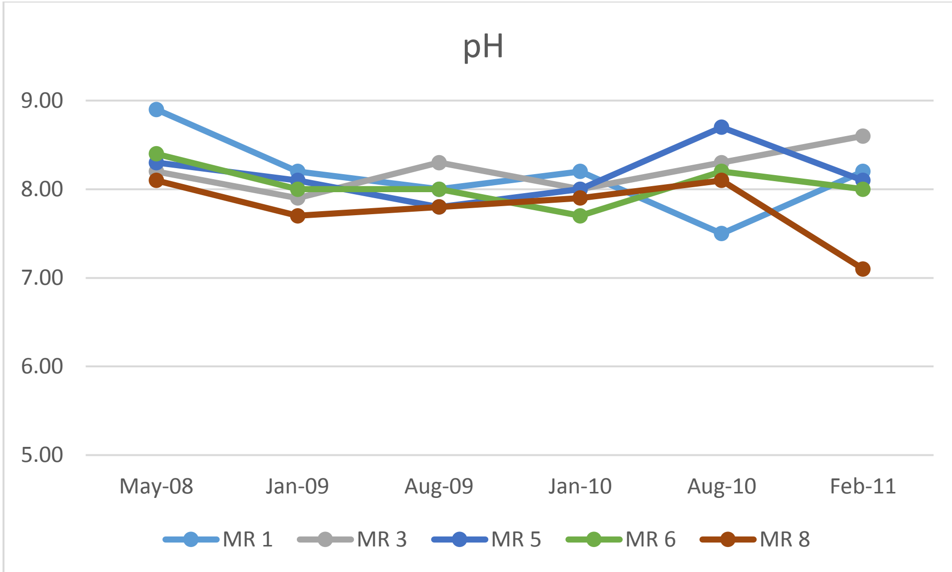
1.3.1 Ridge Top (MR1, MR3, MR5, MR6, and MR8)

1.3.1.1 Electrical conductivity (mS/cm)

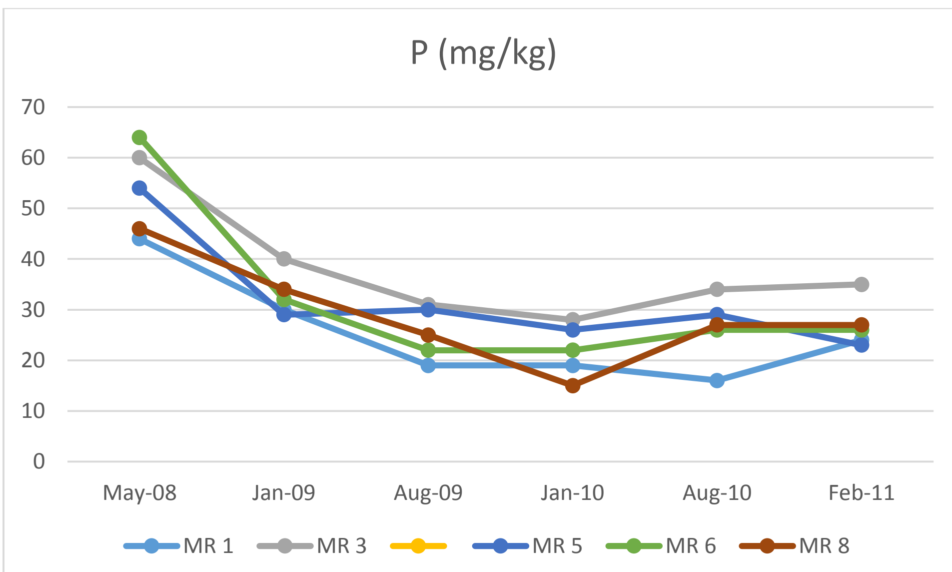


EC and pH were analyzed based on soil slurry. High variation of EC at the first sampling in May 2008 (1.22-20.10 mS/cm). However, the last sampling in February 2011, EC were dropped between 1.86-3.93 mS/cm.

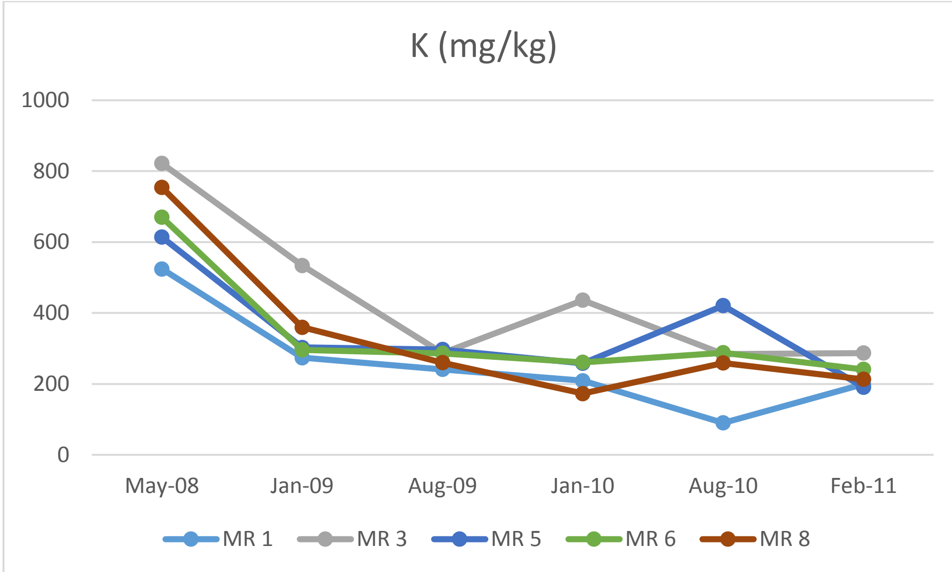
1.3.1.2 pH



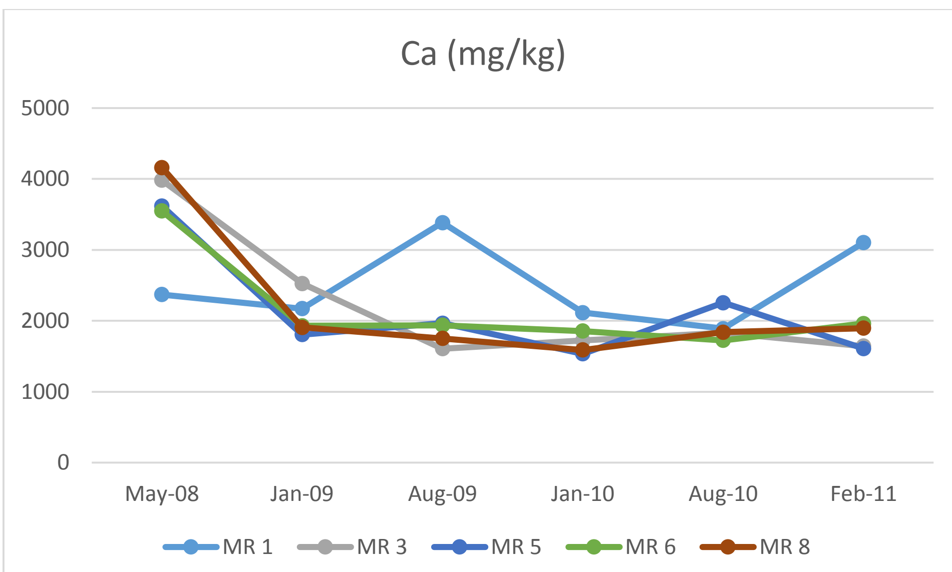
1.3.1.3 Extractable P (mg/kg)



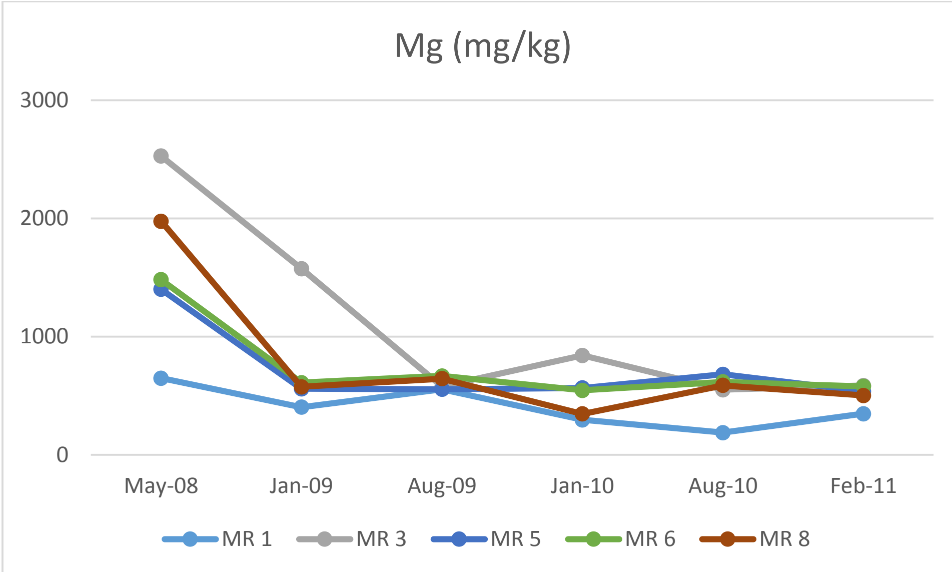
1.3.1.4 Extractable K (mg/kg)



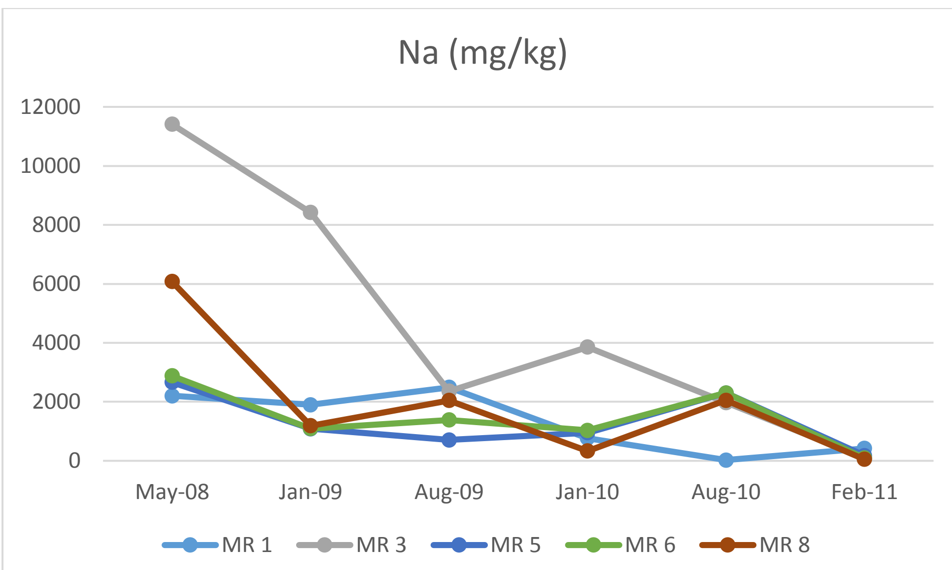
1.3.1.5 Extractable Ca (mg/kg)



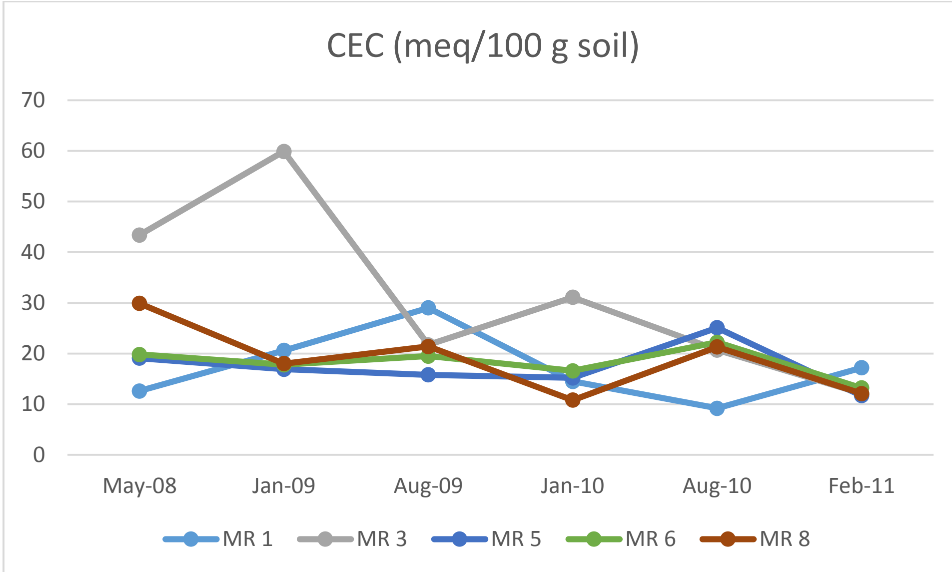
1.3.1.6 Extractable Mg (mg/kg)



1.3.1.7 Extractable Na (mg/kg)



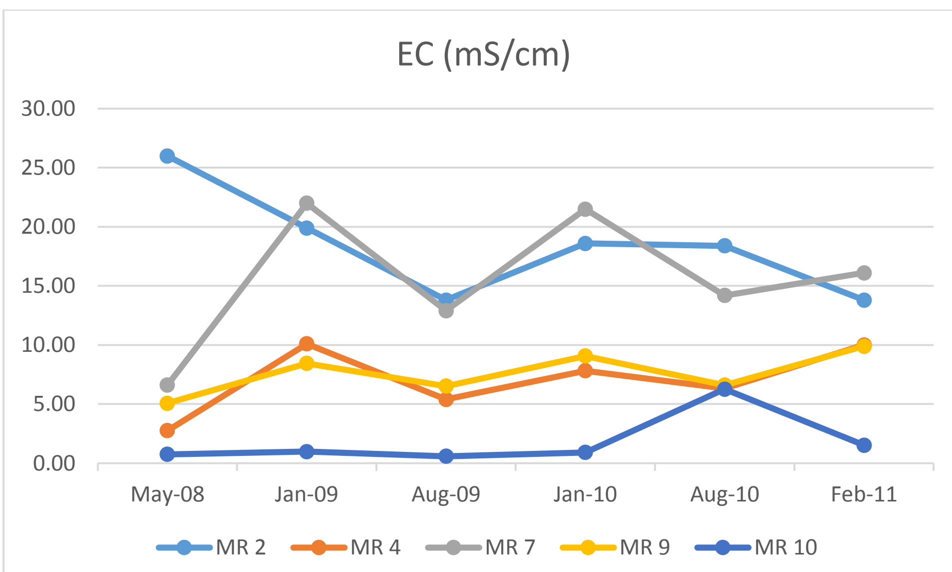
1.3.1.8 Cation exchange capacity (meq/ 100 g soil)



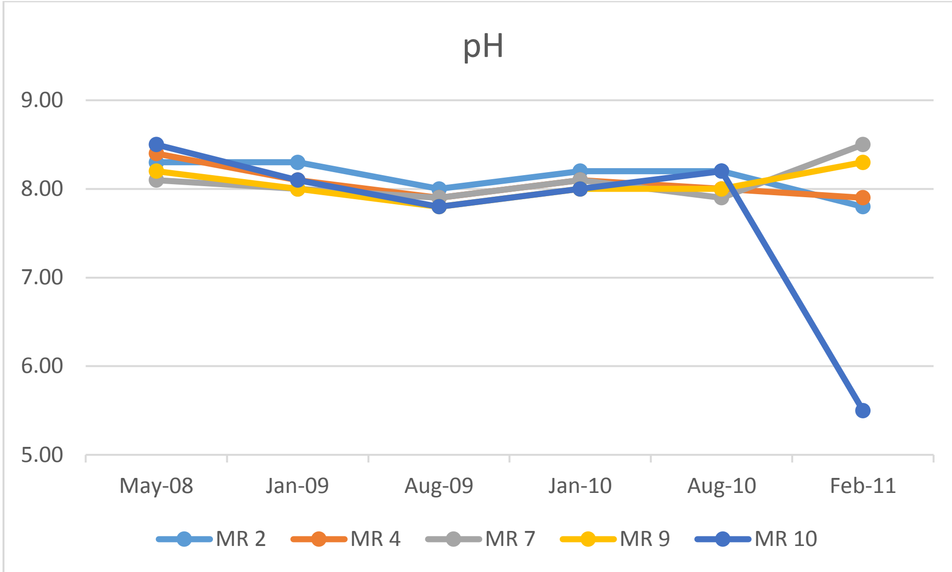
The average extractable P, K, Ca, Mg, Na, including CEC were slightly decreased by time.

1.3.2 Ridge slope (MR10), and Marsh (MR2, MR4, MR7, and MR9). The following 8 charts in this section were included 2 landforms; Ridge slope and Marsh location.

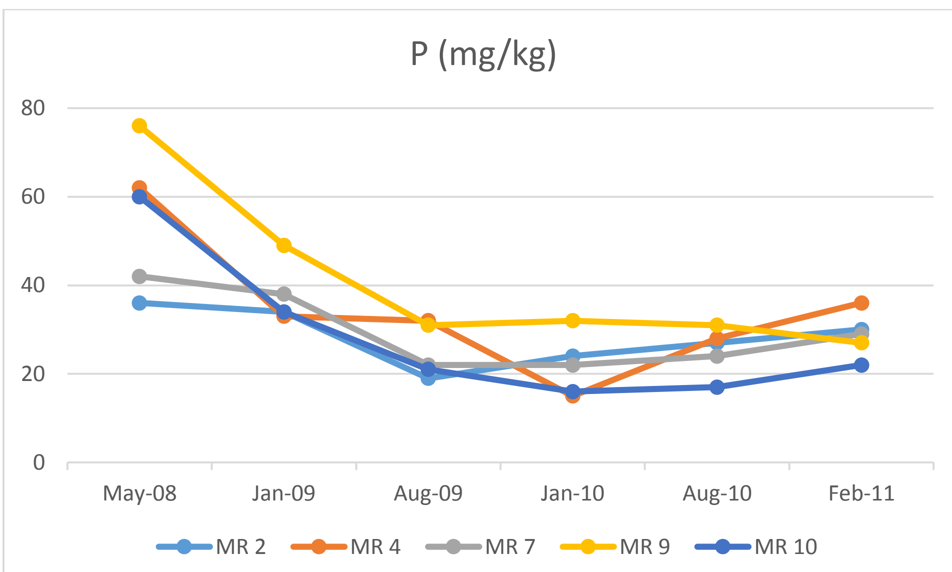
1.3.2.1 Electrical conductivity (mS/cm)



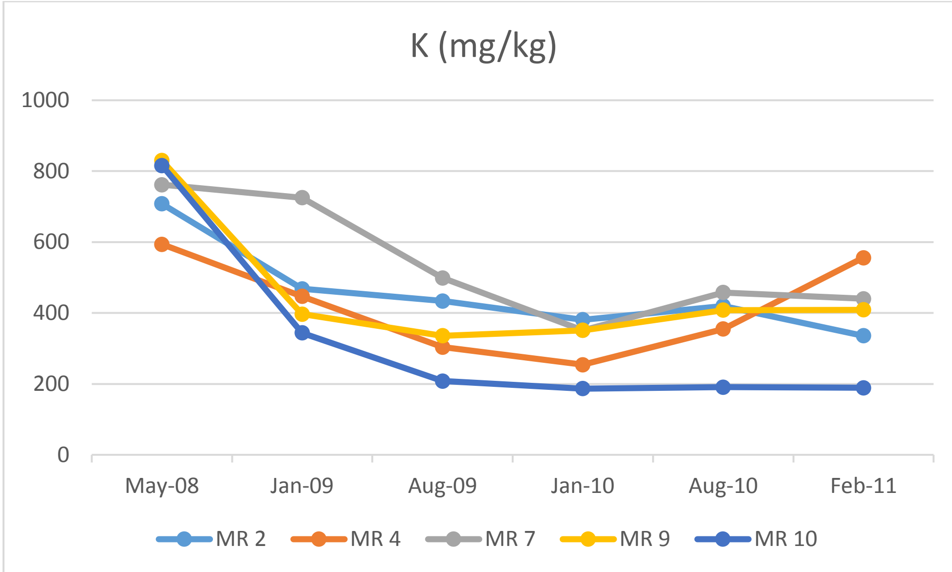
1.3.2.2 pH



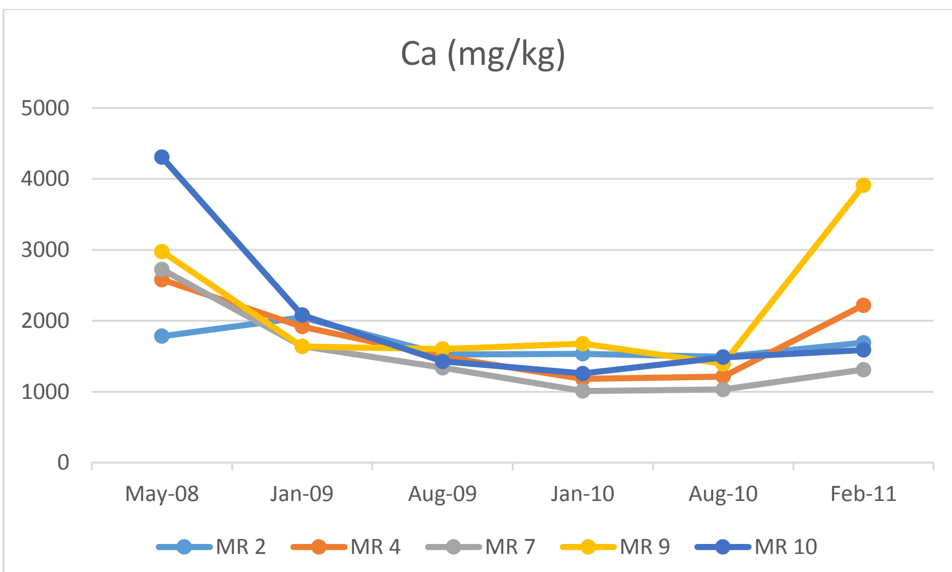
1.3.2.3 Extractable P (mg/kg)



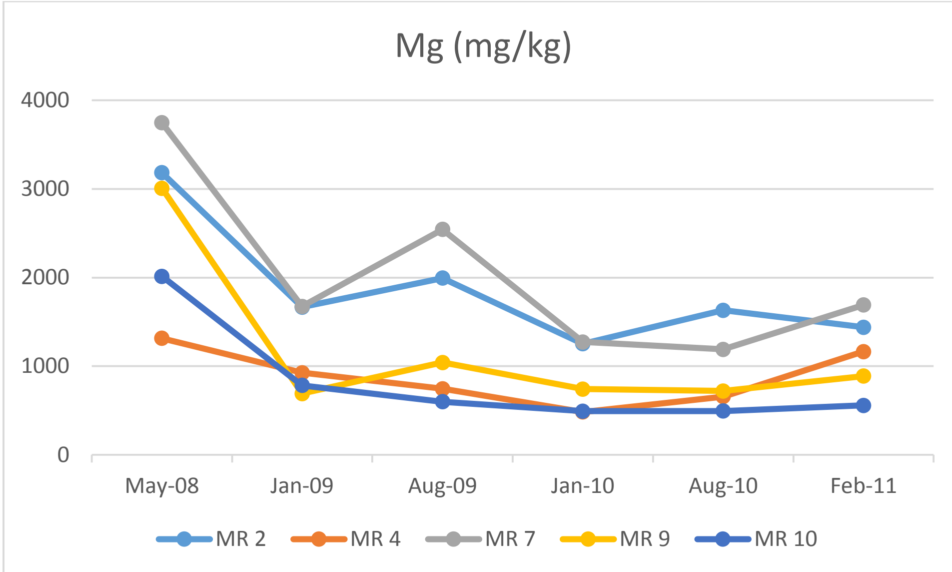
1.3.2.4 Extractable K (mg/kg)



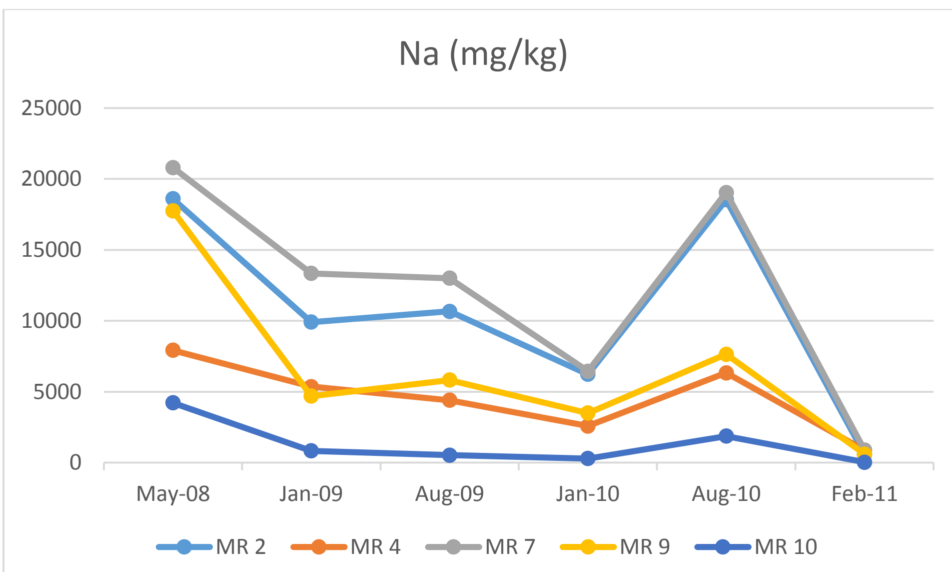
1.3.2.5 Extractable Ca (mg/kg)



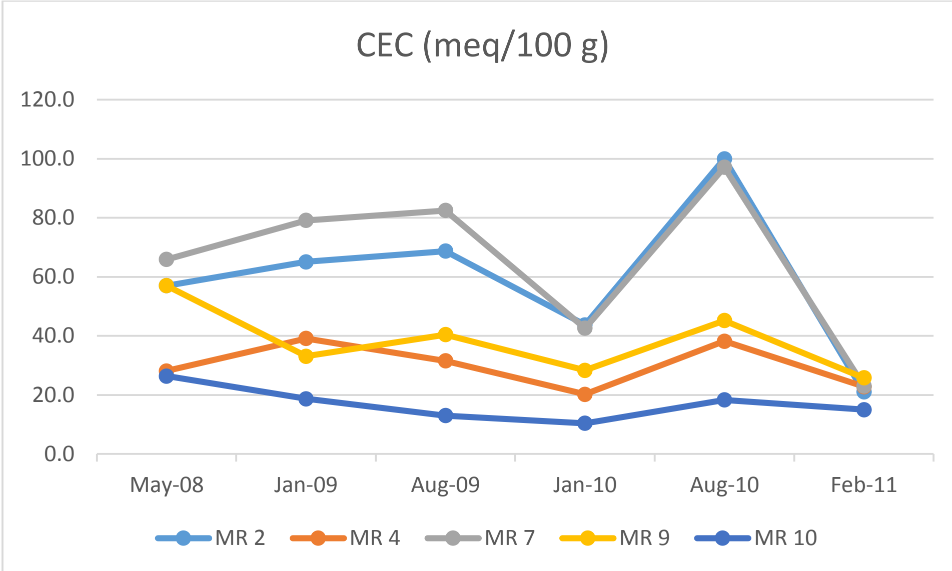
1.3.2.6 Extractable Mg (mg/kg)



1.3.2.7 Extractable Na (mg/kg)



1.3.2.8 Cation exchange capacity (meq/ 100 g soil)

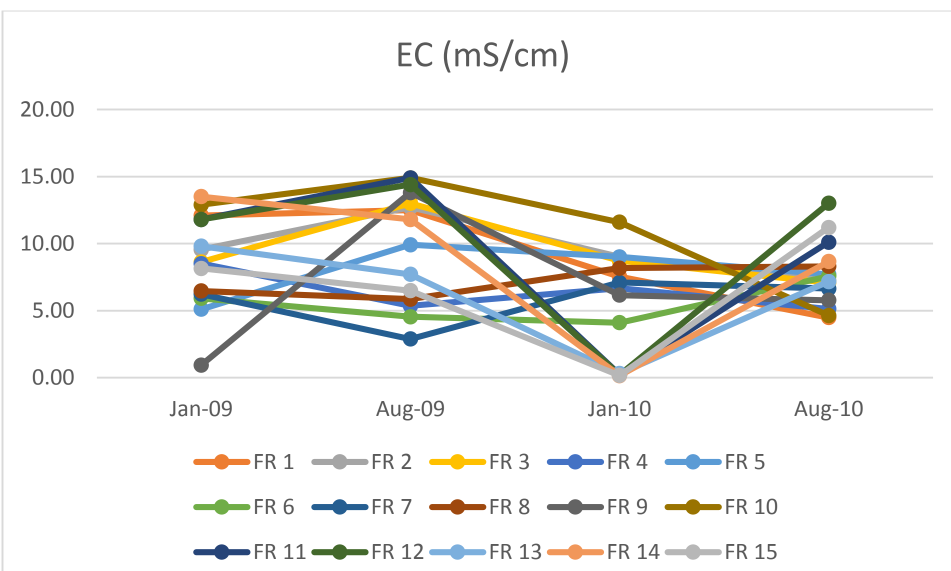


EC from these sites were highly variation while pH were not different except for the last sampling of the Ridge slope (MR10), the pH was dropped from 8.2 to 5.5 that might be due to measurement error. Extractable P, K, Ca, and Mg were significantly lower by time. For extractable Na and CEC were showed similar trend. The Na content for MR2 and MR7 were bumped up. This might be because of MR2 and MR7 were located on the open marsh which could be affected by sea water.

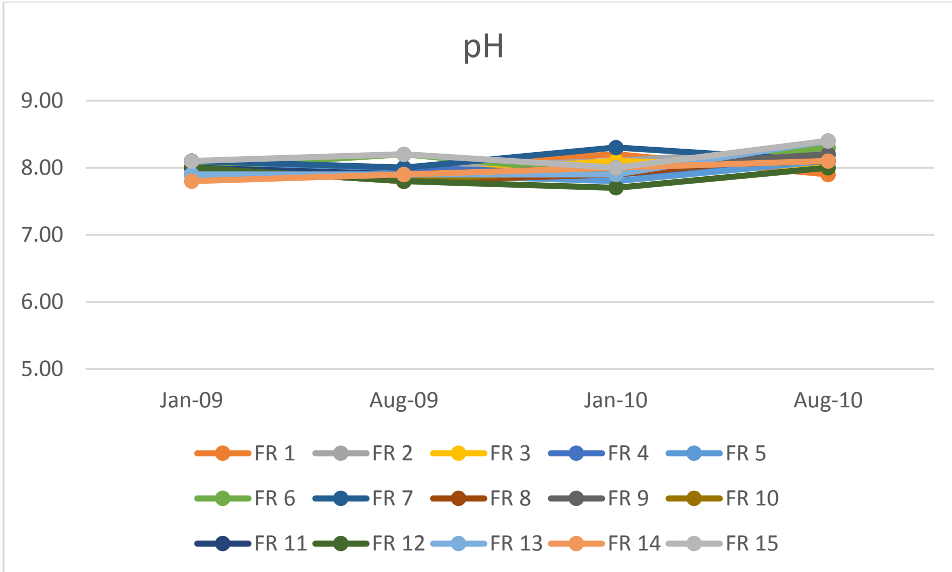
1.4 Far Ridge was formed in the fall of 2008. The samples are broken down into three landforms: Ridge Top (FR1-15), North Marsh (FRN1-5), and South Marsh (FRS1-5)

1.4.1 Ridge Top (FR1-FR15)

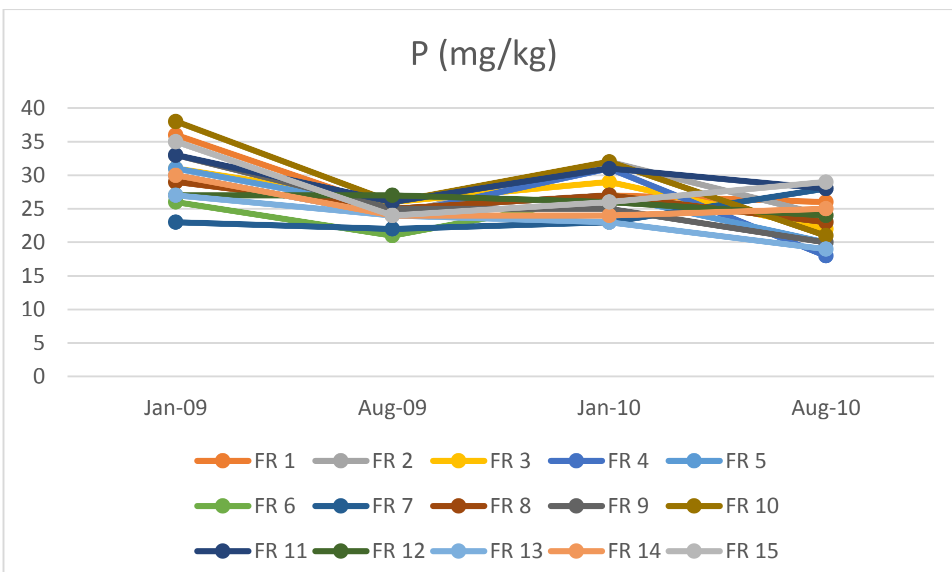
1.4.1.1 Electrical conductivity (mS/cm)



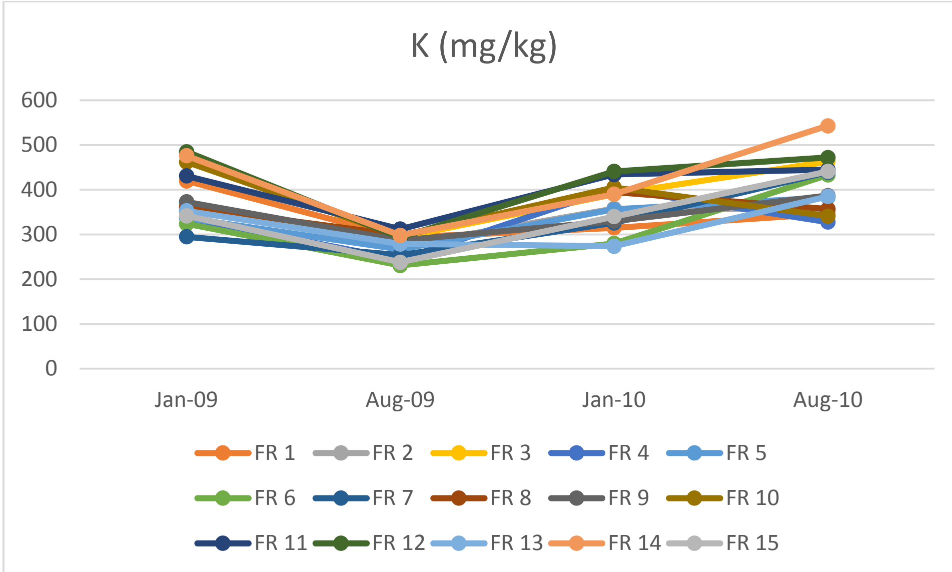
1.4.1.2 pH



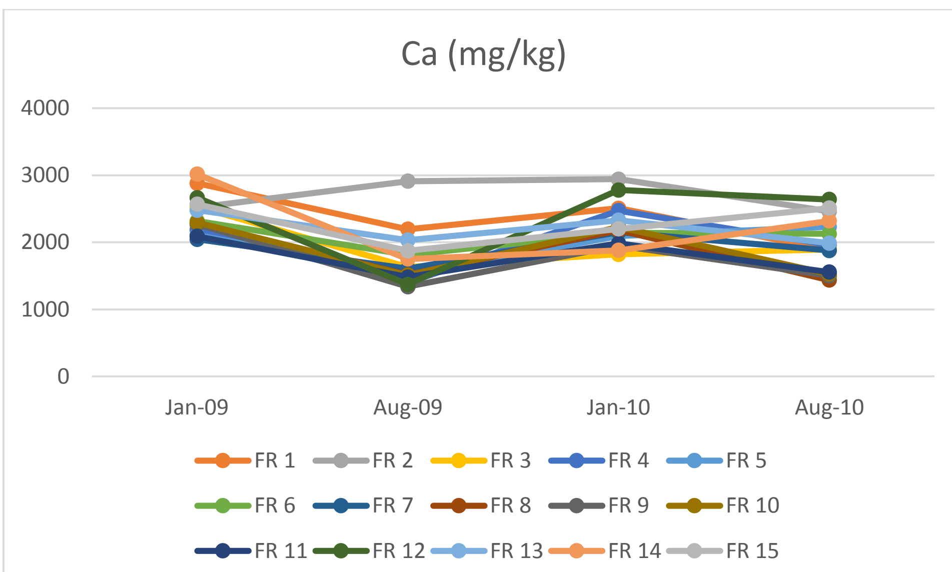
1.4.1.3 Extractable P (mg/kg)



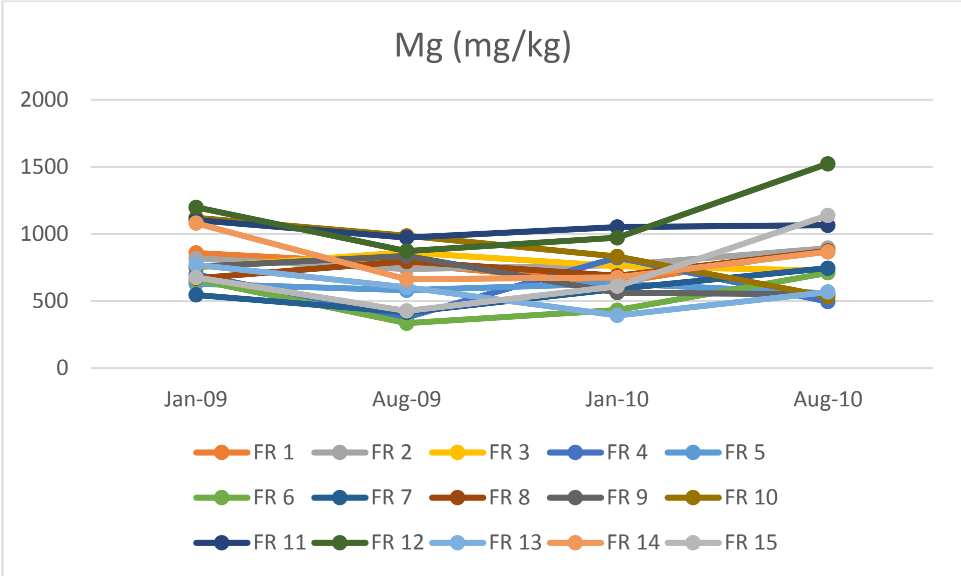
1.4.1.4 Extractable K (mg/kg)



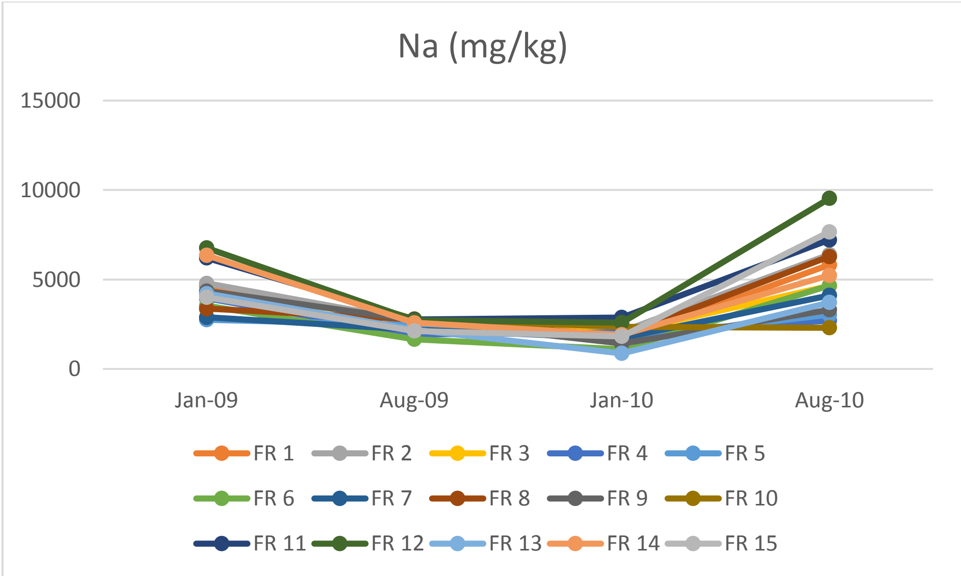
1.4.1.5 Extractable Ca (mg/kg)



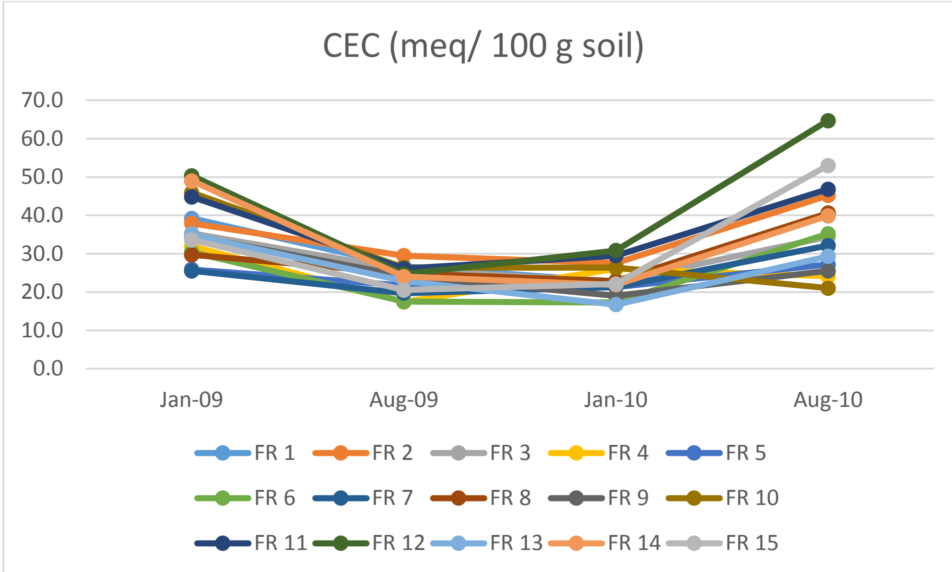
1.4.1.6 Extractable Mg (mg/kg)



1.4.1.7 Extractable Na (mg/kg)



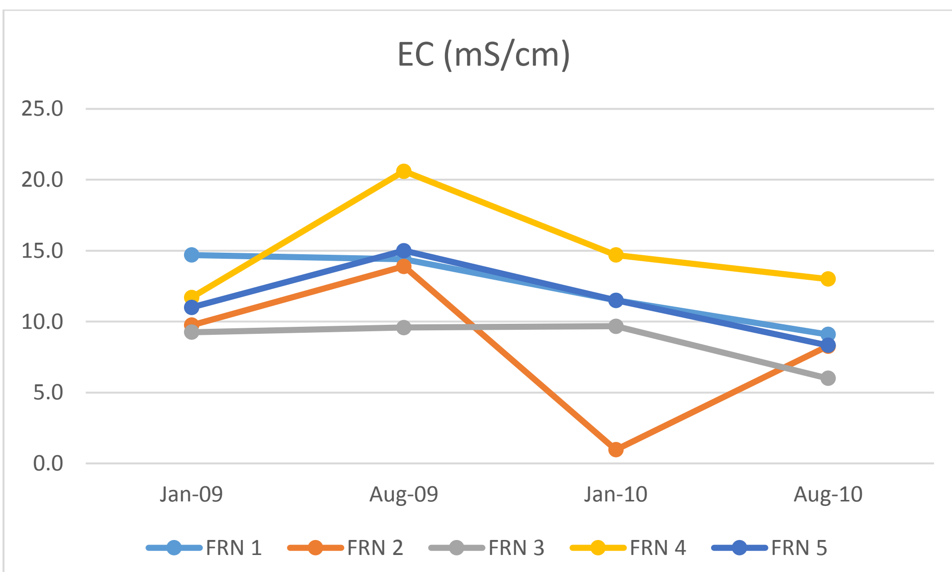
1.4.1.8 Cation exchange capacity (meq/100 g soil)



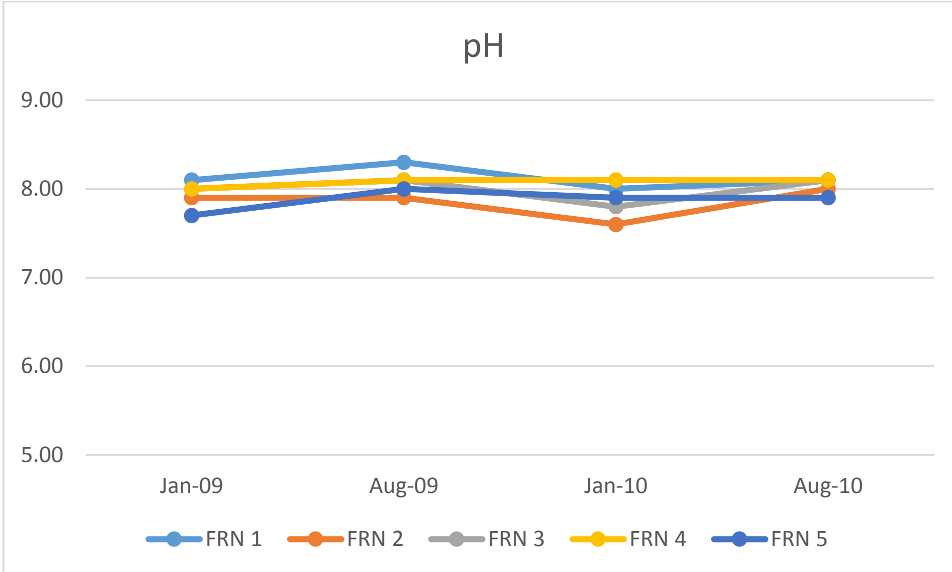
EC highly varied between the sites (0.16-14.90mS/cm). Soil pH were not different from the sites and sampling times (7.7-8.3). Extractable P, K, and Ca were not influenced by time but extractable Mg and Na varied by sites, particularly at the last sampling in August 2010.

1.4.2 Marsh on the north side (FRN1-5).

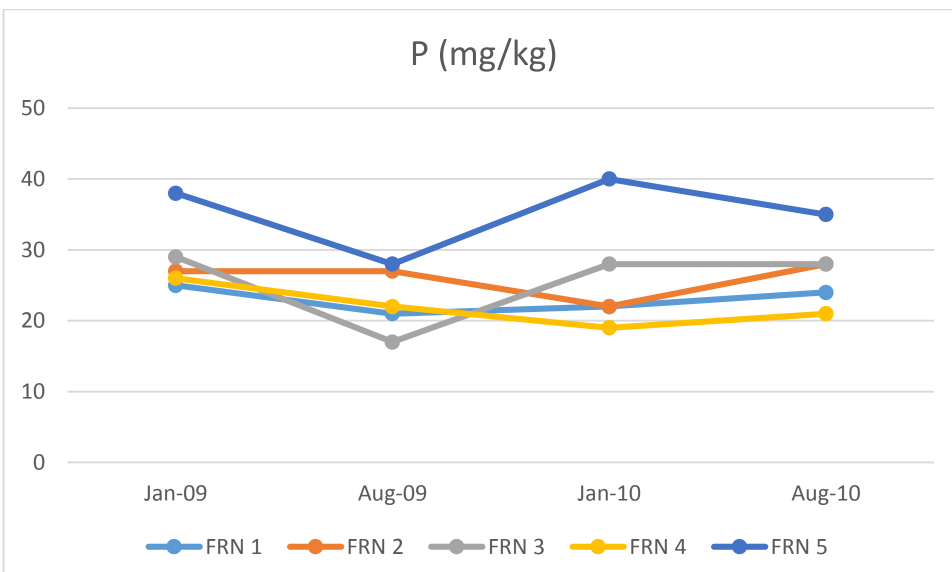
1.4.2.1 Electrical conductivity (mS/cm)



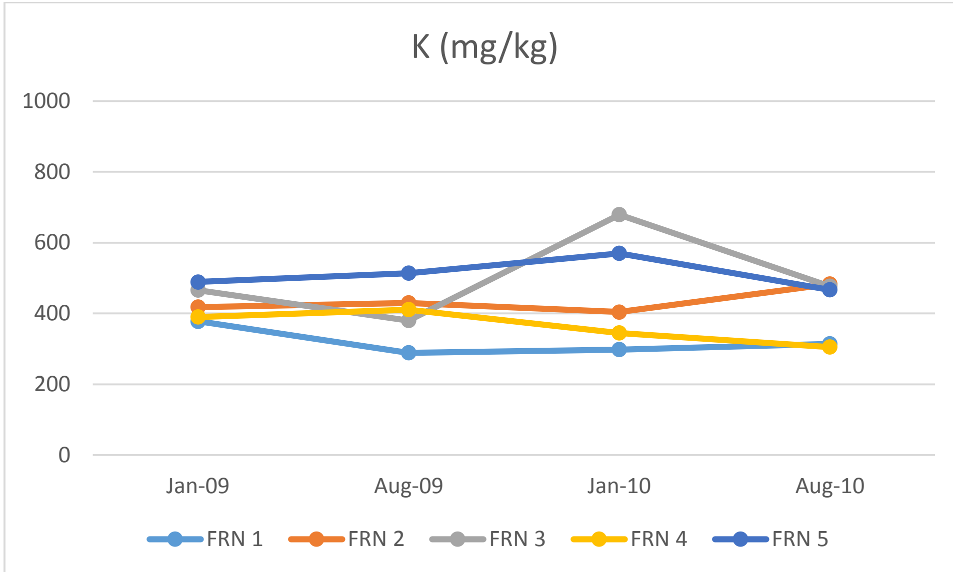
1.4.2.2 pH



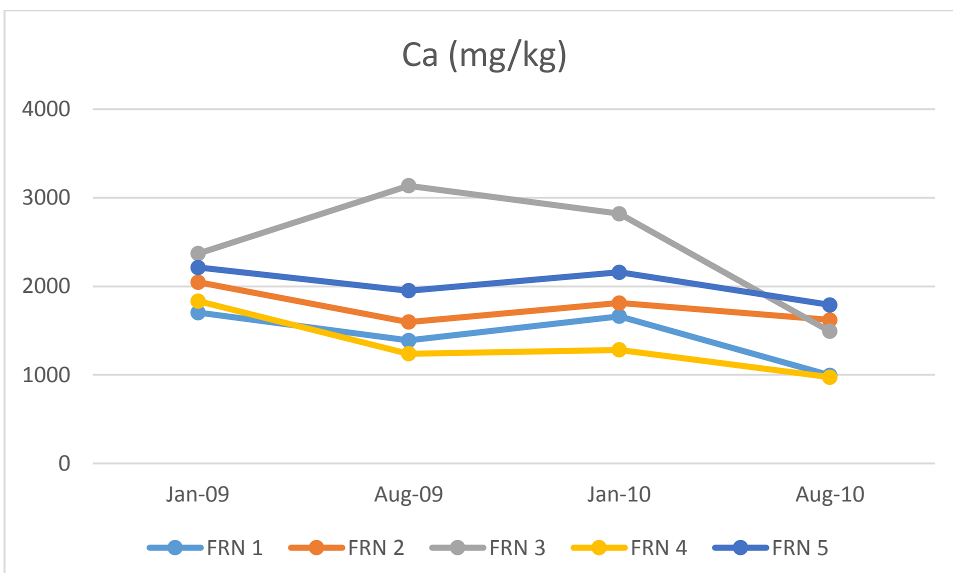
1.4.2.3 Extractable P (mg/kg)



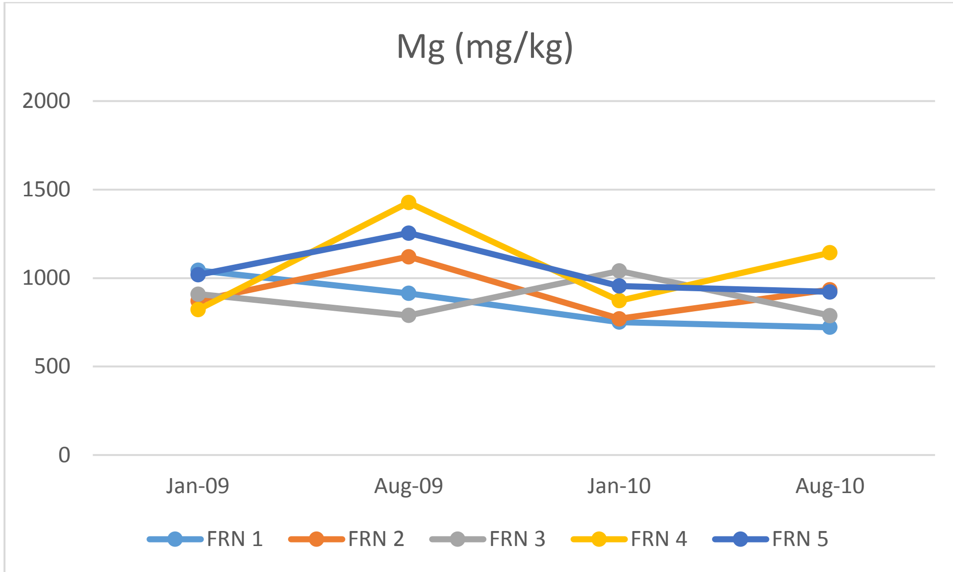
1.4.2.4 Extractable K (mg/kg)



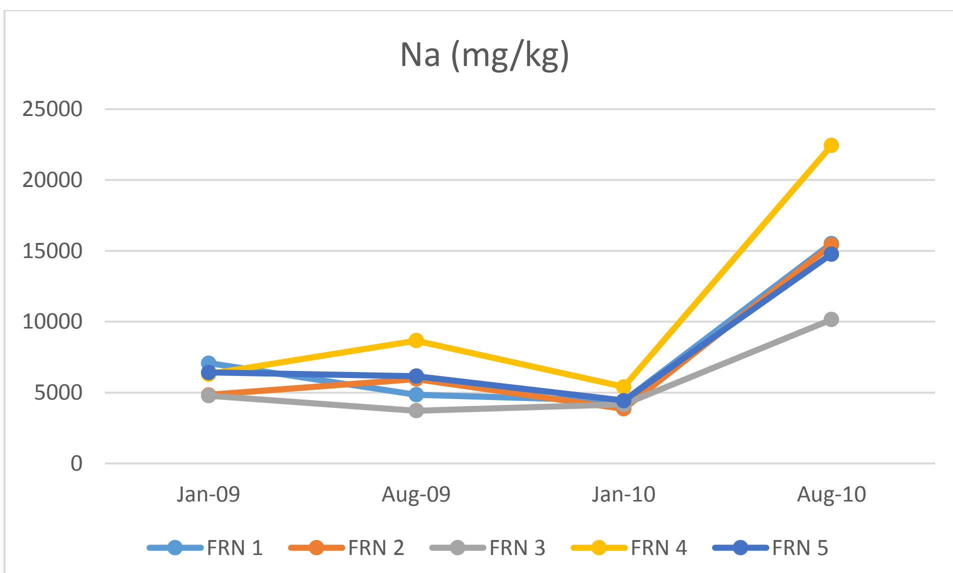
1.4.2.5 Extractable Ca (mg/kg)



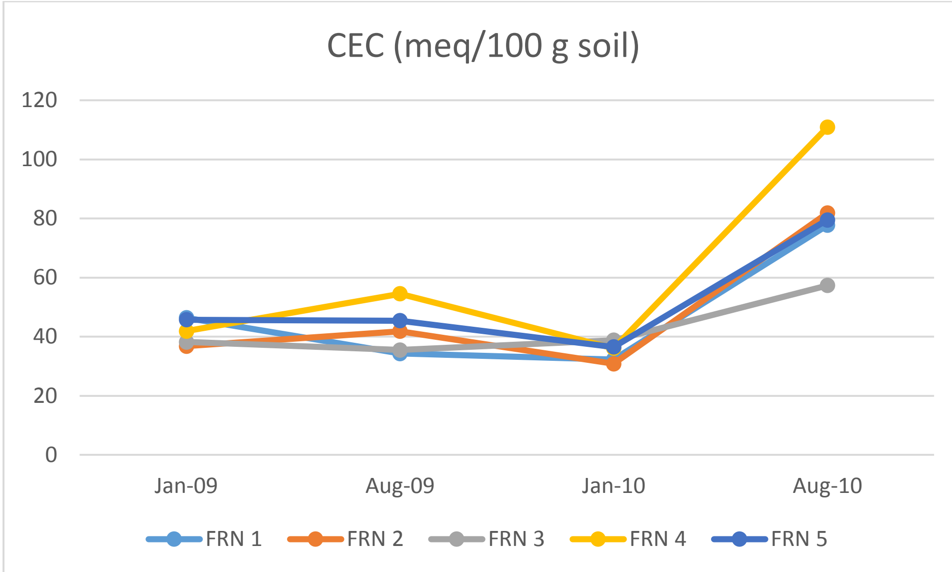
1.4.2.6 Extractable Mg (mg/kg)



1.4.2.7 Extractable Na (mg/kg)



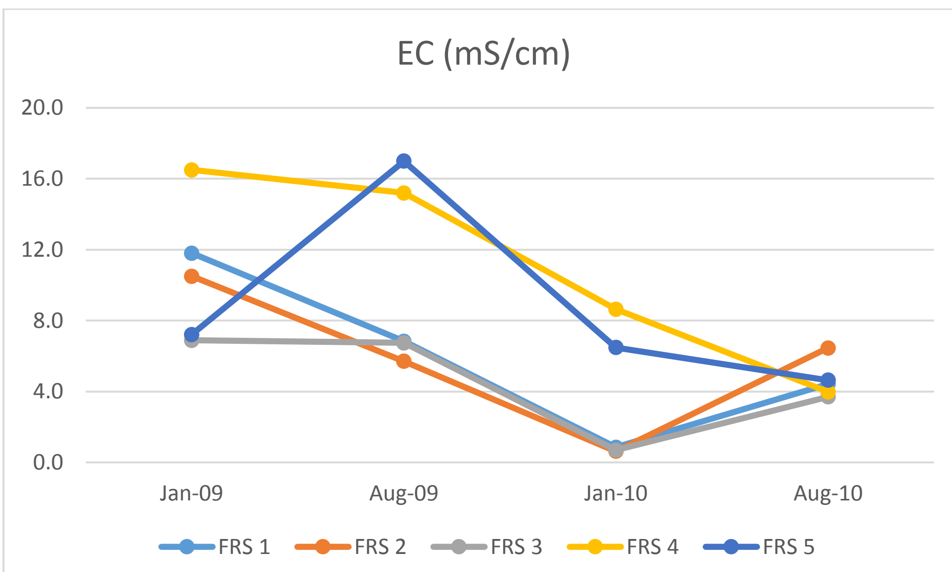
1.4.2.8 Cation exchange capacity (meq/100 g soil)



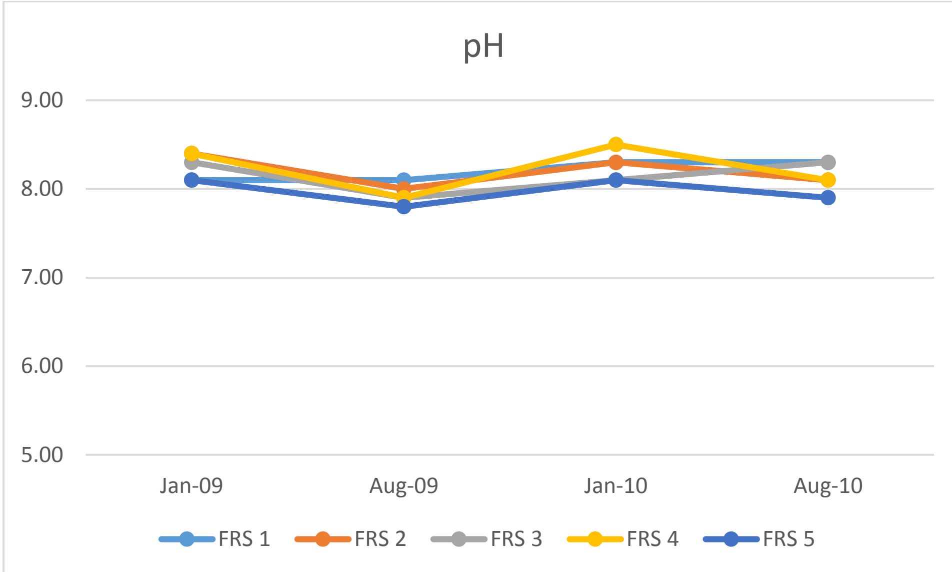
EC for this area (marsh) were higher than 4.0 mS/cm. Soil pH were below 8.5. High sodium concentration ranged from 3725 to 22440 mg/kg. These properties are common for saltmarsh environment.

1.4.3 Marsh on the south side (FRS1-5)

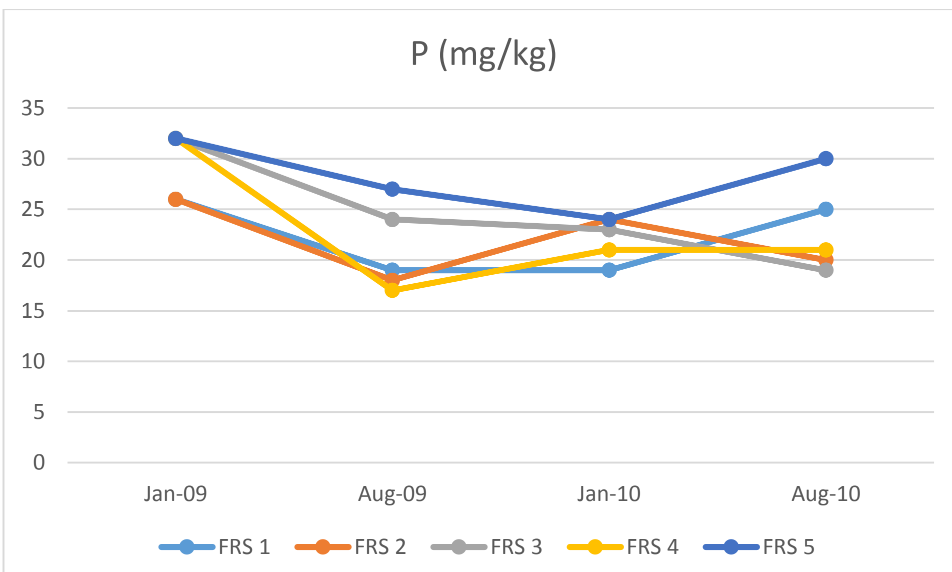
1.4.3.1 Electrical conductivity (mS/cm)



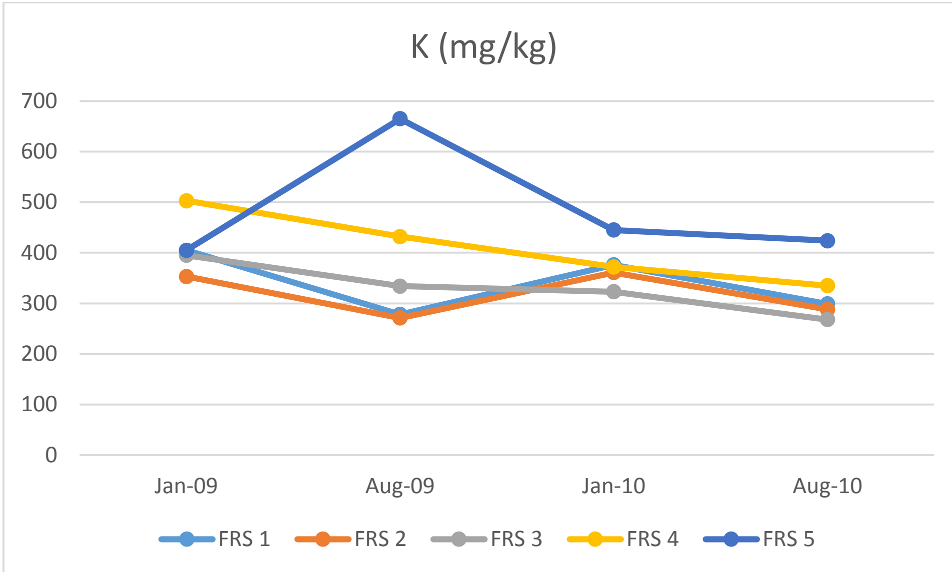
1.4.3.2 pH



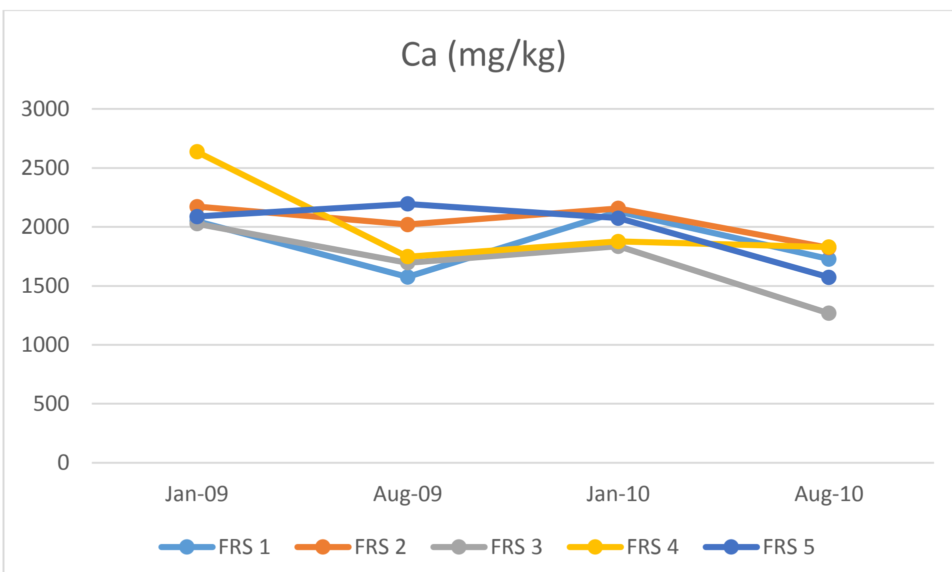
1.4.3.3 Extractable P (mg/kg)



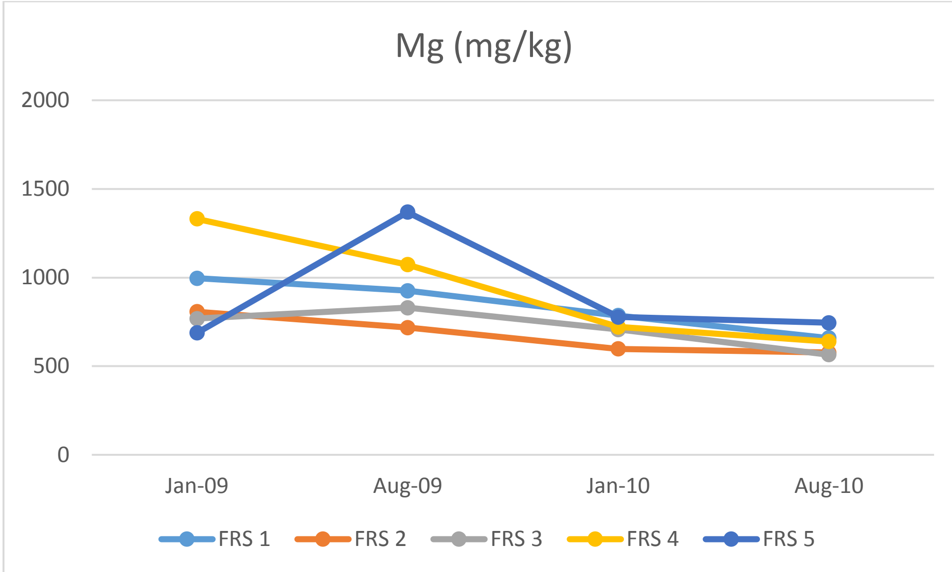
1.4.3.4 Extractable K (mg/kg)



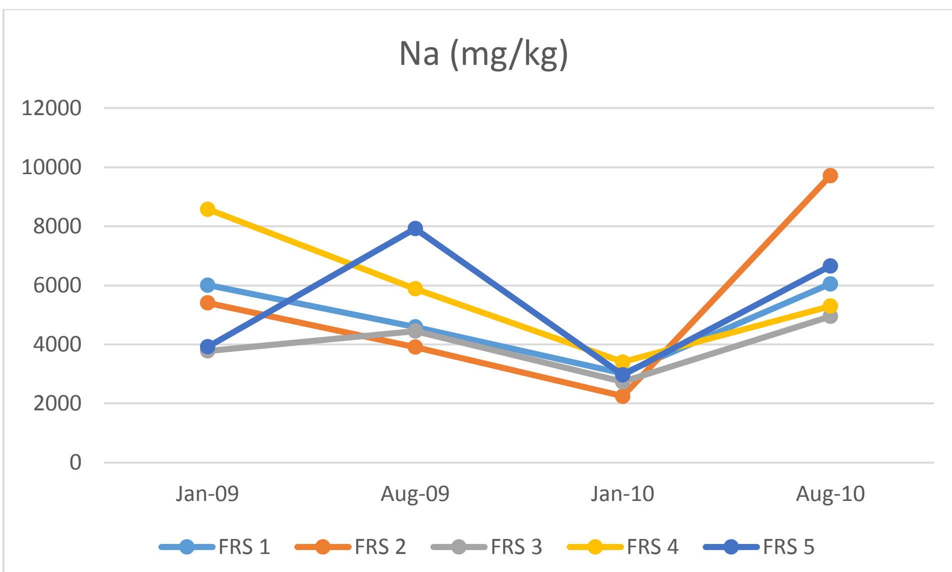
1.4.3.5 Extractable Ca (mg/kg)



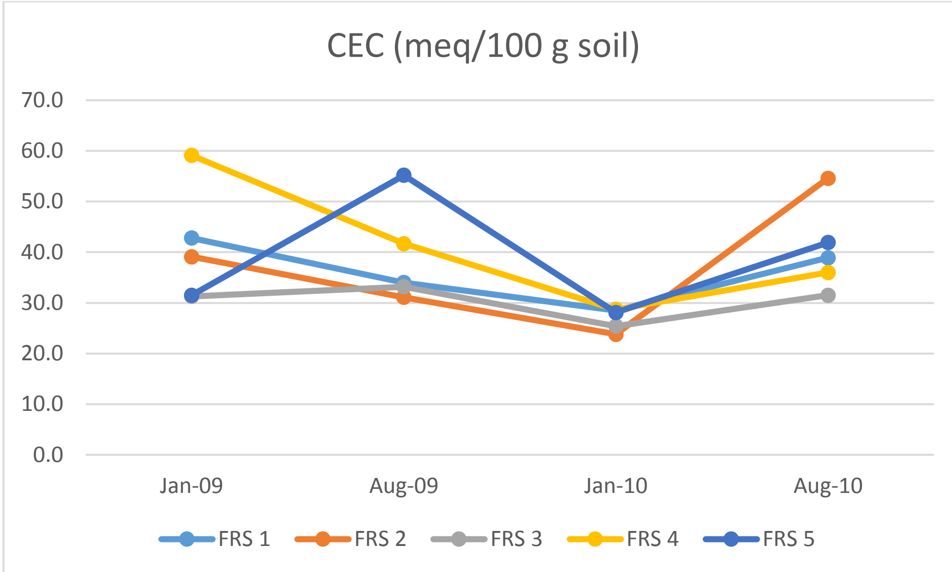
1.4.3.6 Extractable Mg (mg/kg)



1.4.3.7 Extractable Na (mg/kg)



1.4.3.8 Cation exchange capacity (meq/100 g soil)



EC for this area (marsh) were higher than 4.0 mS/cm. Soil pH were below 8.5. High sodium concentration ranged from 3725 to 22440 mg/kg. The high EC and Na concentrations are common for saltmarsh environment.

2 Soil test results from Soil Testing Laboratory, Louisiana State University Agricultural Center (1:2 water extraction method)

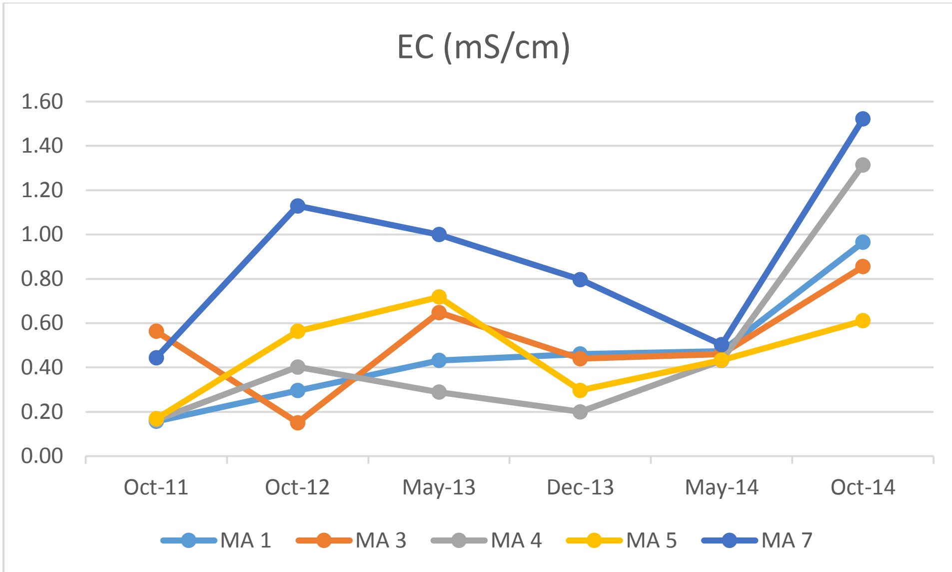
The samples were collected at 6 different times from 2011-2014: October 2011, October 2012, May 2013, December 2013, May 2014, and October 2014. The analysis package included electrical conductivity (EC), salinity, pH, soluble salts, cation exchange capacity, sodium absorption ratio (SAR), macro and micronutrients (P, K, Ca, Mg, Na, S, Cl, Fe, and Mn). In addition, SAR and CEC were calculated from sum of cations. The full test results are summarized by the sampling dates in Table 8 - Table 13. Besides summary tables, graphs that related to salinity and other important cations are showed below by the locations.

2.1 Mitigation Area (MA1-MA10). Ten samples were collected from this area. The site is a created marsh initially pumped with sediment in 2001. The samples were collected from 3 landforms: Low ridge (MA1, MA3, MA4, MA5, and MA7); Low Ridge Slope (MA2, MA6, andMA8); and Marsh (MA9 and MA10). All salinity factors i.e. electrical conductivity, soluble salt, sodium content, and SAR were higher in the marsh area as compared to the ridge area. This was likely associated with the influence of tidal water which floods the marsh. Figures below show details for each variable from different sampling times.

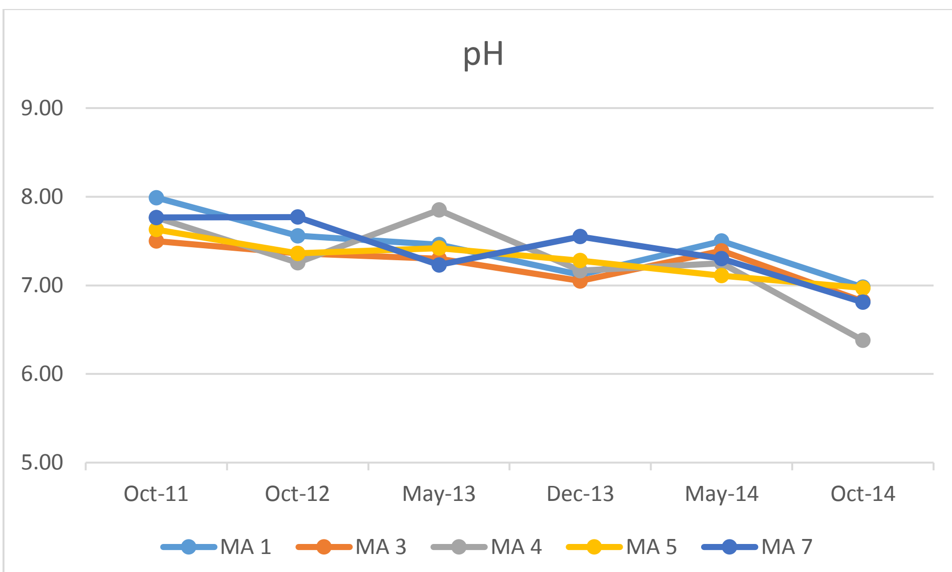
Test results showed that marsh sites (MA9 and MA10) have significantly greater salinity-related factors than the others, which is common for a saltmarsh. However, the variation of these factors from sampling times are the result of the influence of seasonal tidal water.

2.1.1 Low Ridge (MA1, MA3, MA4, MA5, and MA7)

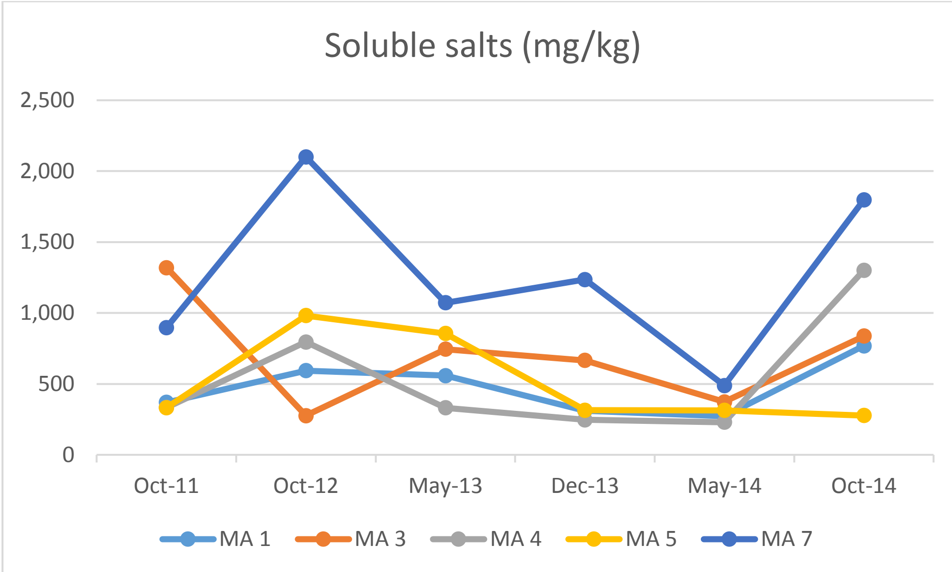
2.1.1.1 Electrical conductivity (mS/cm)



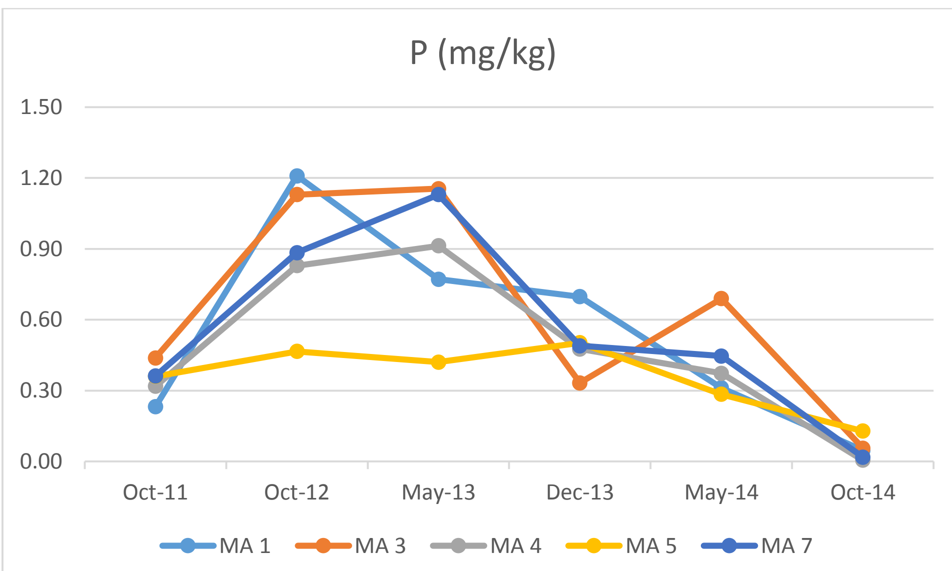
2.1.1.2 pH



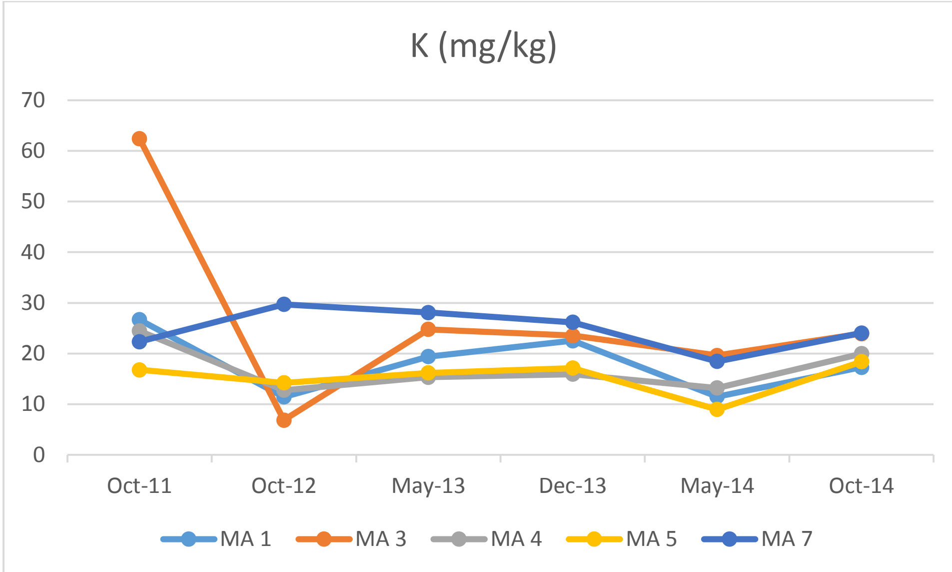
2.1.1.3 Soluble salts (mg/kg)



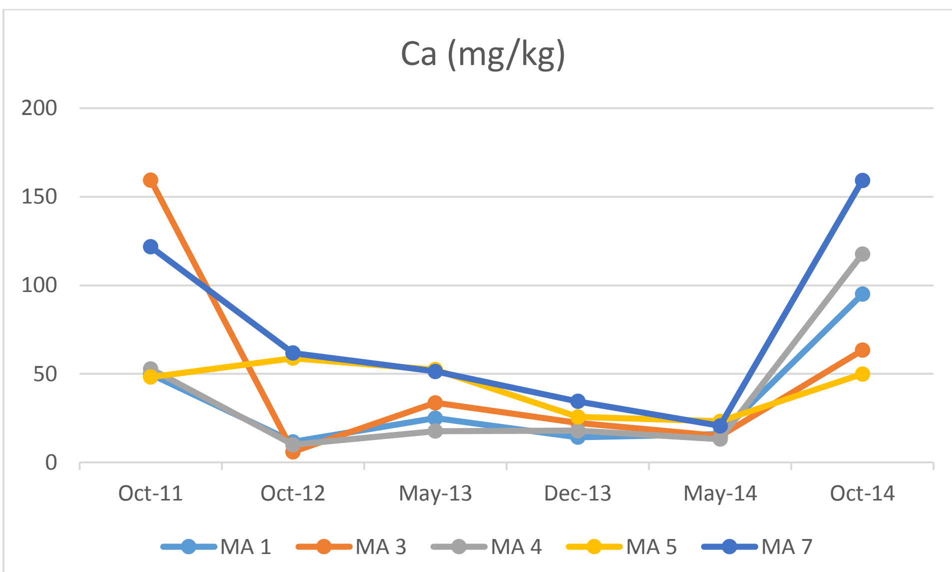
2.1.1.4 Soluble P (mg/kg)



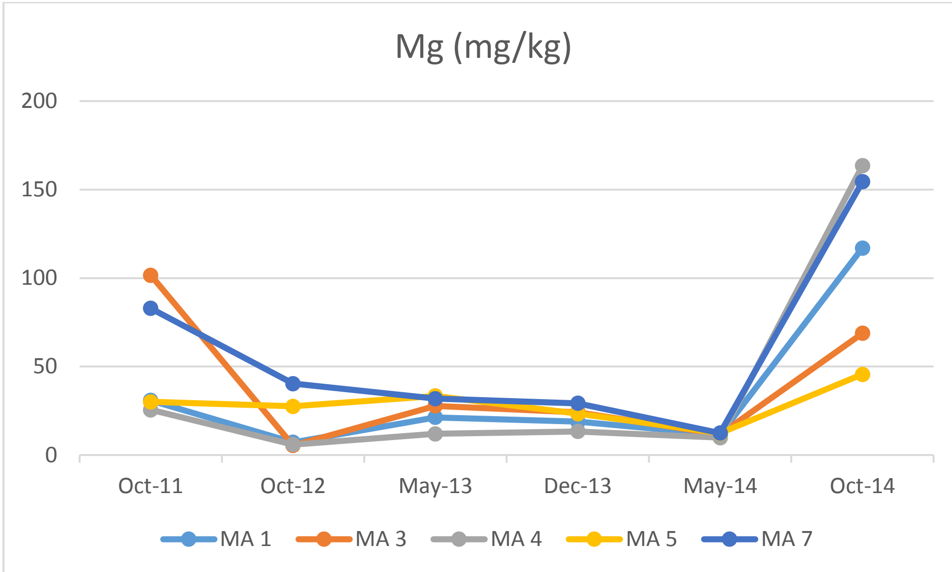
2.1.1.5 Soluble K (mg/kg)



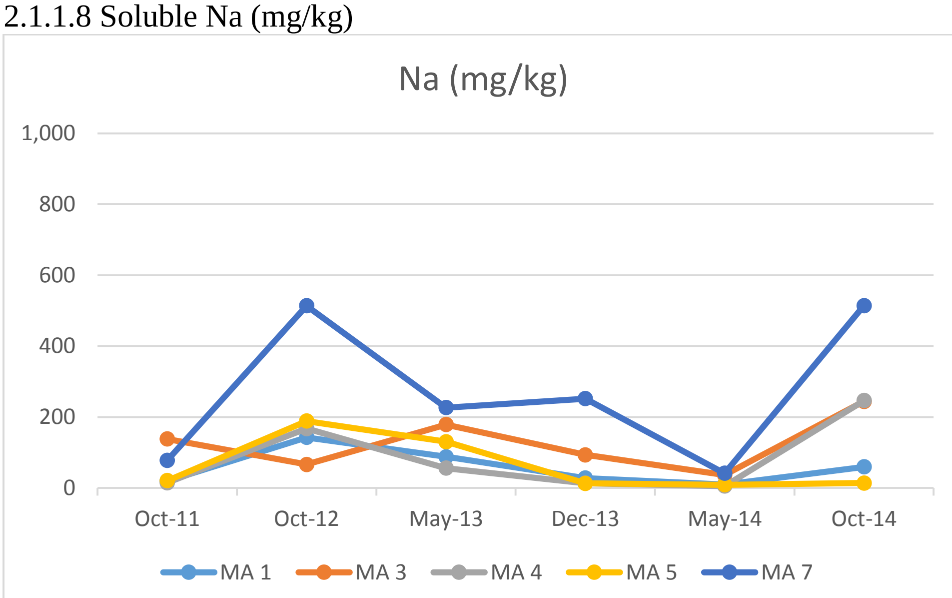
2.1.1.6 Soluble Ca (mg/kg)



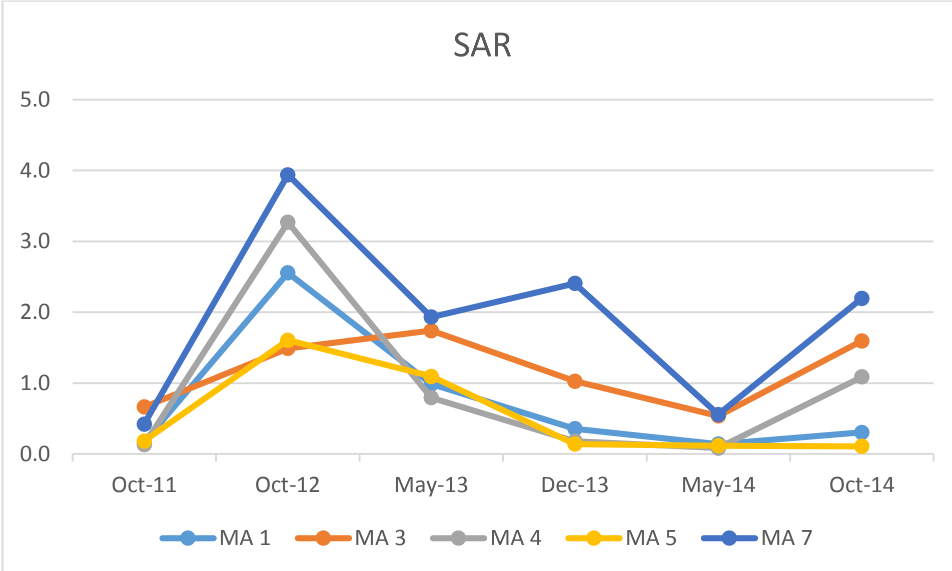
2.1.1.7 Soluble Mg (mg/kg)



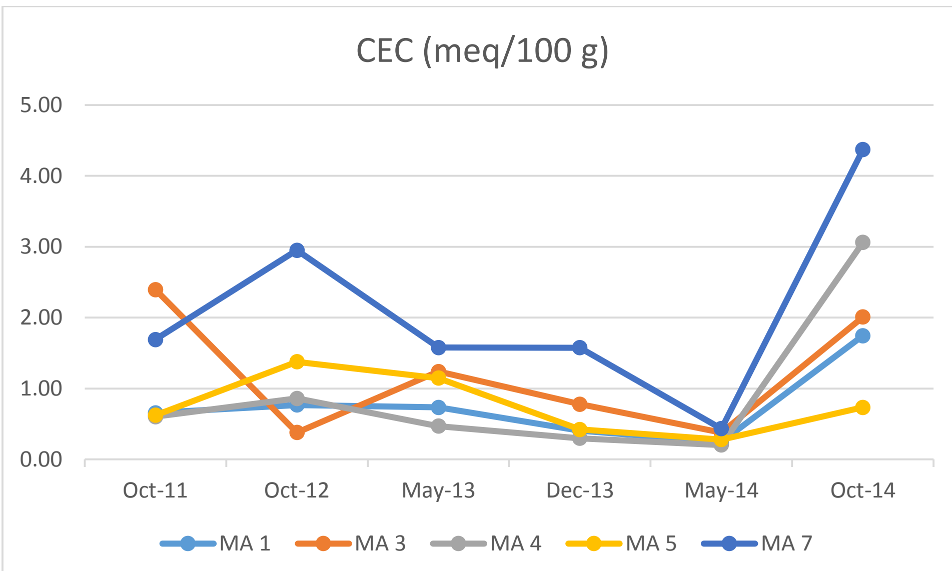
2.1.1.8 Soluble Na (mg/kg)



2.1.1.9 Sodium absorption ratio



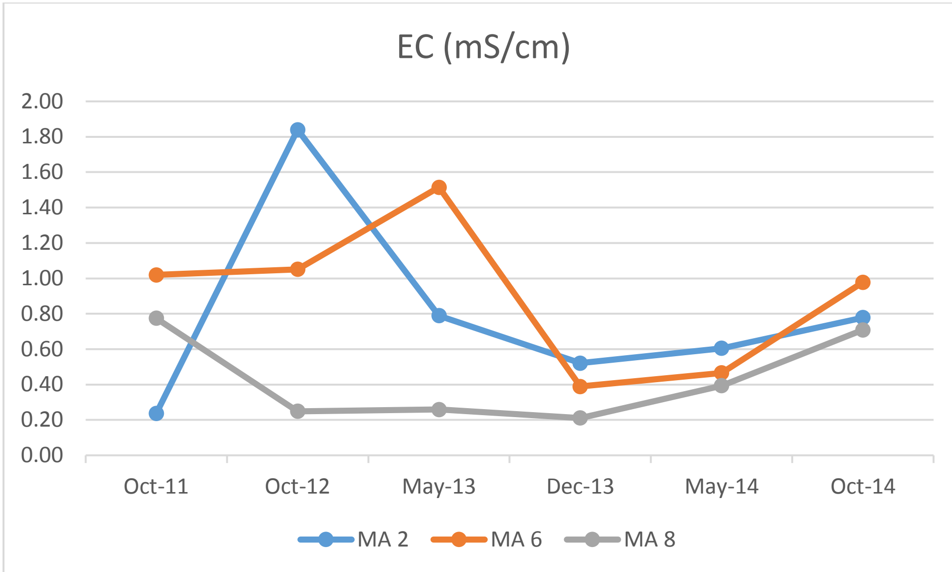
2.1.1.10 Cation exchange capacity (meq/100g soil)



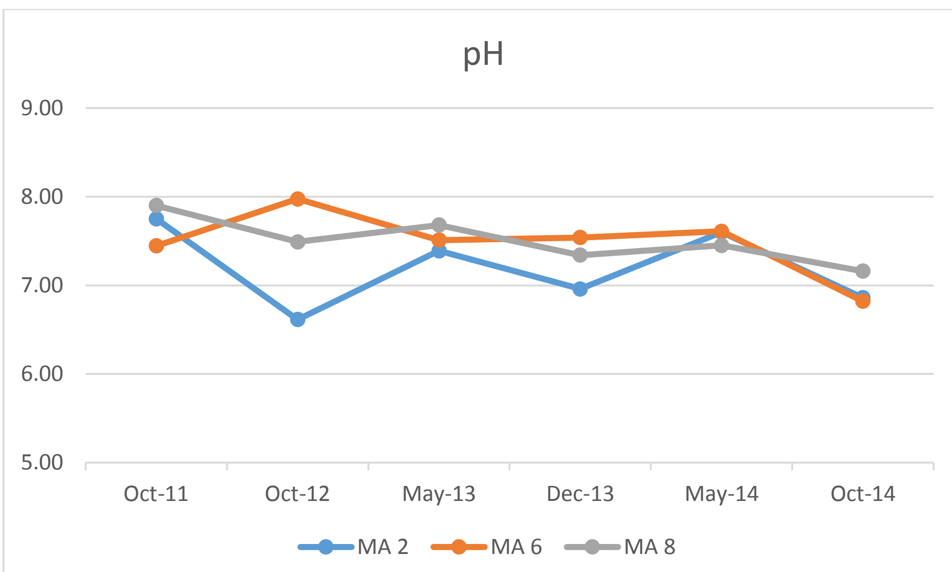
Electrical conductivity of all sites for this area were below 4.0 mS/cm. Soil pH were below 8.0 and sodium absorption ratio were below 13. The results indicated that these soil did not meet any categories for saline, sodic or saline-sodic soil. However, soluble sodium were still high for non-halophytic species. In addition, soil nutrients concertation such as P were also low. To increase productivity, fertilization for the plants in these sites would be a good practice.

2.1.2 Low Ridge Slope (MA2, MA6, and MA8).

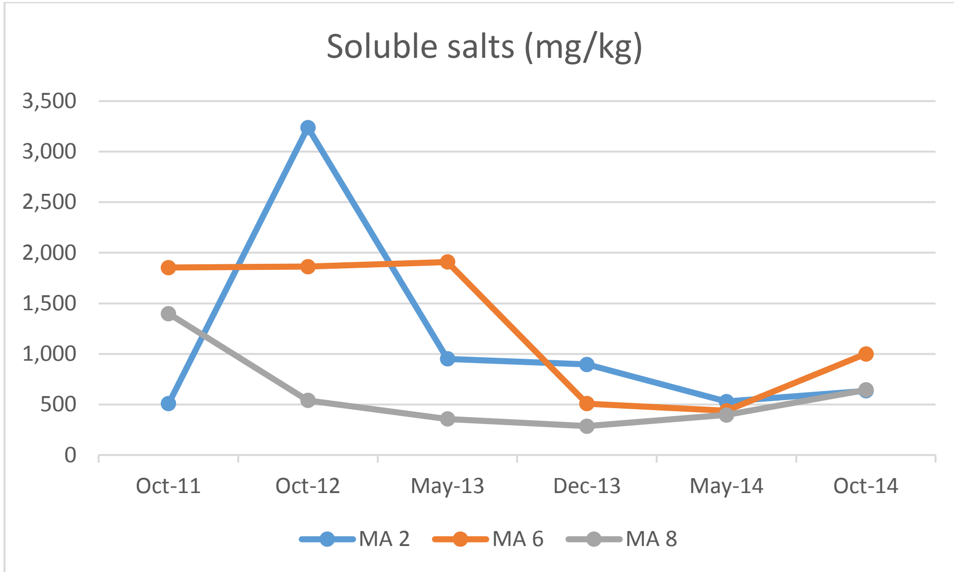
2.1.2.1 Electrical conductivity (mS/cm)



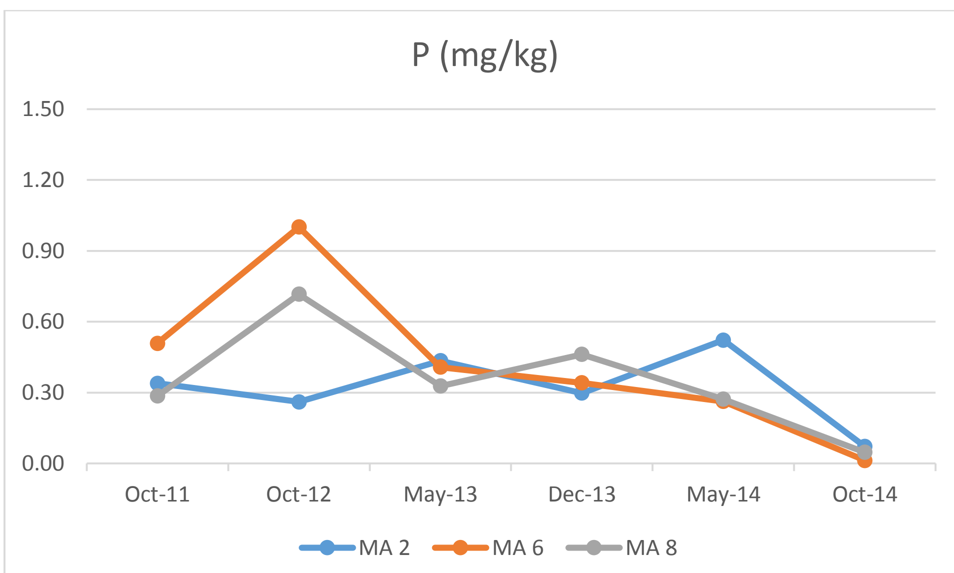
2.1.2.2 pH



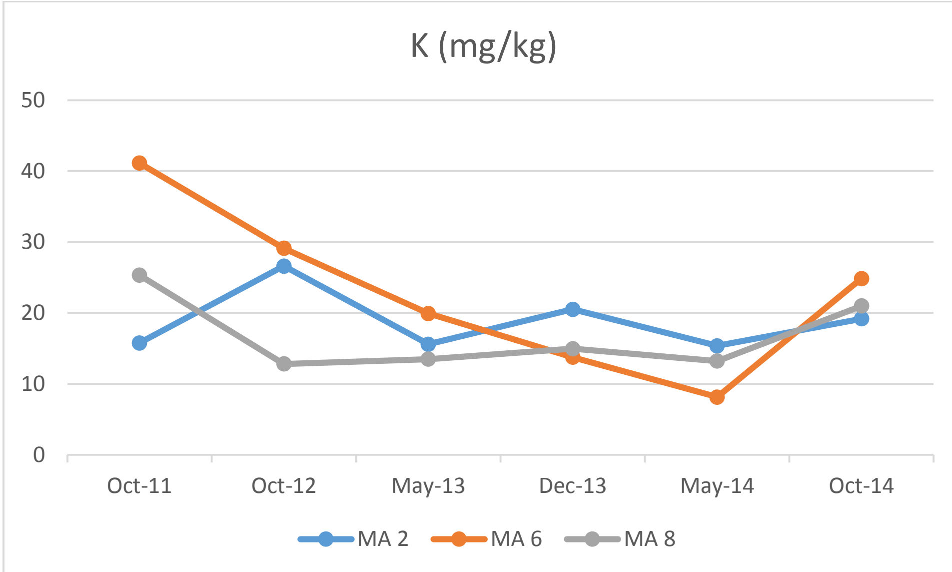
2.1.2.3 Soluble salts (mg/kg)



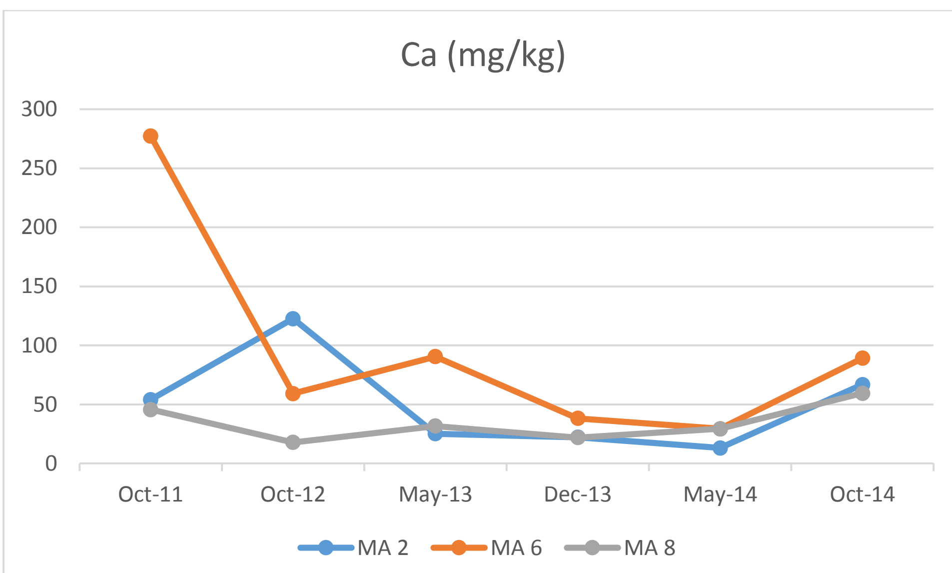
2.1.2.4 Soluble P (mg/kg)



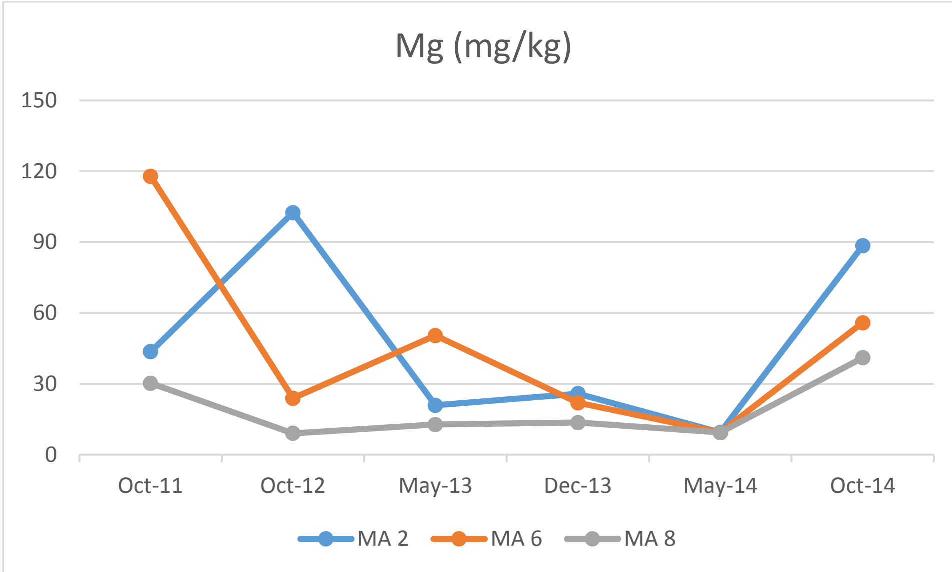
2.1.2.5 Soluble K (mg/kg)



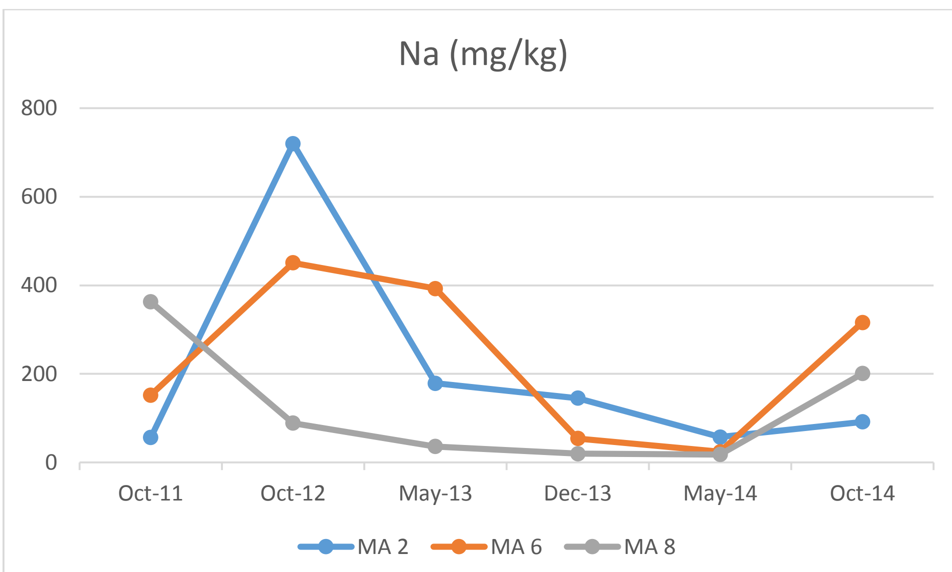
2.1.2.6 Soluble Ca (mg/kg)



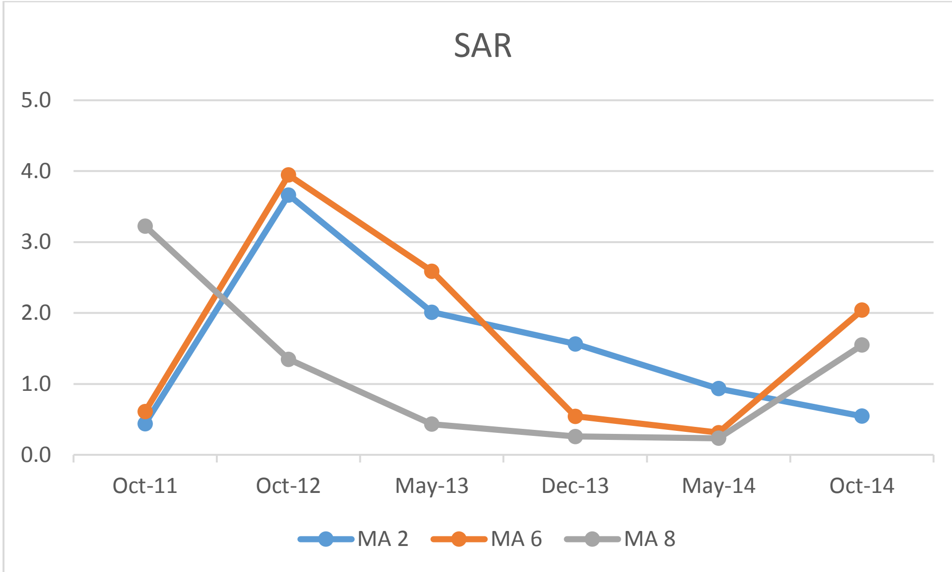
2.1.2.7 Soluble Mg (mg/kg)



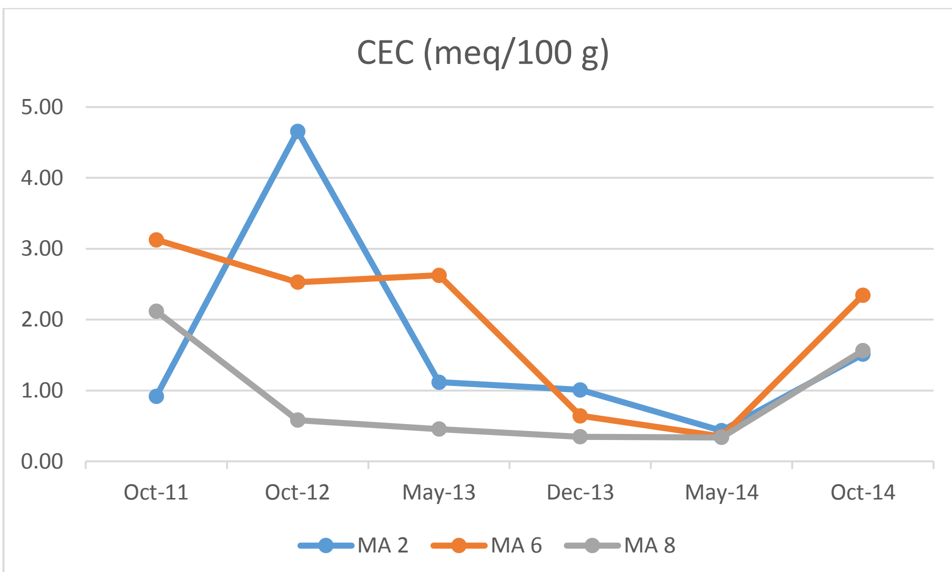
2.1.2.8 Soluble Na (mg/kg)



2.1.2.9 Sodium absorption ratio



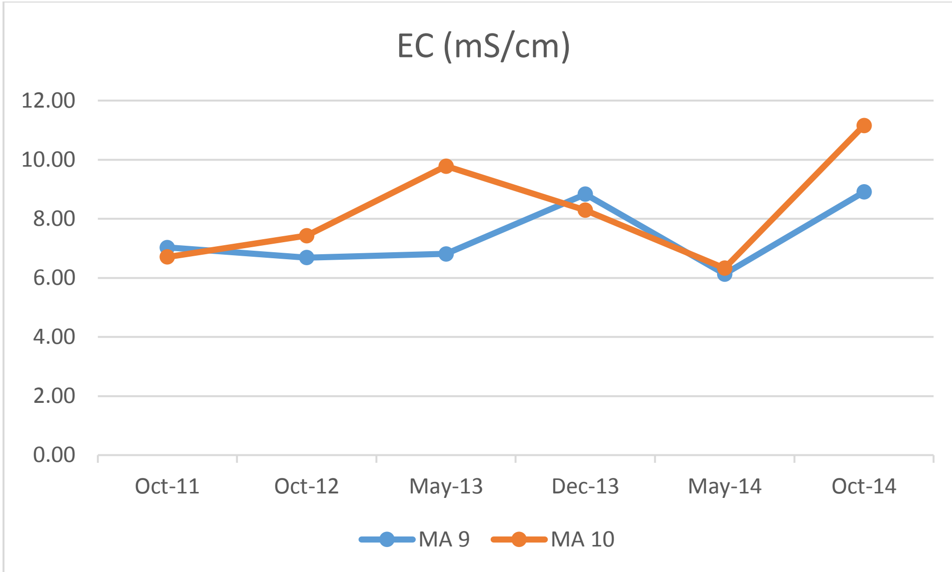
2.1.2.10 Cation exchange capacity



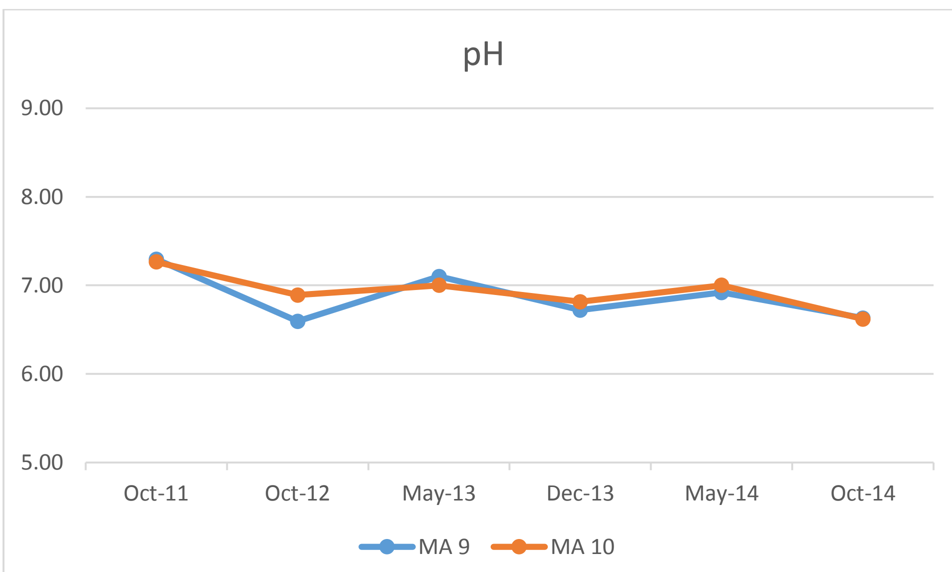
Soil test results from the Low Ridge slope were similar to the Low Ridge area. Electrical conductivity, soil pH, and sodium absorption ratio did not meet any categories for saline, sodic or saline-sodic soil. However, soil nutrients concertation such as P and K might be slightly low for some plant species.

2.1.3 Marsh (MA9 and MA10)

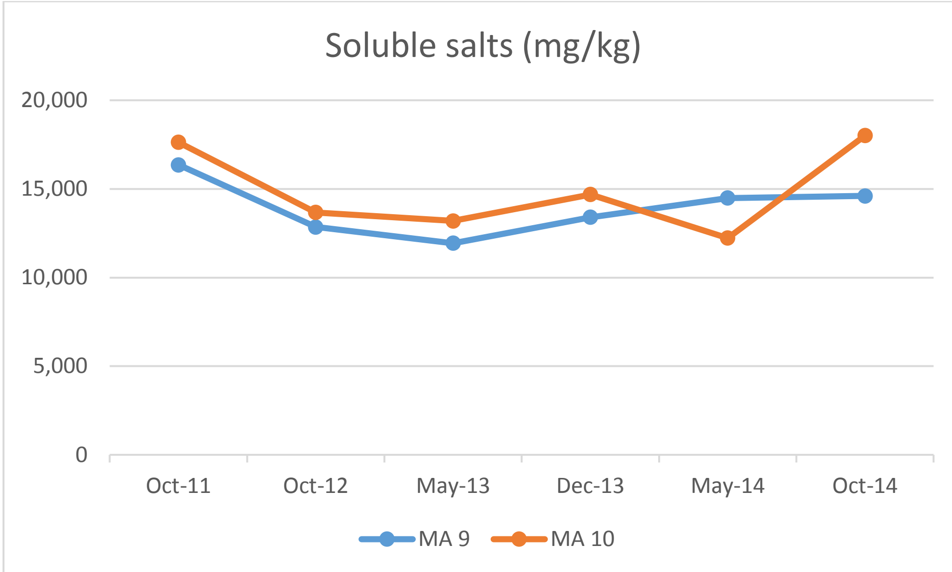
2.1.3.1 Electrical conductivity (mS/cm)



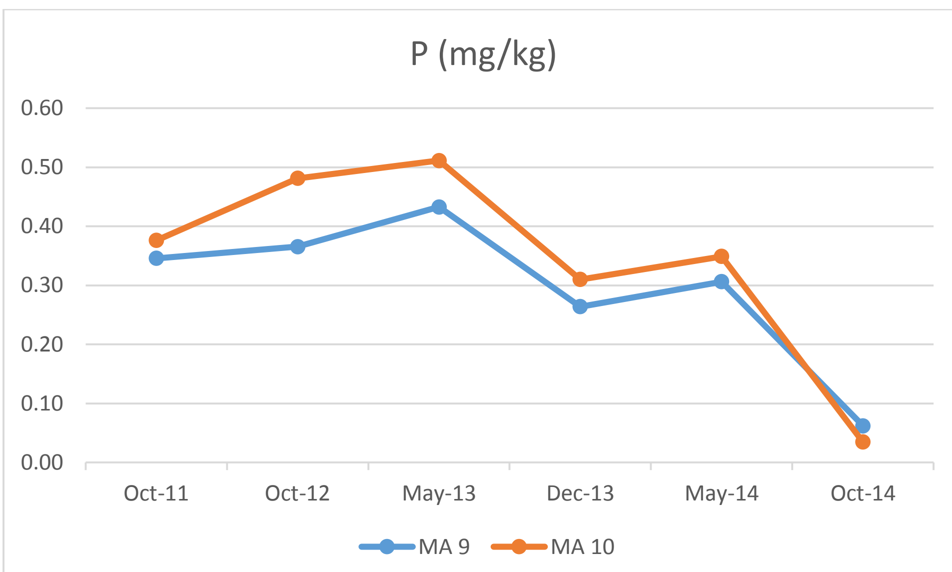
2.1.3.2 pH



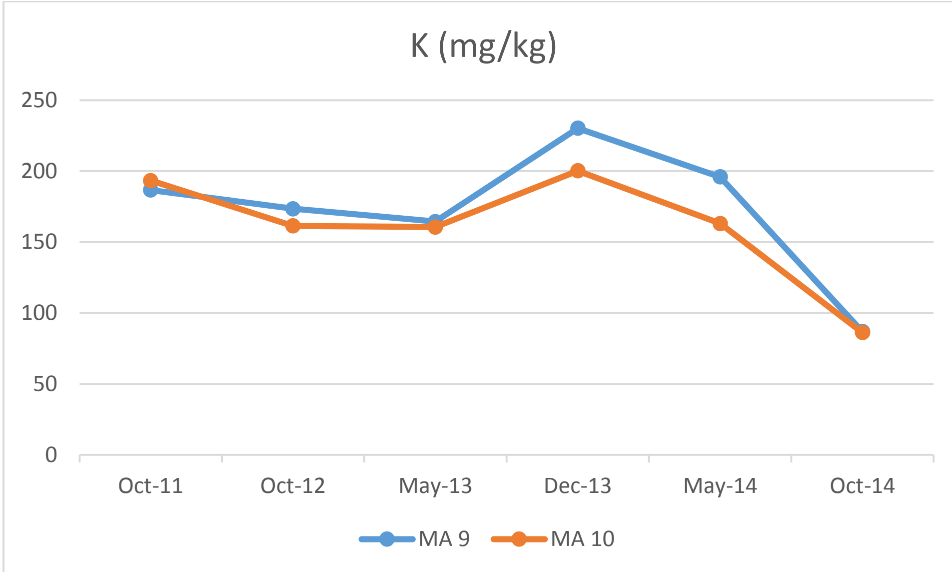
2.1.3.3 Soluble salts (mg/kg)



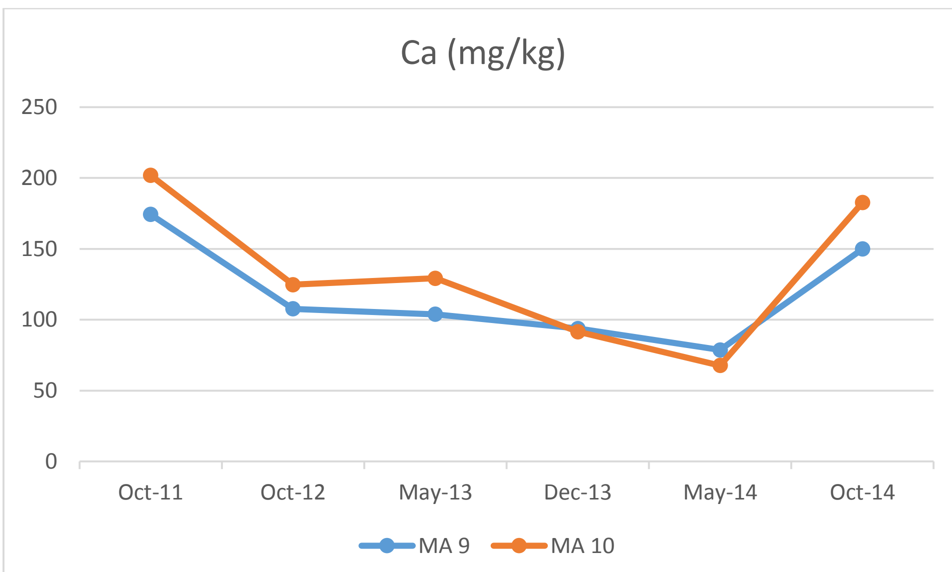
2.1.3.4 Soluble P (mg/kg)



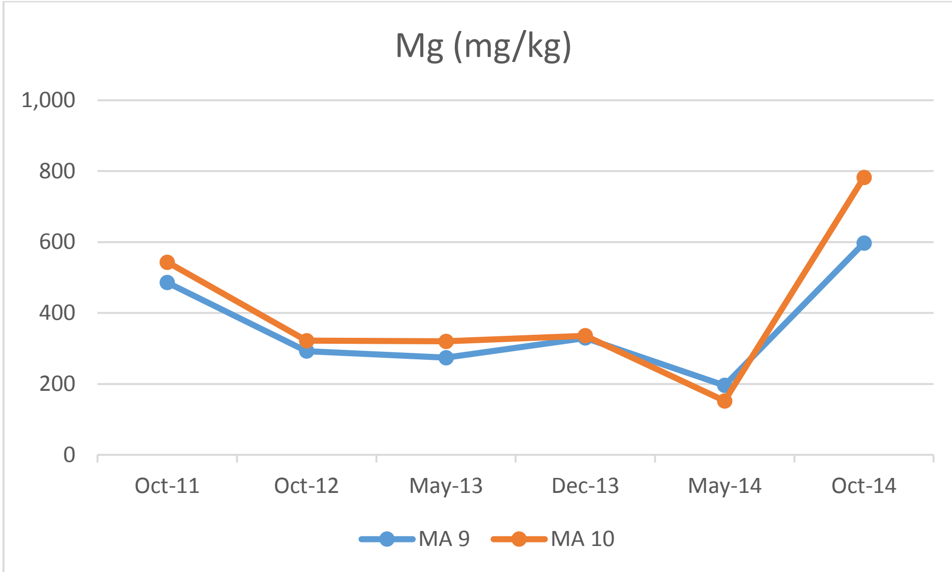
2.1.3.5 Soluble K (mg/kg)



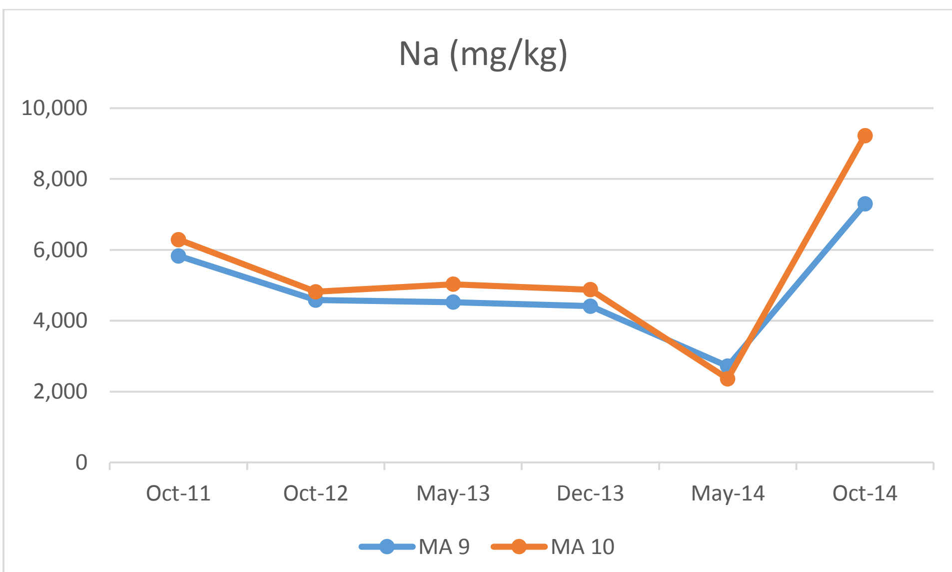
2.1.3.6 Soluble Ca (mg/kg)



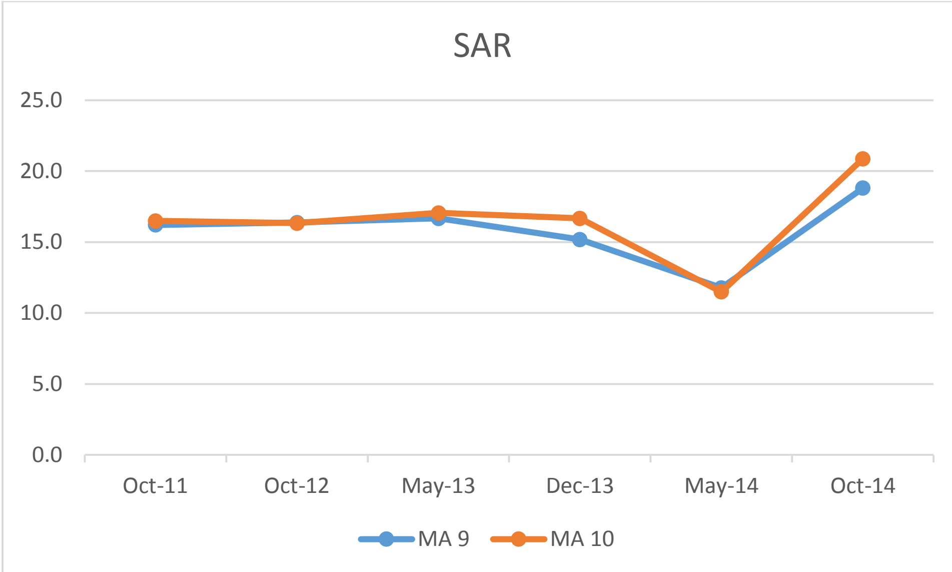
2.1.3.7 Soluble Mg (mg/kg)



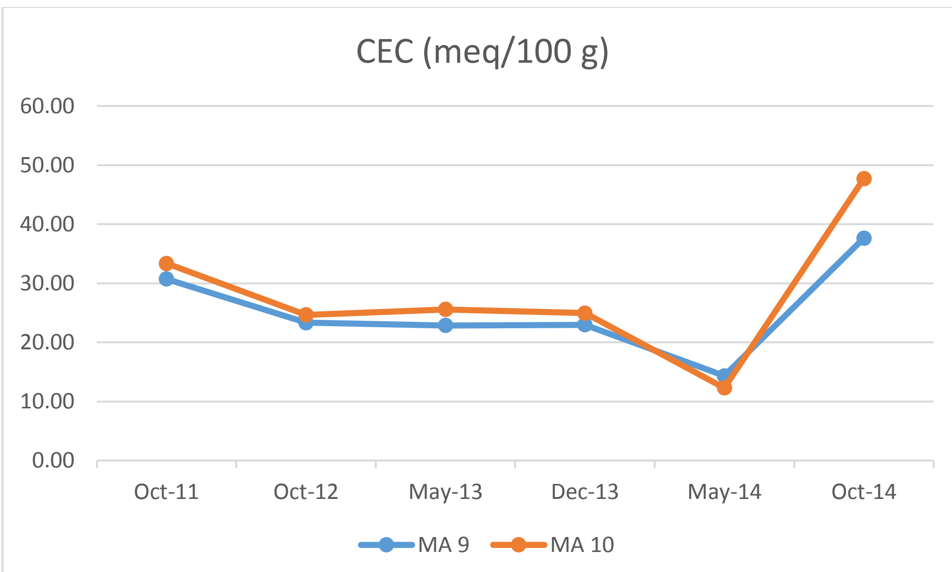
2.1.3.8 Soluble Na (mg/kg)



2.1.3.9 Sodium absorption ratio



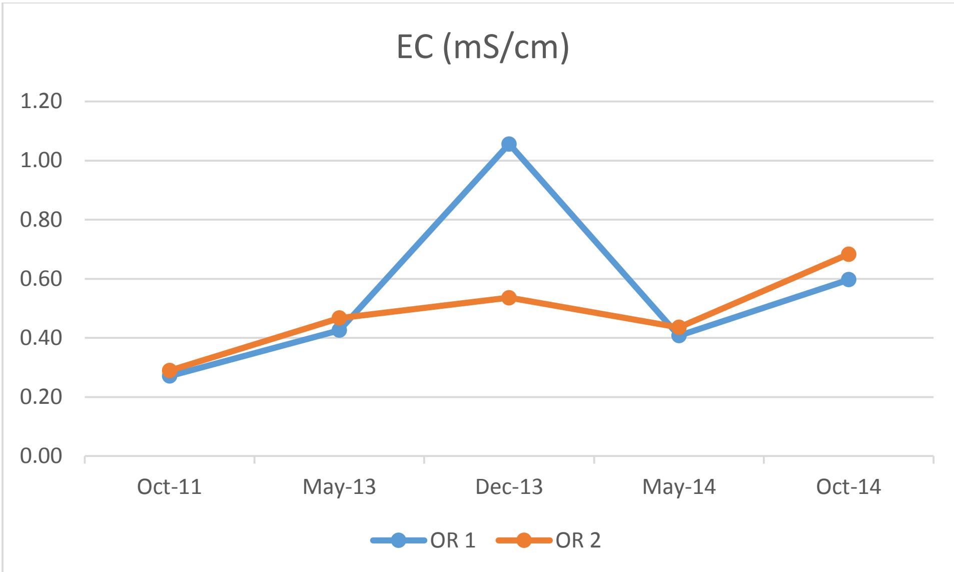
2.1.3.10 Cation exchange capacity



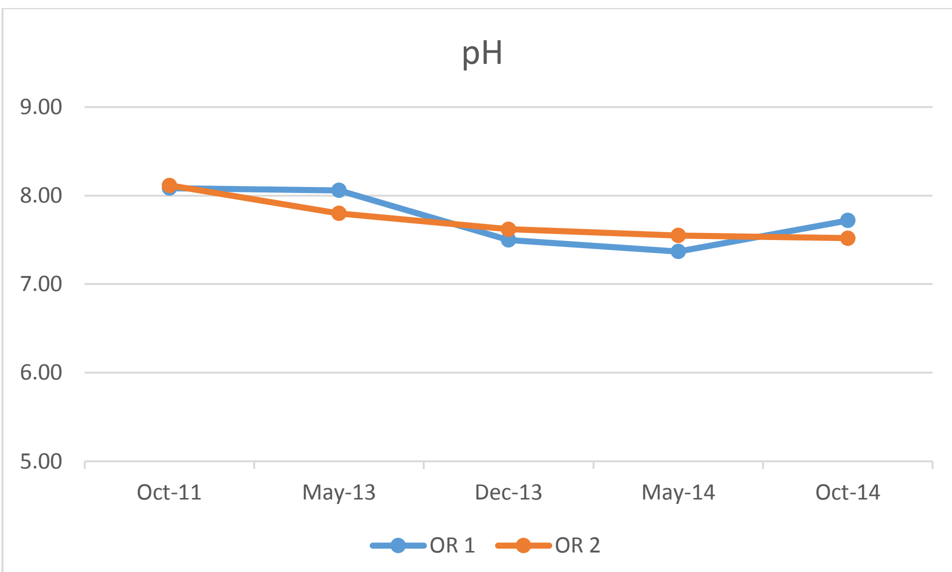
Unlike the soil test results for the Low Ridge and the Low Ridge slope, the marsh area were high in EC (>4.0 mS/cm), pH were lower than 8.5, and sodium absorption ratio were greater than 13. The site MA9 and MA10 would be classified as saline-sodic soil. Halophytic plant species, such as smooth cordgrass or black mangrove would be suitable for this area.

2.2 Old Ridge (OR): This site was created in 2003. Only two samples were collected from the Old Ridge. The average of salinity related factors appeared to be the lowest as compared to other locations and would likely not restrict plant growth.

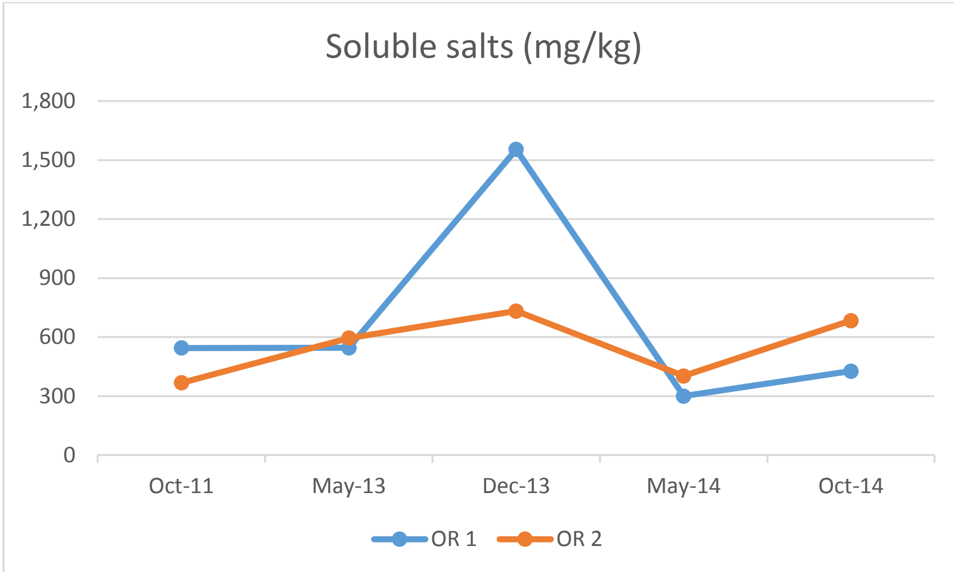
2.2.1 Electrical conductivity (mS/cm)



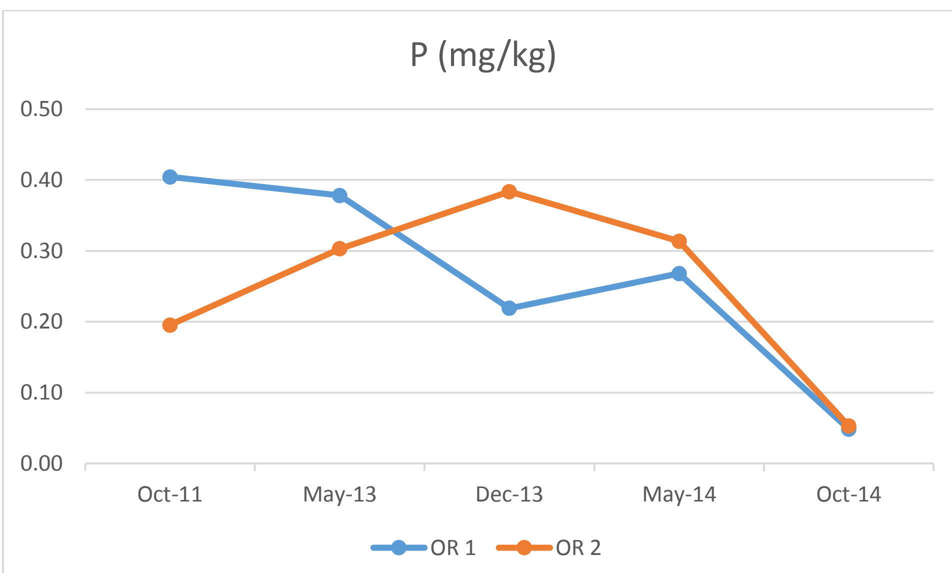
2.2.2 pH



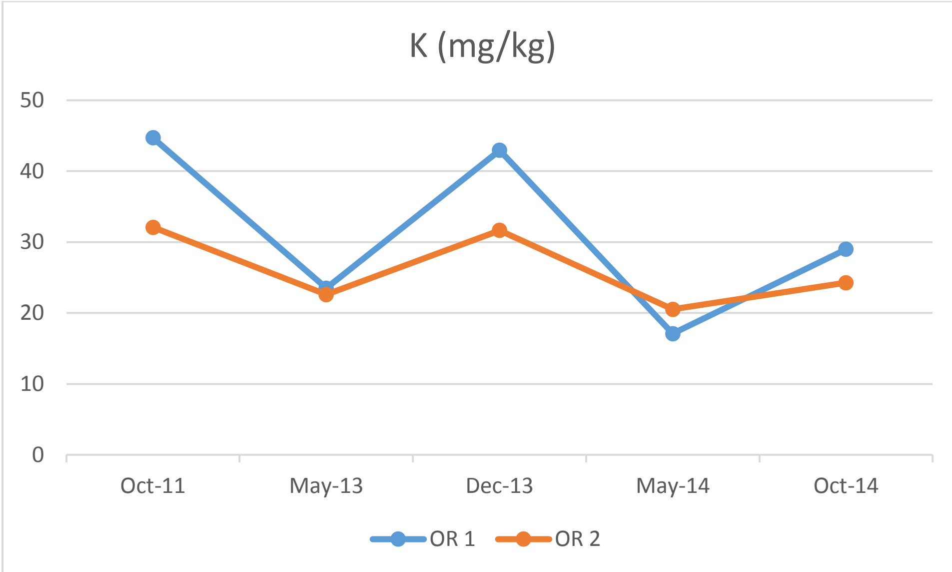
2.2.3 Soluble salts (mg/kg)



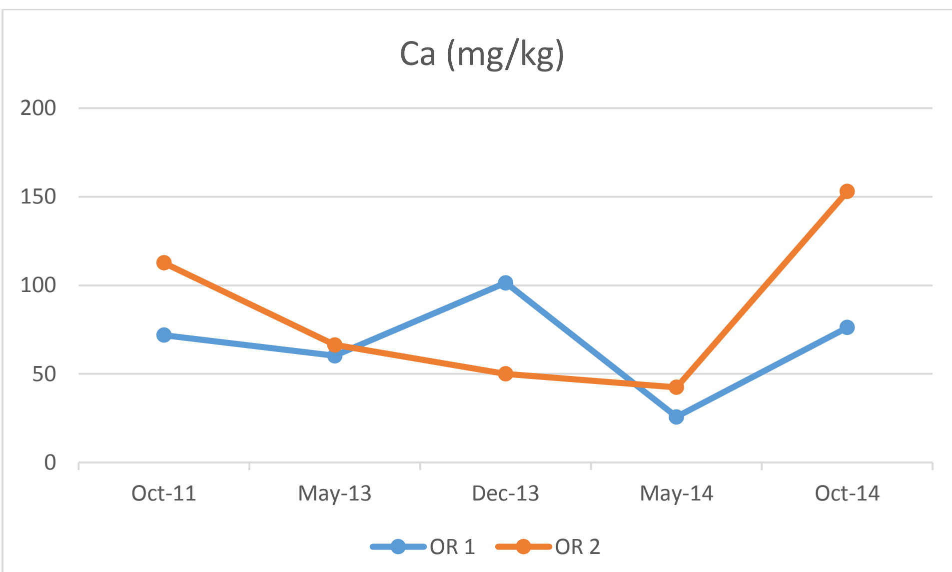
2.2.4 Soluble P (mg/kg)



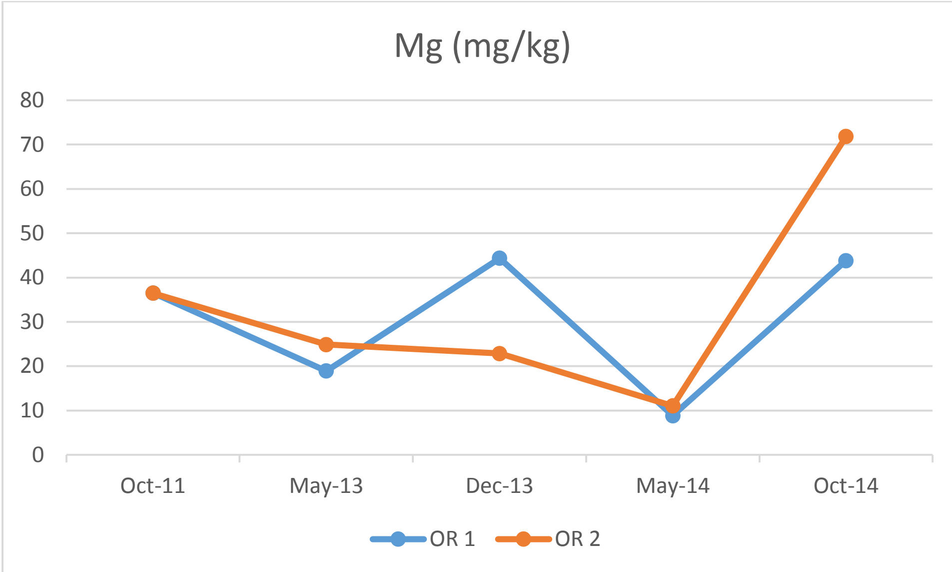
2.2.5 Soluble K (mg/kg)



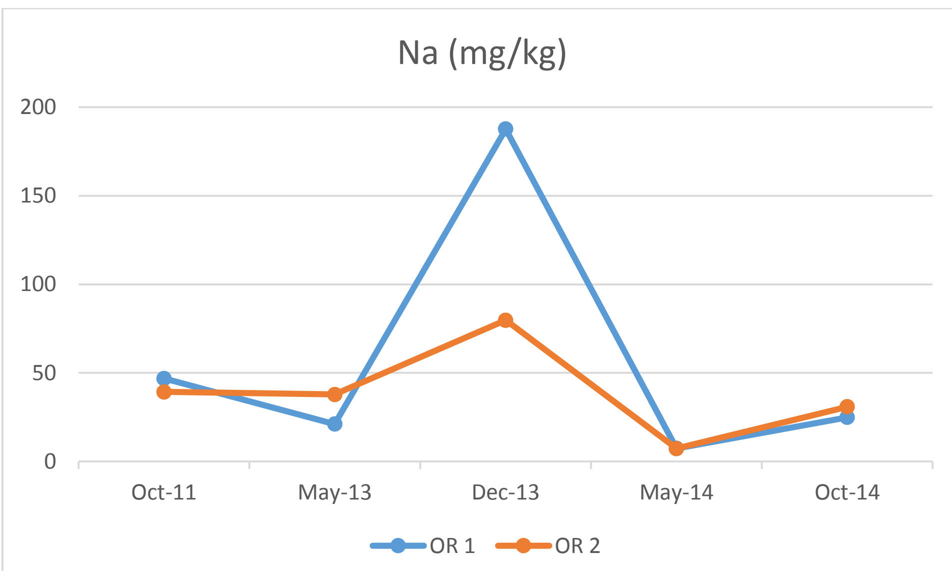
2.2.6 Soluble Ca (mg/kg)



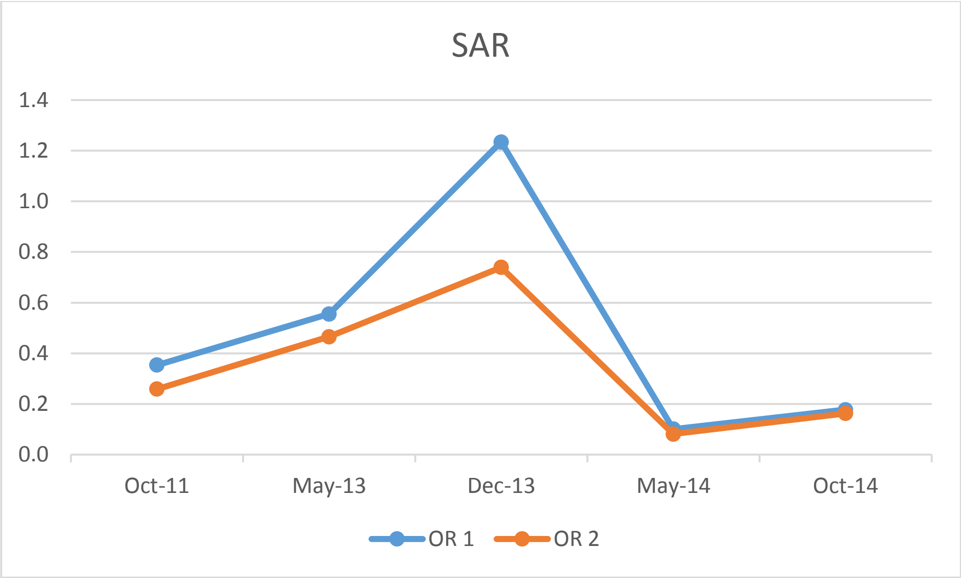
2.2.7 Soluble Mg (mg/kg)



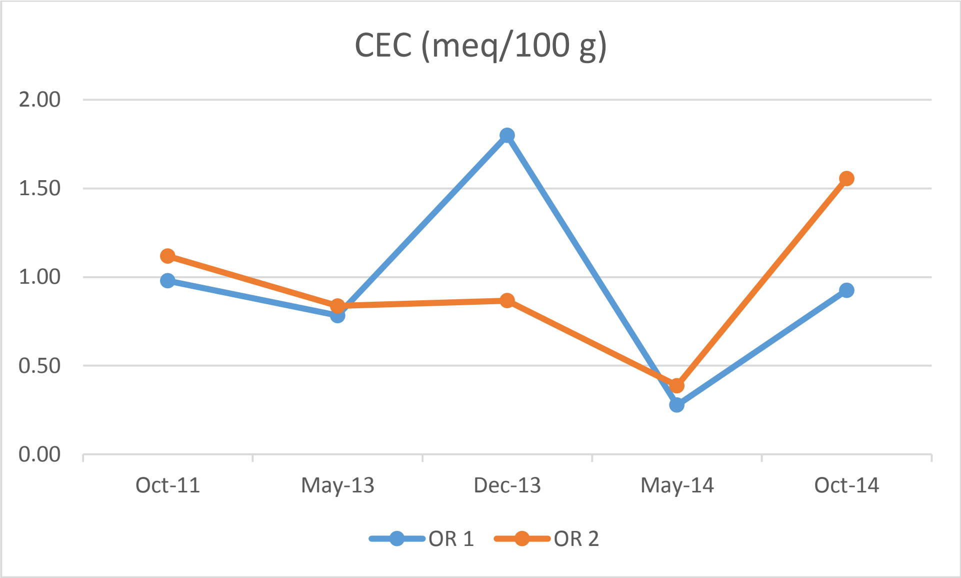
2.2.8 Soluble Na (mg/kg)



2.2.9 Sodium absorption ratio



2.2.10 Cation exchange capacity (meq/100 g soil)

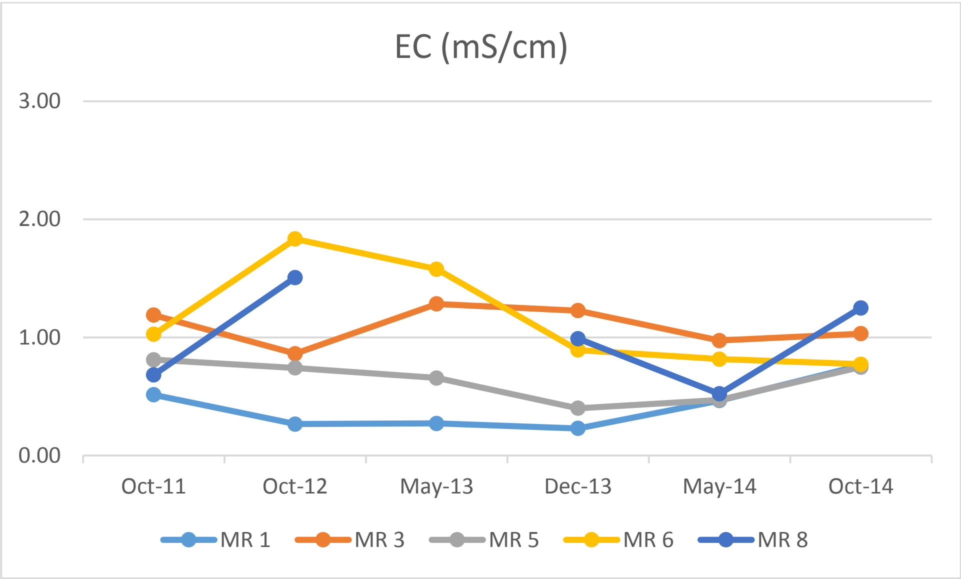


EC, pH, and SAR were lower than the minimum requirement for any soil salinity categories. The test results were similar to the Mitigation Area (both Low Ridge and Low Ridge slope), which indicated that the soil condition could be ready for many plant species from minimum to high salt tolerant.

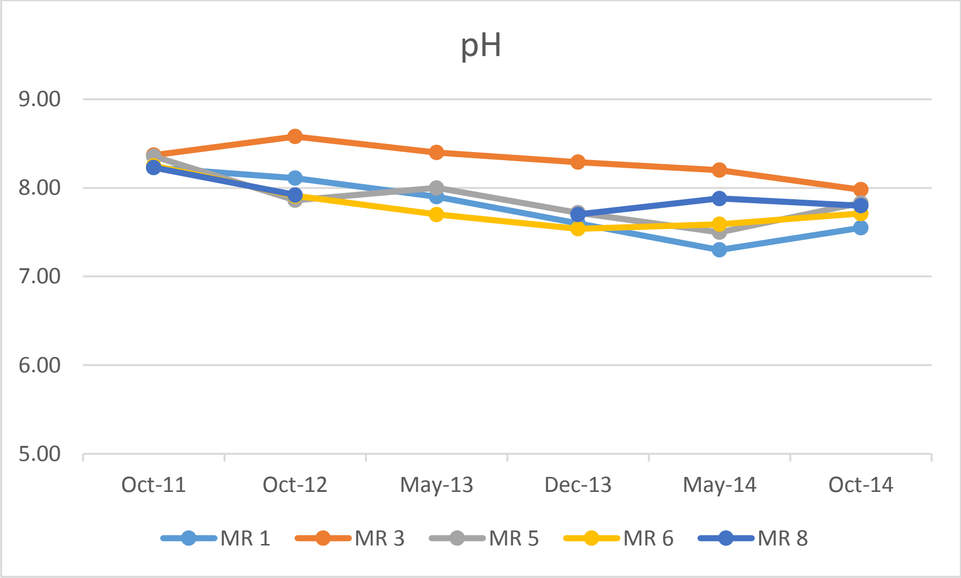
2.3 Middle Ridge (MR1-MR10). Ten samples were collected from this site that was created in summer 2005. Five samples were collected from ridge top (MR1, MR3, MR5, MR6, and MR8); four samples from marsh area (MR2, MR4, MR7, and MR9); and one sample from ridge slope (MR10). In addition to Middle Ridge area, an additional site collected from Middle Ridge North (MRN1), which was created from a pipeline pipe slurry outfall consisting entirely of oyster shell in summer 2011.

2.3.1 Ridge Top (MR1, MR3, MR5, MR6, and MR8)

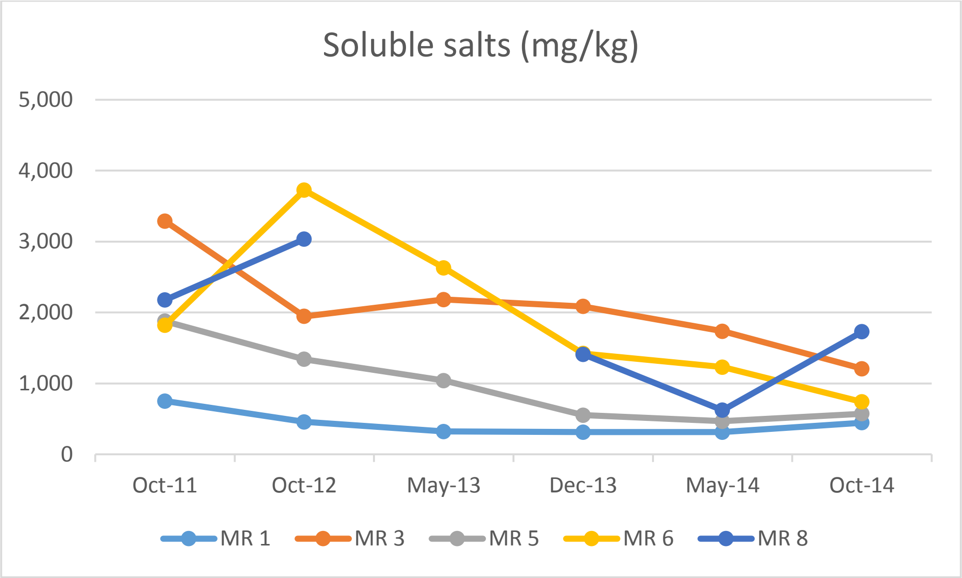
2.3.1.1 Electrical conductivity (mS/cm)



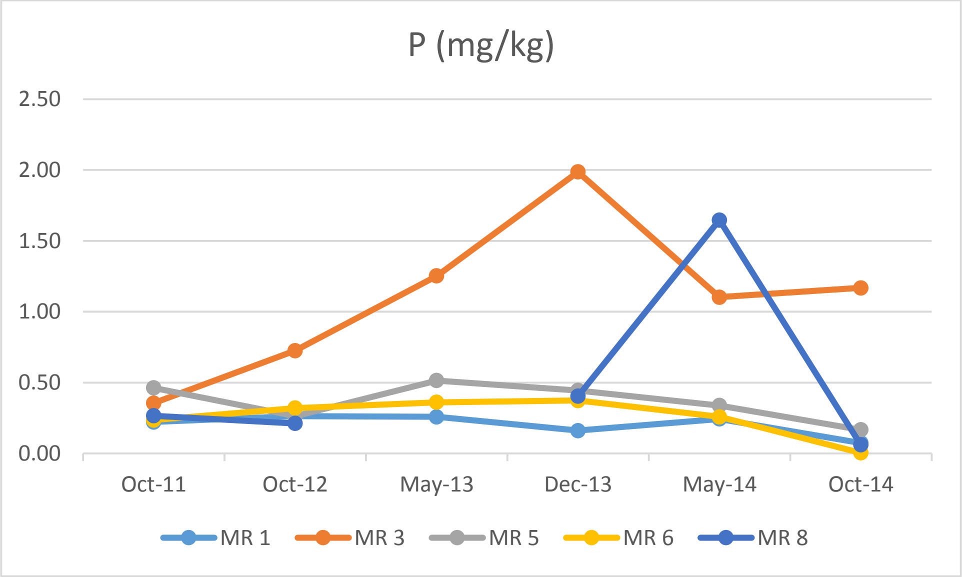
2.3.1.2 pH



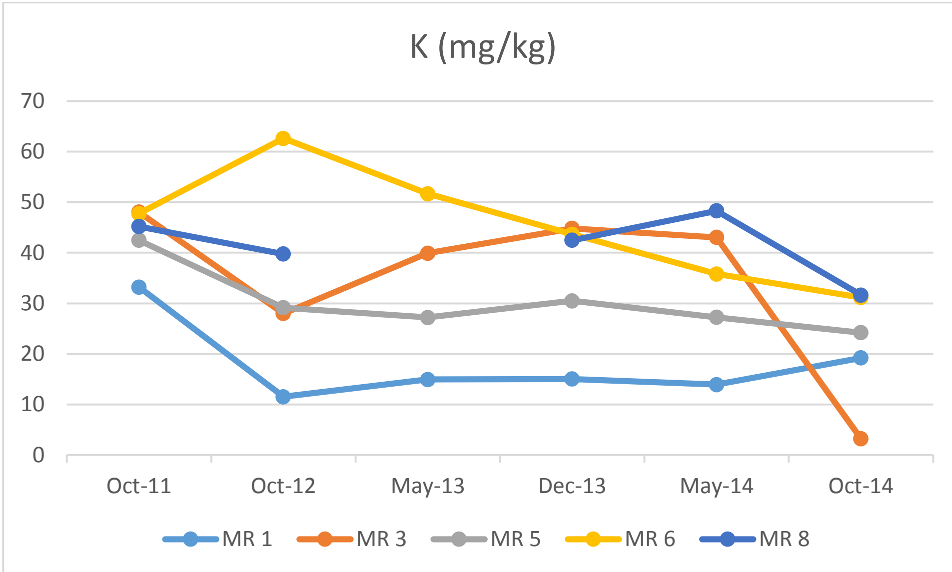
2.3.1.3 Soluble salts (mg/kg)



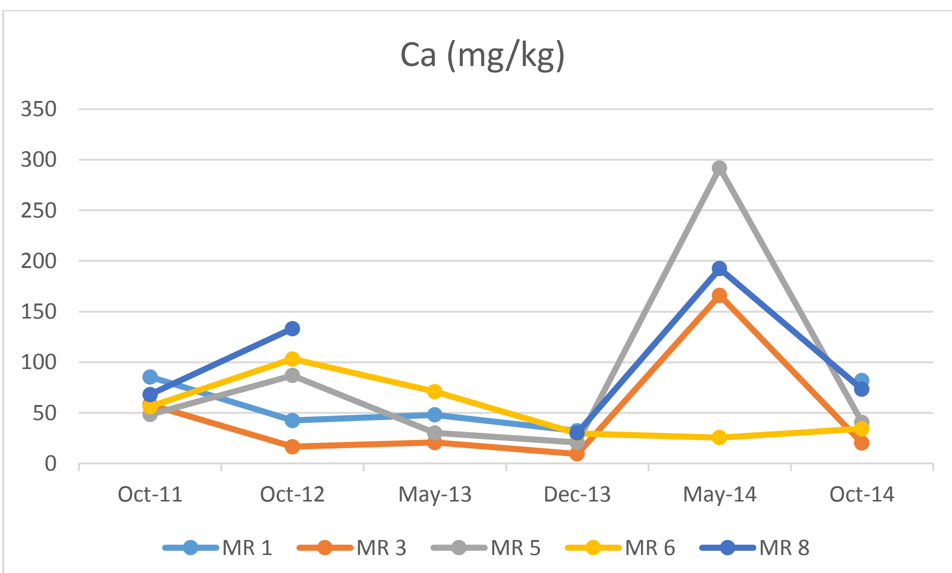
2.3.1.4 Soluble P (mg/kg)



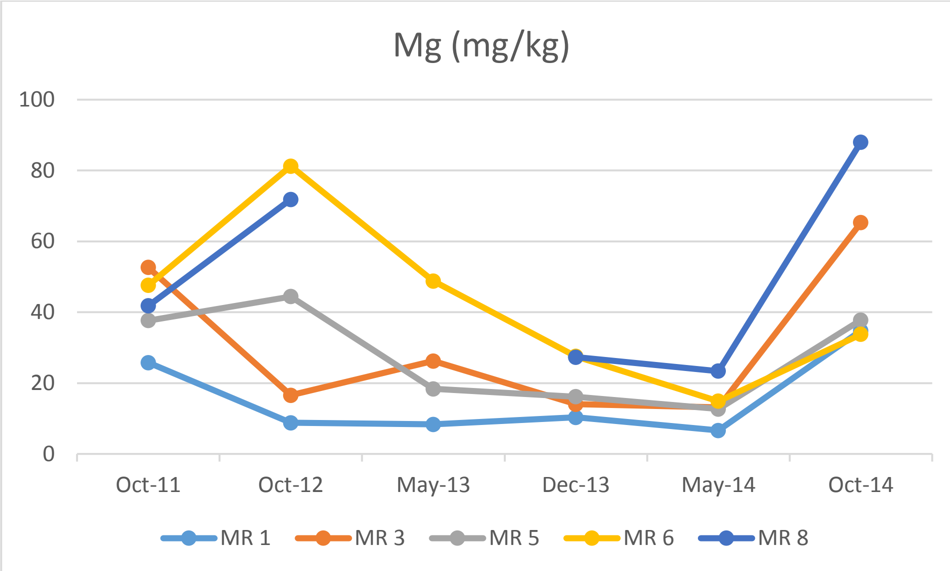
2.3.1.5 Soluble K (mg/kg)



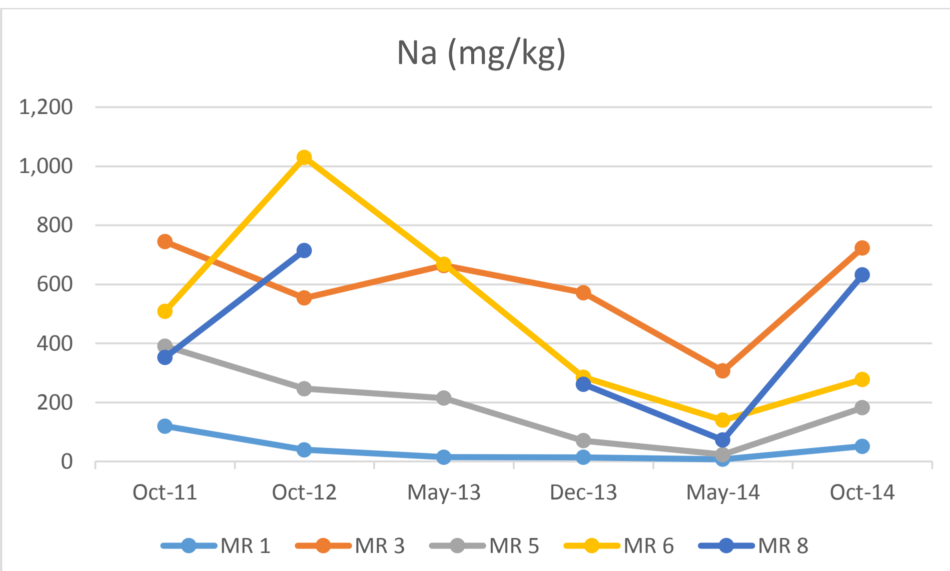
2.3.1.6 Soluble Ca (mg/kg)



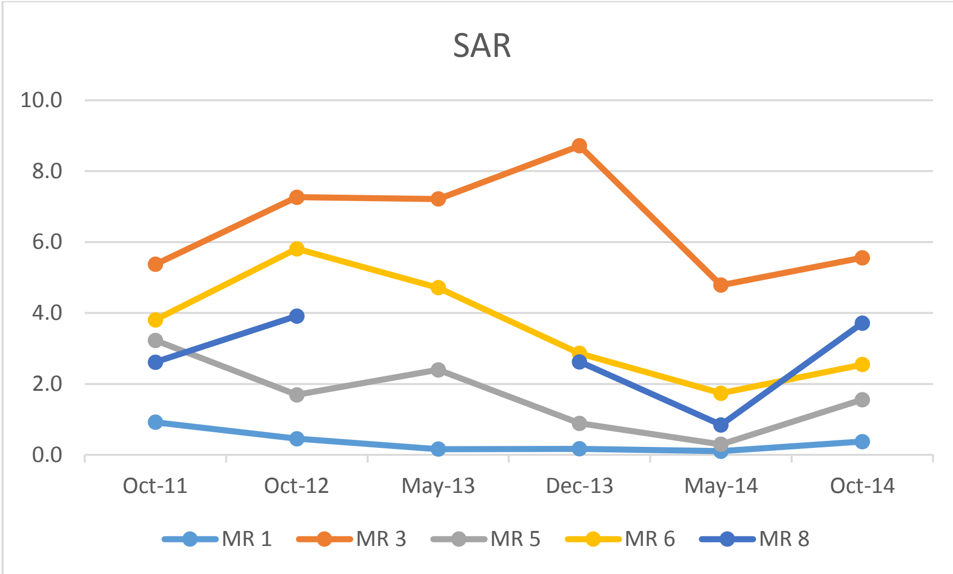
2.3.1.7 Soluble Mg (mg/kg)



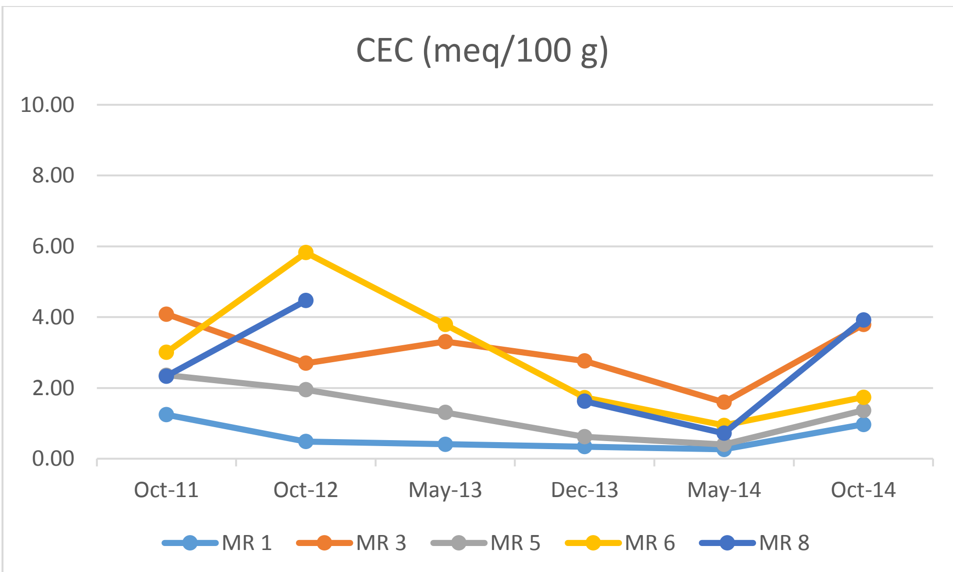
2.3.1.8 Soluble Na (mg/kg)



2.3.1.9 Sodium absorption ratio



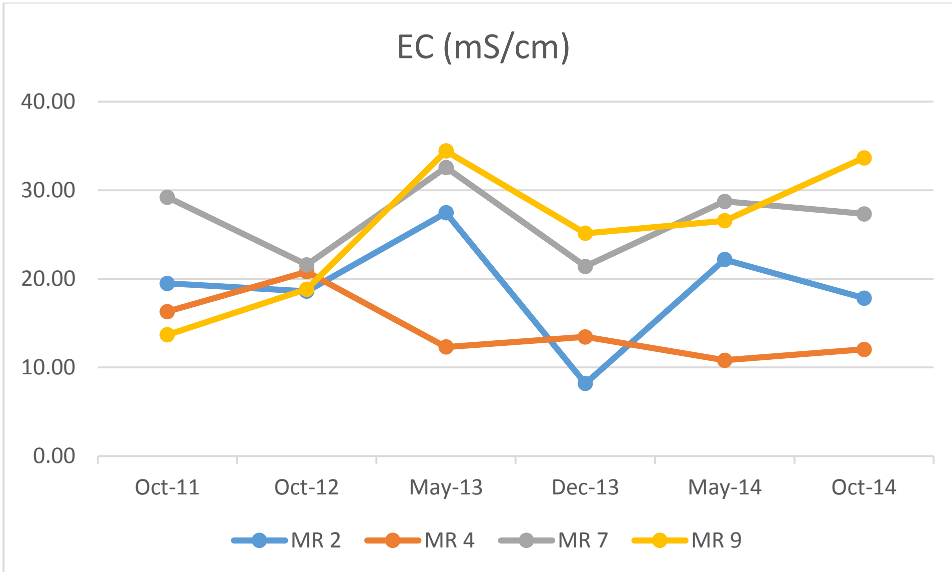
2.3.1.10 Cation exchange capacity (meq/100 g soil)



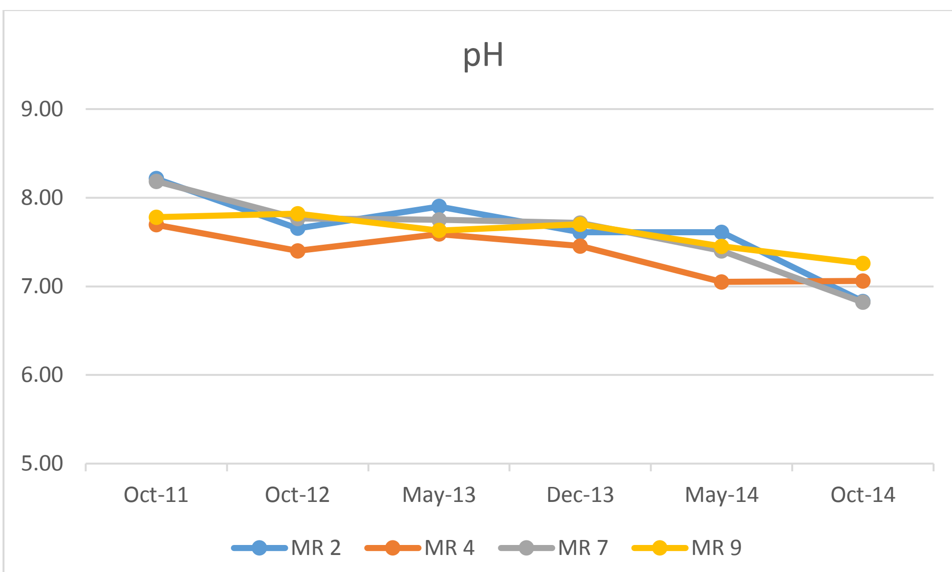
Soil test results from the Ridge Top of Middle Ridge area were similar to the Mitigation Area (Low Ridge and Low Ridge slope), particularly for the EC, pH, and SAR, which were lower than the minimum requirement for any soil salinity categories. The test results indicated that the soil conditions could be ready for many plant species. However, soluble sodium were high that might impact some plant species.

2.3.2 Marsh (MR2, MR4, MR7, and MR9)

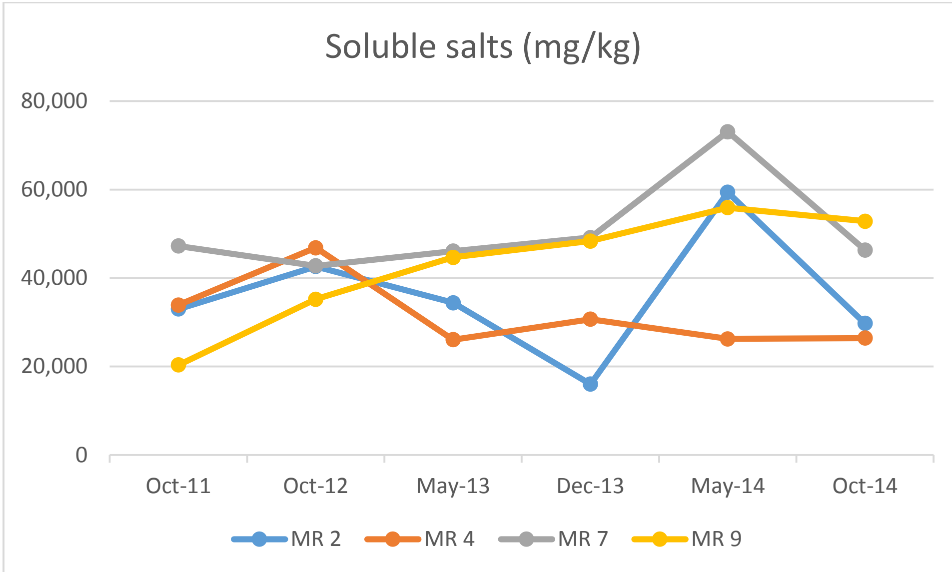
2.3.2.1 Soluble salts (mg/kg)



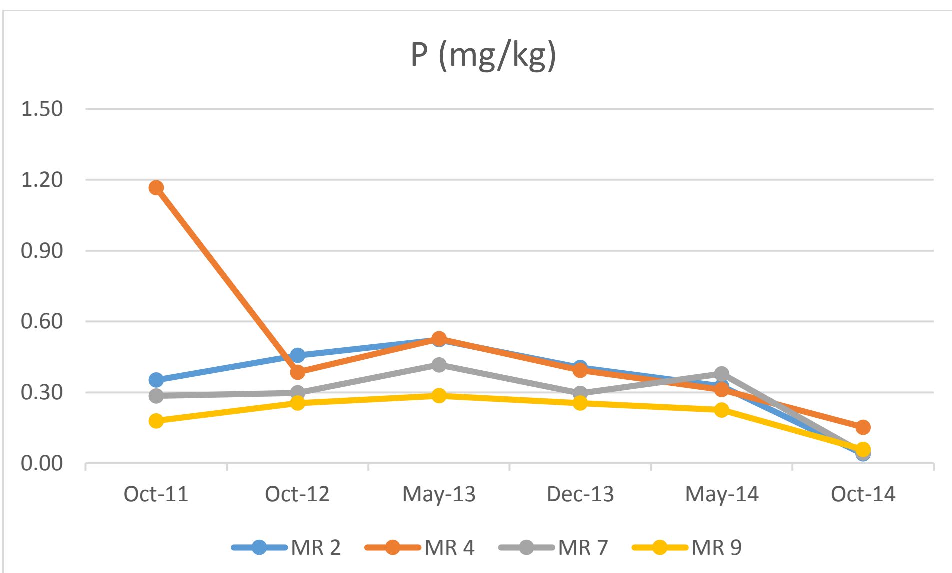
2.3.2.2 pH



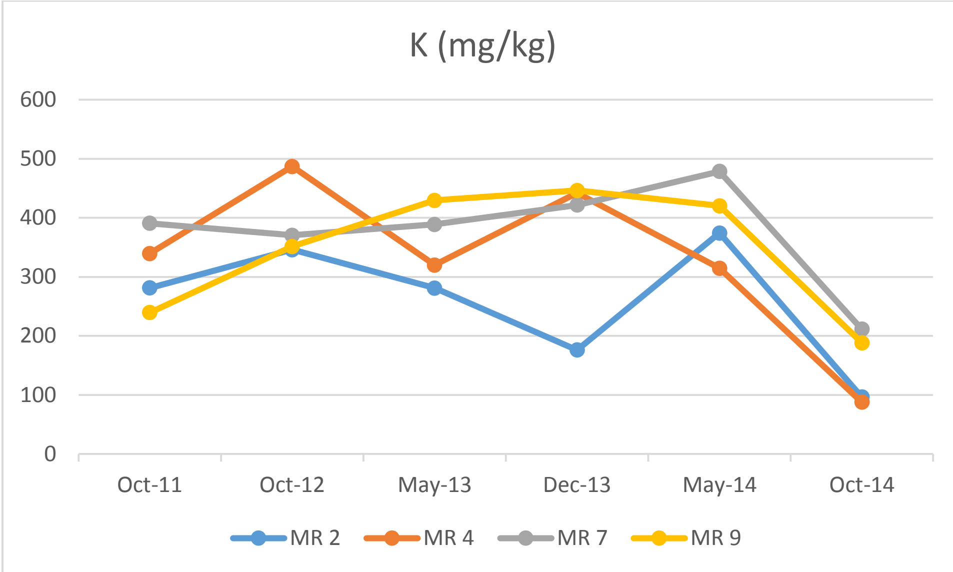
2.3.2.3 Soluble salts (mg/kg)



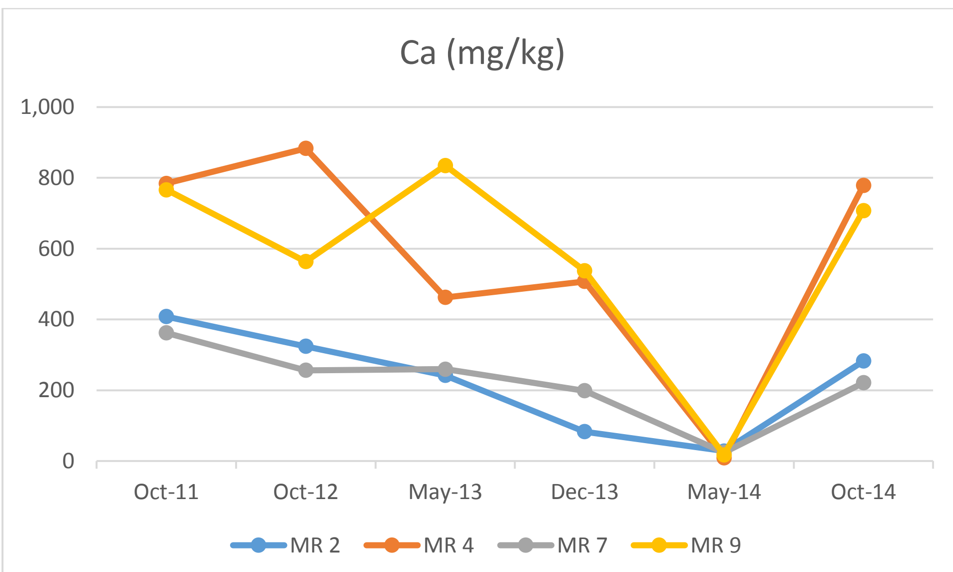
2.3.2.4 Soluble P (mg/kg)



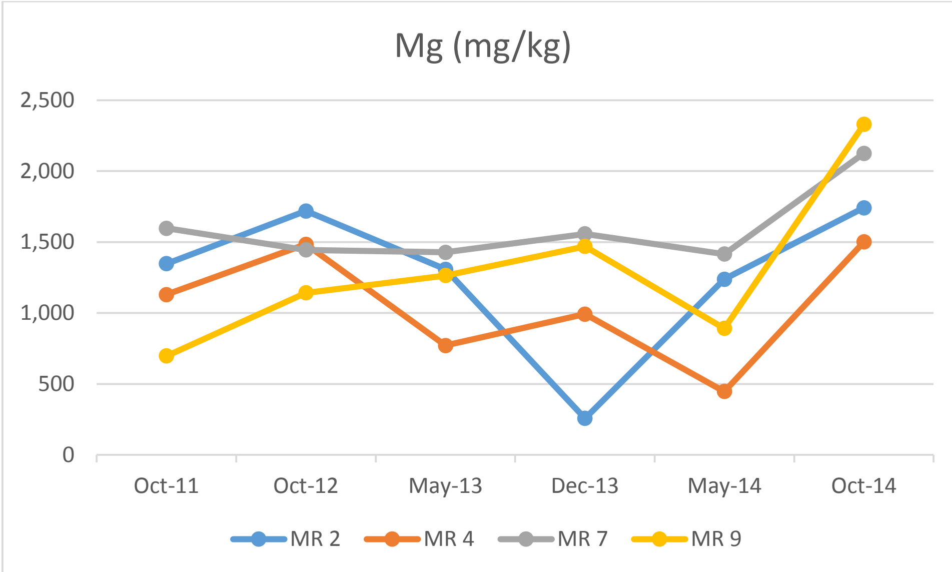
2.3.2.5 Soluble K (mg/kg)



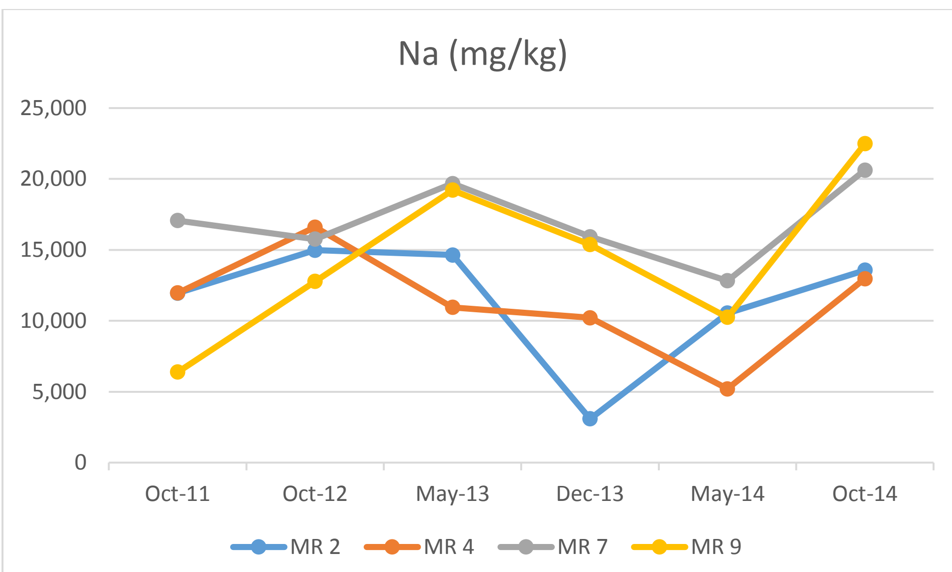
2.3.2.6 Soluble Ca (mg/kg)



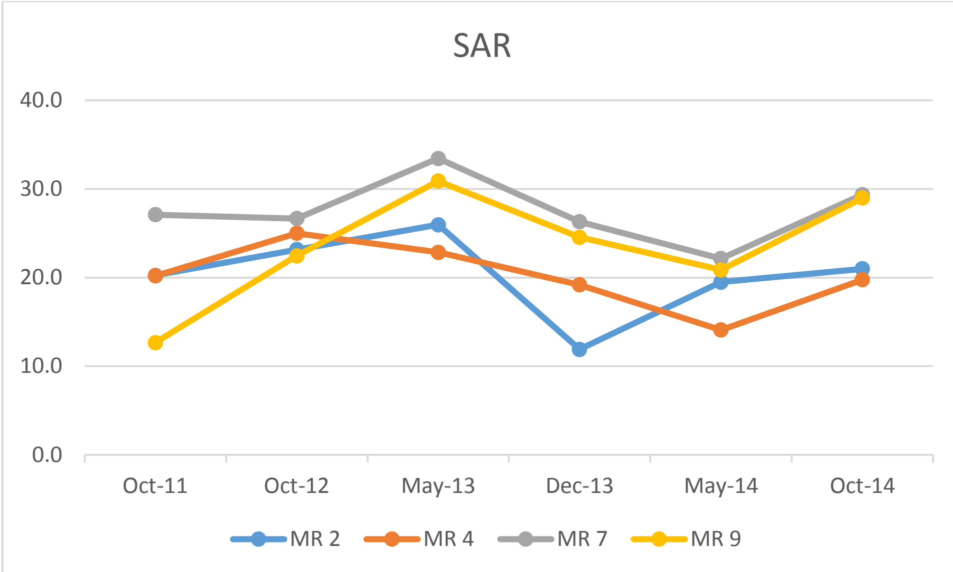
2.3.2.7 Soluble Mg (mg/kg)



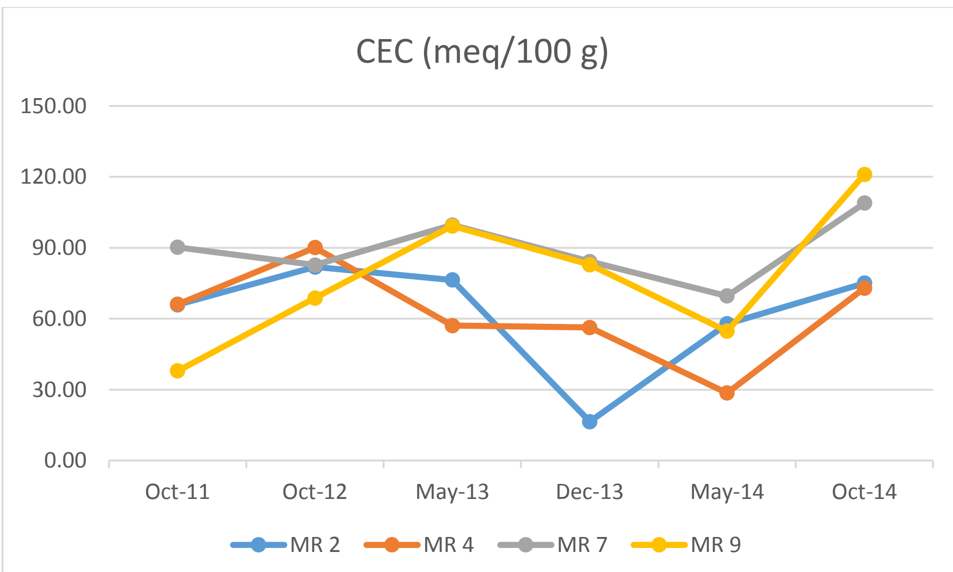
2.3.2.8 Soluble Na (mg/kg)



2.3.2.9 Sodium absorption ratio



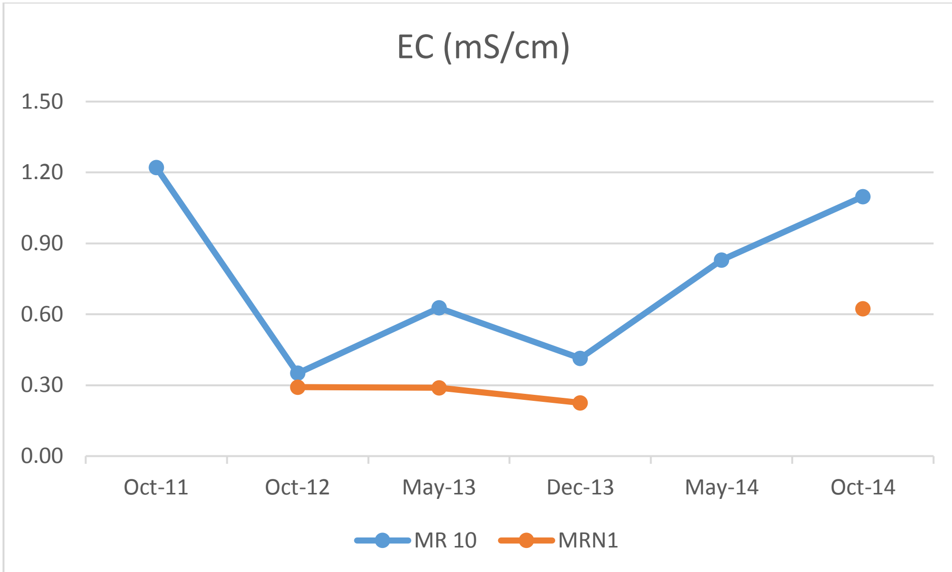
2.3.2.10 Cation exchange capacity (meq/100 g soil)



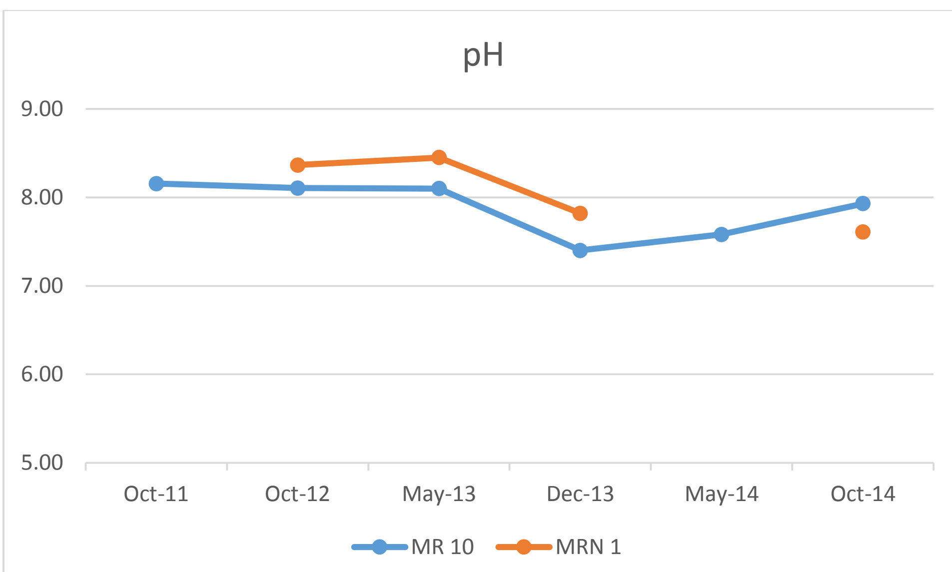
EC from this area were greater than 4.0 mS/cm, pH were below 8.5 and SAR were higher than13. These 4 sites (MR2, MR4, MR7, and MR9) would be classified as saline-sodic soil. Soluble P were also low (< 1.0 ppm). Soluble Ca were unusual dropped in May 2014 for the site MR4 and MR9 (below 20 mg/kg as compared to >400 mg/kg from other sampling times). This might be because of sample preparation and analysis processes.

2.3.3 Middle Ridge Slope (MR10) and Middle Ridge North (MRN1)

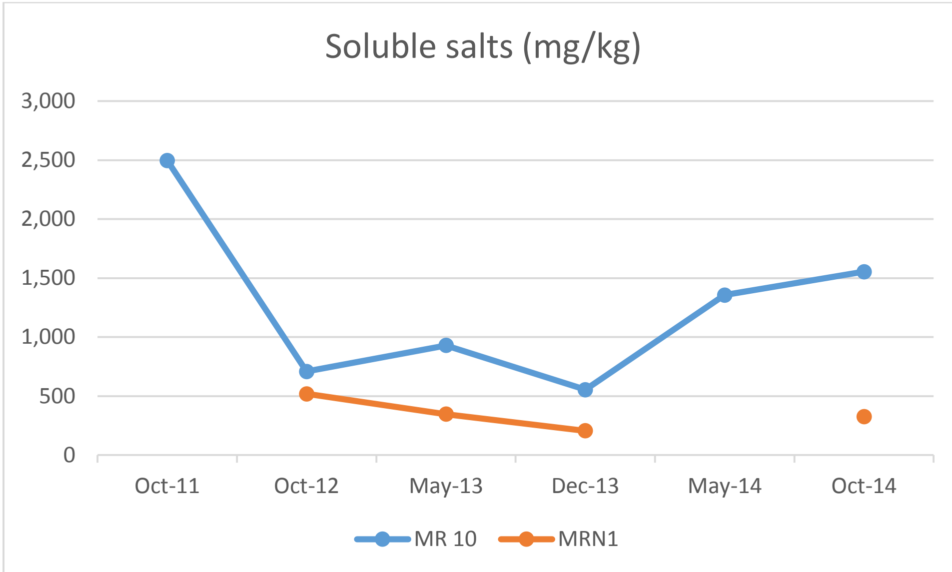
2.3.3.1 Electrical conductivity (mS/cm)



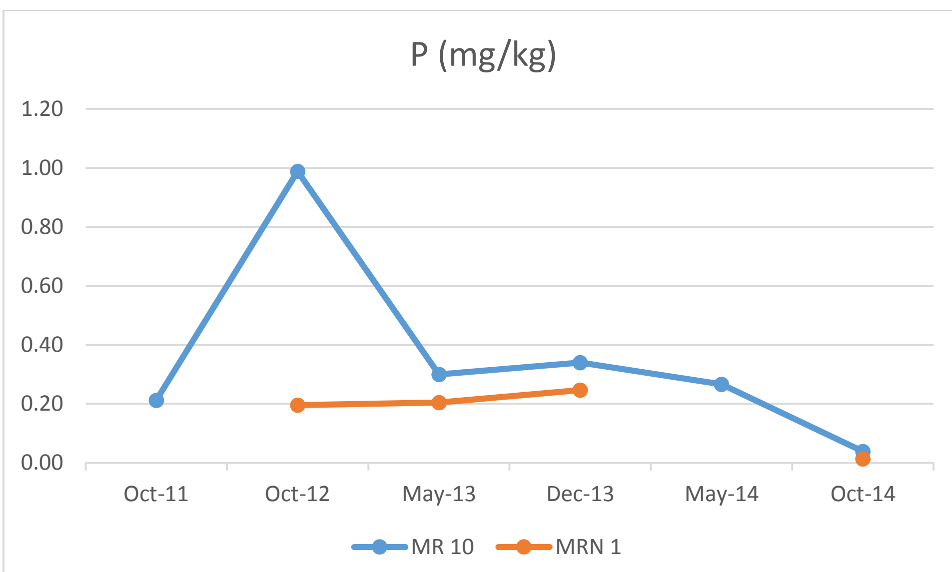
2.3.3.2 pH



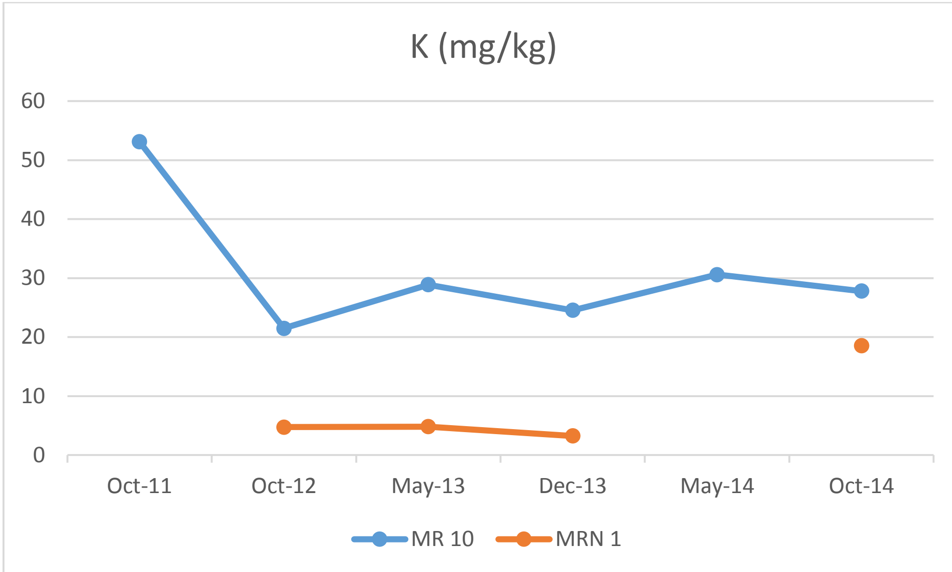
2.3.3.3 Soluble salts (mg/kg)



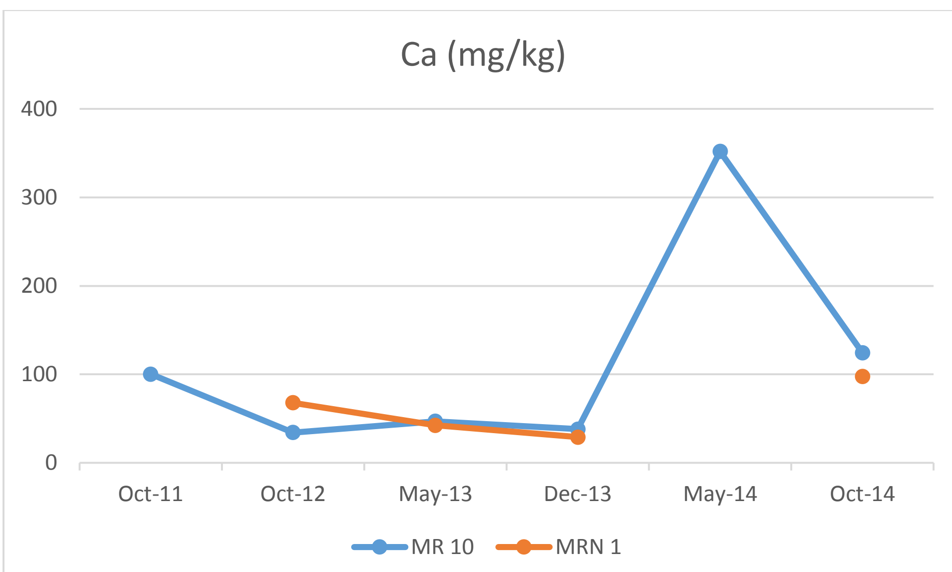
2.3.3.4 Soluble P (mg/kg)



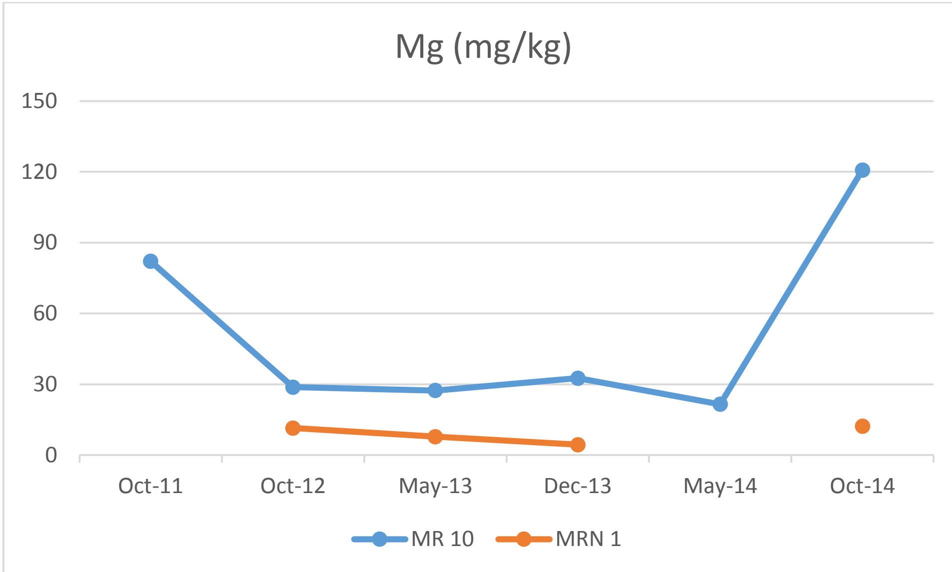
2.3.3.5 Soluble K (mg/kg)



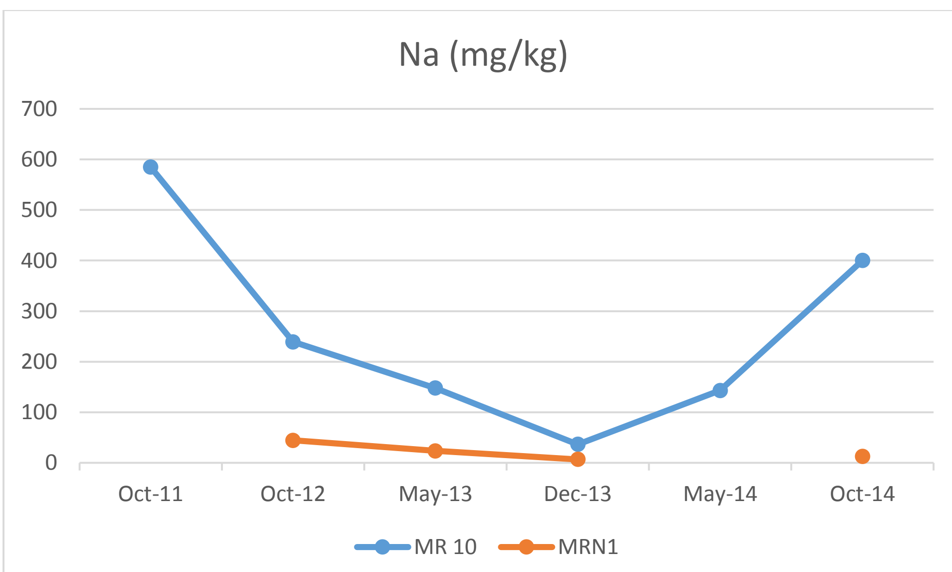
2.3.3.6 Soluble Ca (mg/kg)



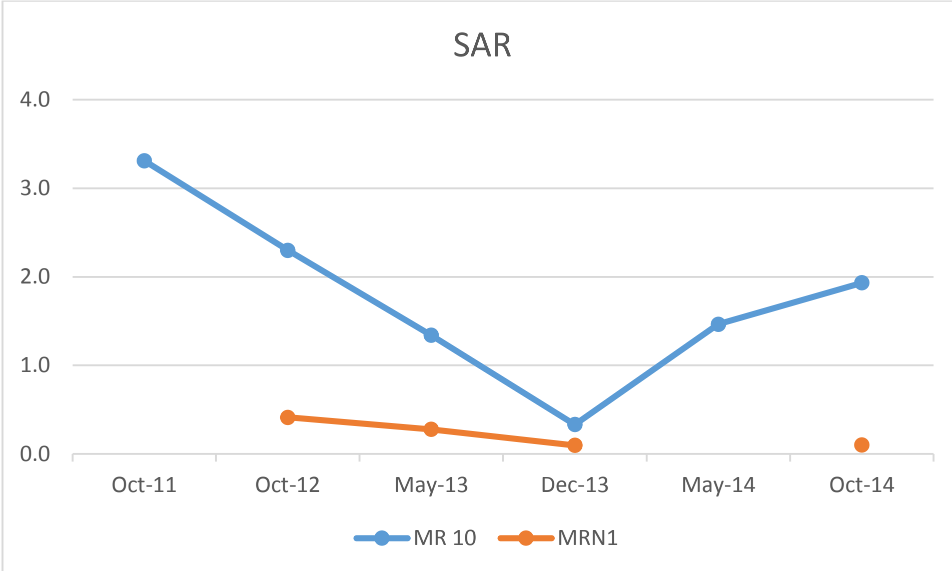
2.3.3.7 Soluble Mg (mg/kg)



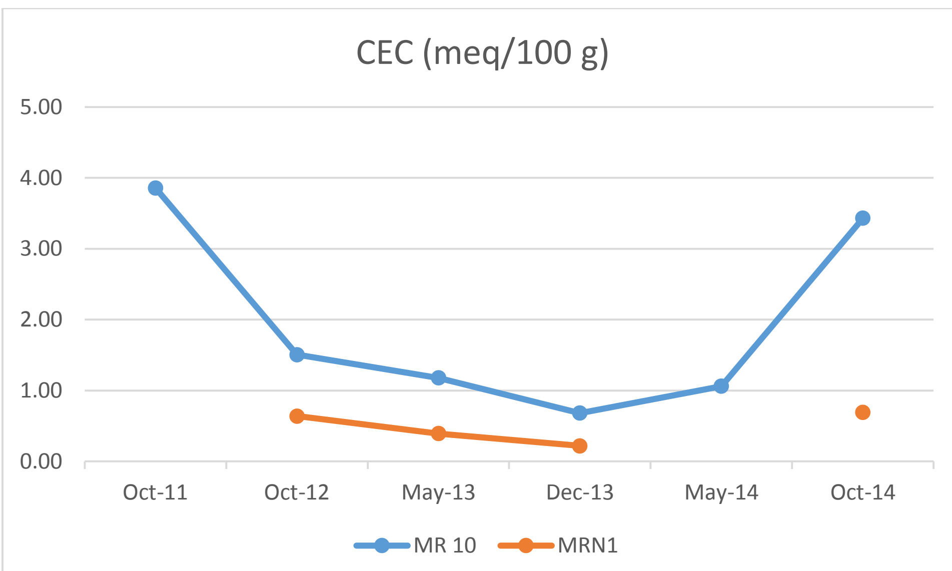
2.3.3.8 Soluble Na (mg/kg)



2.3.3.9 Sodium absorption ratio



2.3.3.10 Cation exchange capacity (meq/100 g soil)

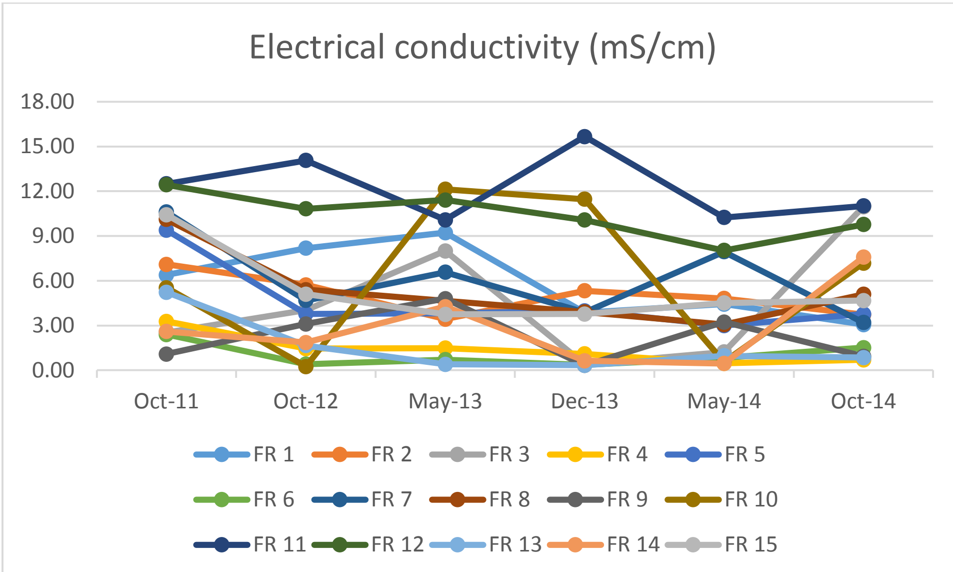


MR10 and MRN1 are formed at different time but the test results were in the same range, which can plot in the same chart. The MR10 ridge slope site is from a created ridge in 2005. The MRN1 high marsh site is located at a dredge pipeline slurry outfall at a marsh creation site just north and adjacent to the ridge and consisting almost entirely of oyster shell. Although MRN1 created several years later, the salinity results were lower than MR10. This because of the composition of materials are different. Higher content of oyster shell and clam shell had potential to decrease salinity problem and enhance plant growth, which can be observed in the mitigation area (MA) that created in 2001. Both MR10 and MRN1 did not meet any categories of saline soil.

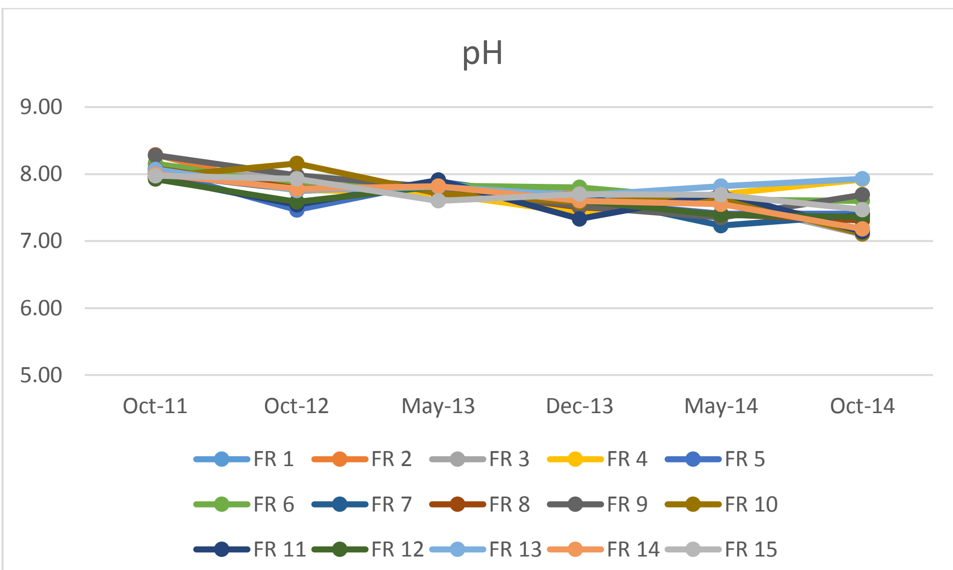
2.4 Far Ridge Area (FR): This site was constructed in fall of 2008. There were 27 samples collected from this site which were broken down into 3 different landforms: Ridge top (FR1-15), Far Ridge slope (FRN7, FRN13) and Marsh area (FRN1-5, FRS1-5). The graphs below display value and variation of each parameter.

2.4.1. Ridge top (FR1-FR15)

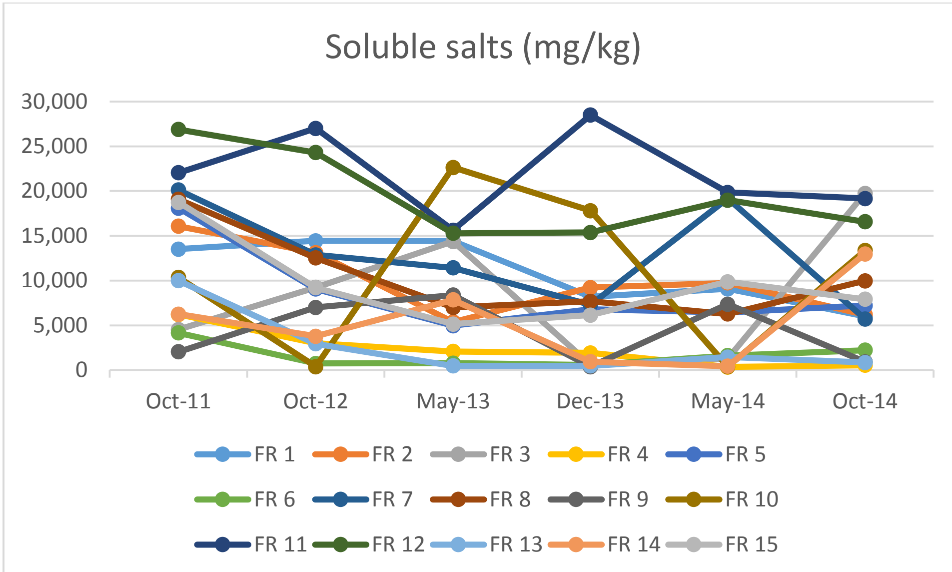
2.4.1.1 Electrical conductivity (mS/cm)



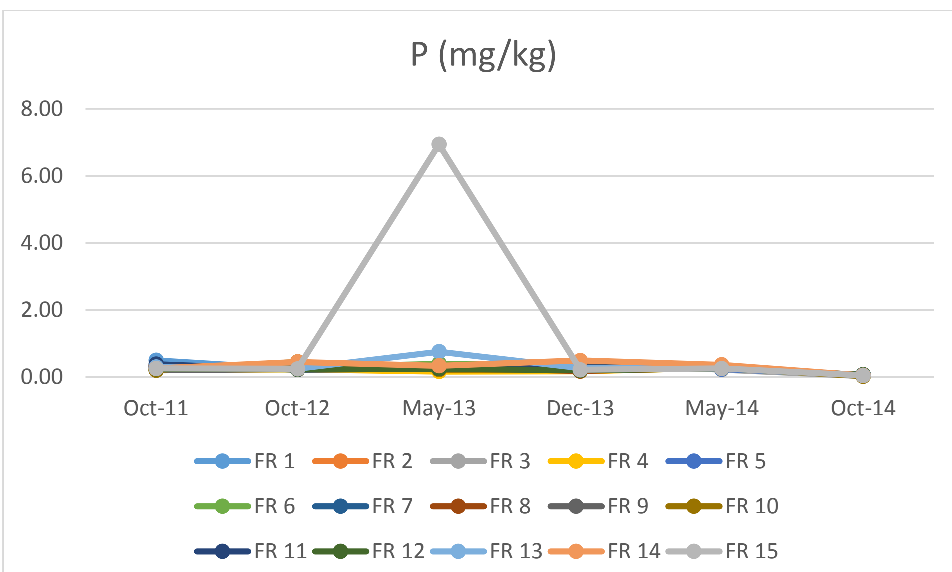
2.4.1.2 pH



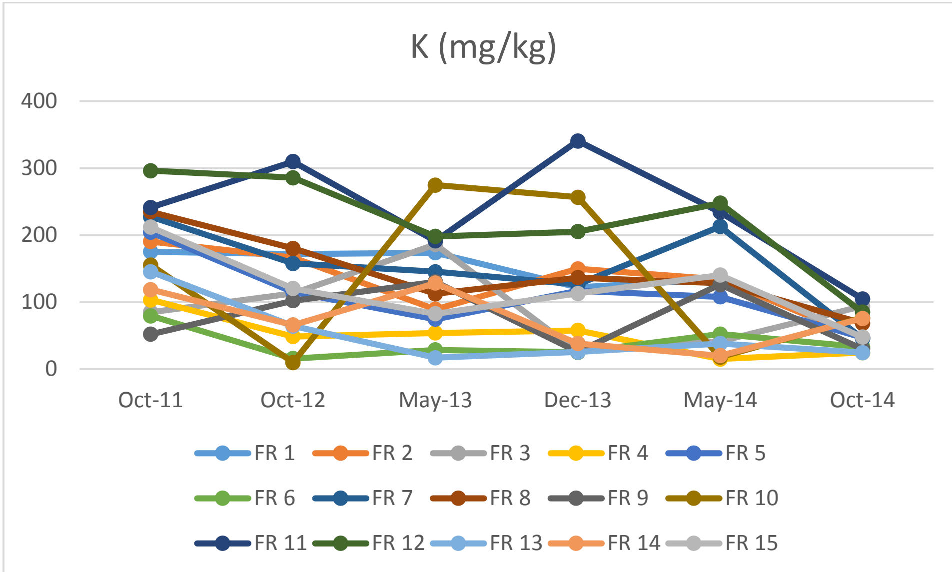
2.4.1.3 Soluble salts (mg/kg)



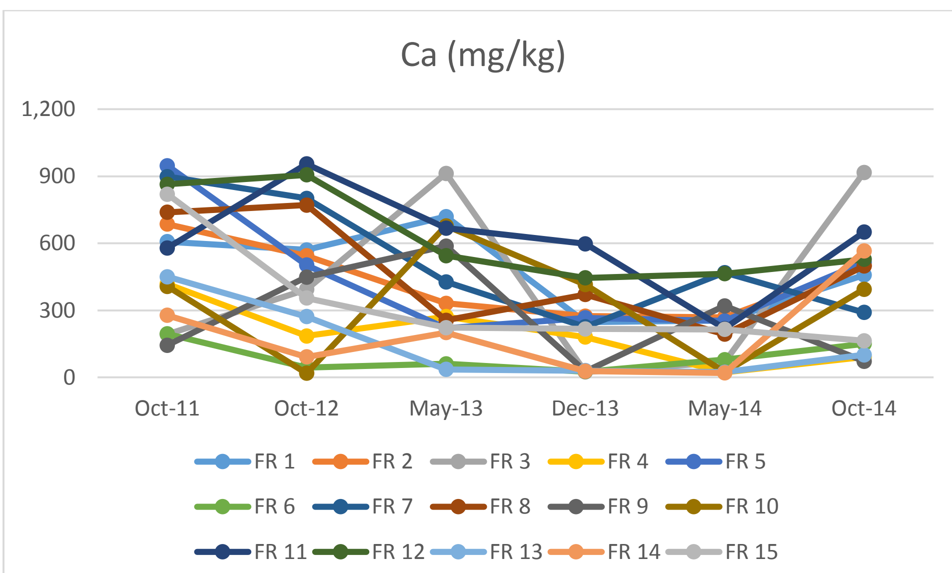
2.4.1.4 Soluble P (mg/kg)



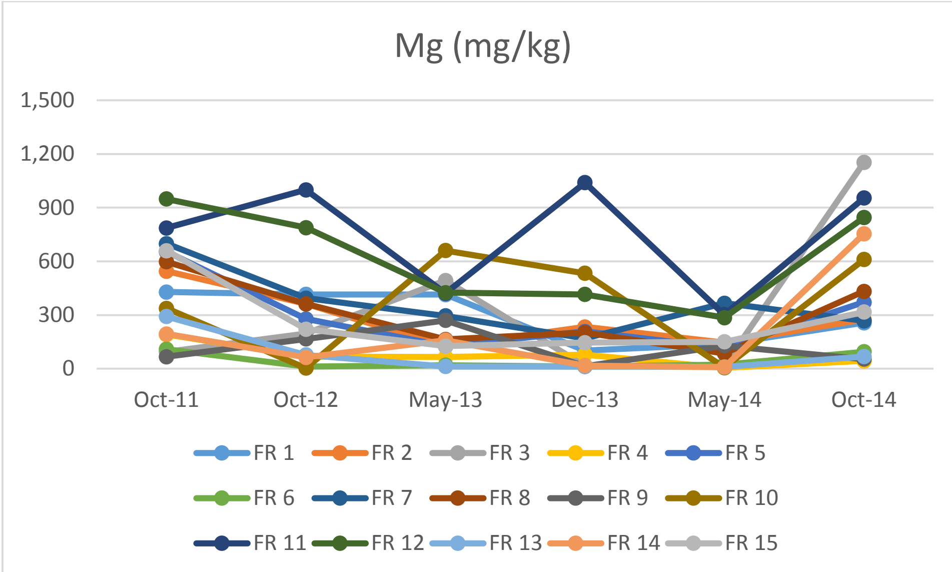
2.4.1.5 Soluble K (mg/kg)



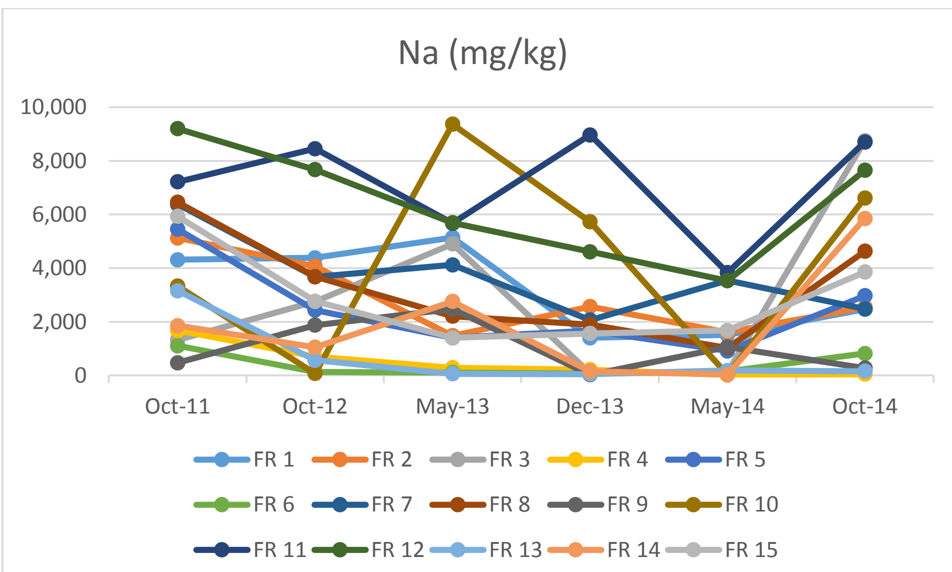
2.4.1.6 Soluble Ca (mg/kg)



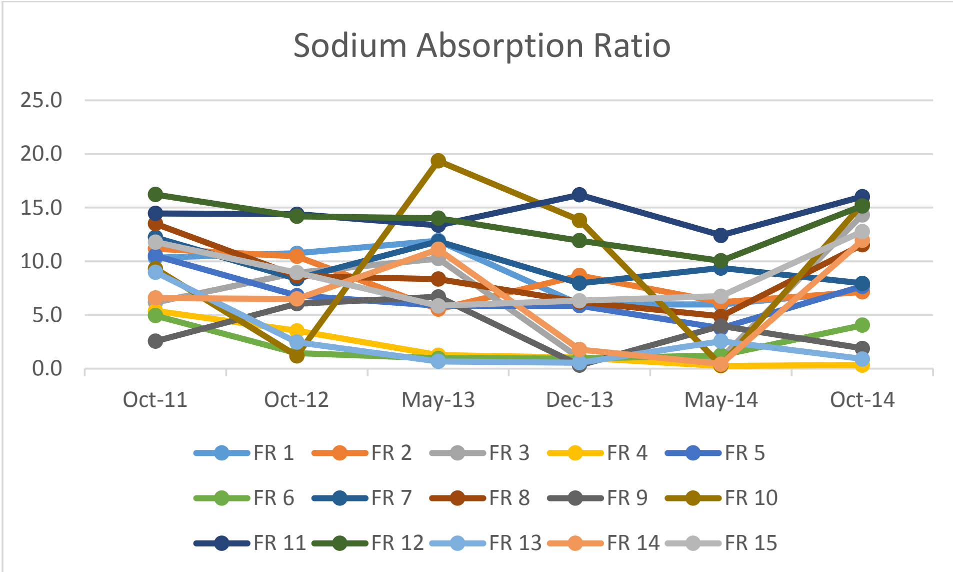
2.4.1.7 Soluble Mg (mg/kg)



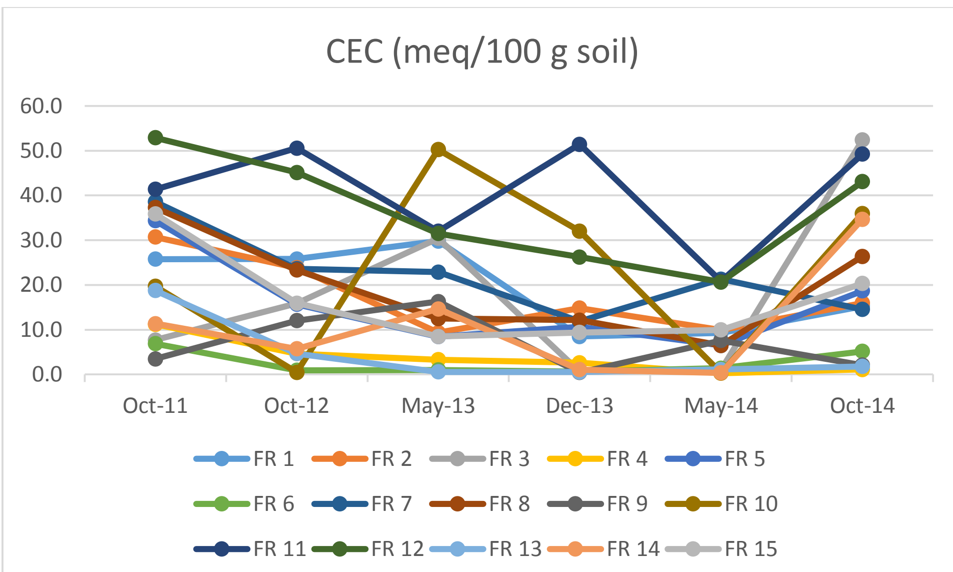
2.4.1.8 Soluble Na (mg/kg)



2.4.1.9 Sodium absorption ratio



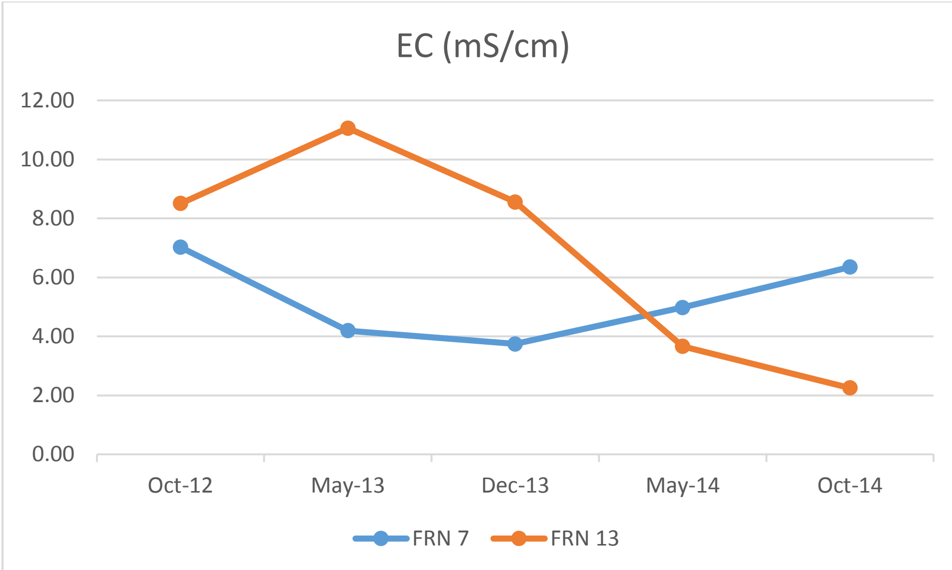
2.4.1.10 Cation exchange capacity (meq/100 g soil)



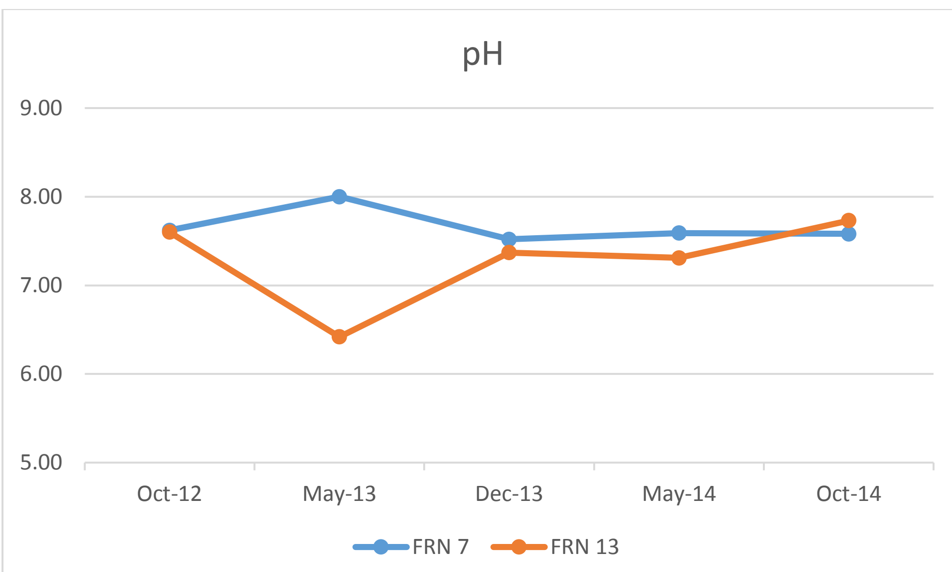
Test results of the Far Ridge (Ridge top; FR1-FR15) varied from the sites and time of sampling. Even though the landform of the sample are similar, the parent materials of each sites could be different. For example, FR4 and FR13 did not show salinity problem, while FR11 and FR12 show saline-sodic potential. Therefore, this area will need more time to allow the natural dynamic changes to reduce salinity level.

2.4.2 Far Ridge slope (FRN 7 and FRN 13)

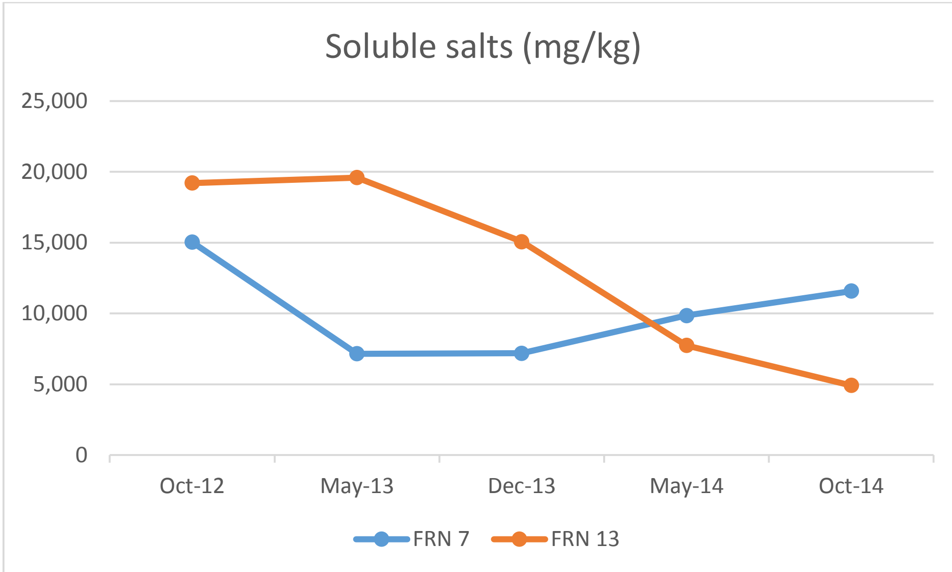
2.4.2.1 Electrical conductivity (mS/cm)



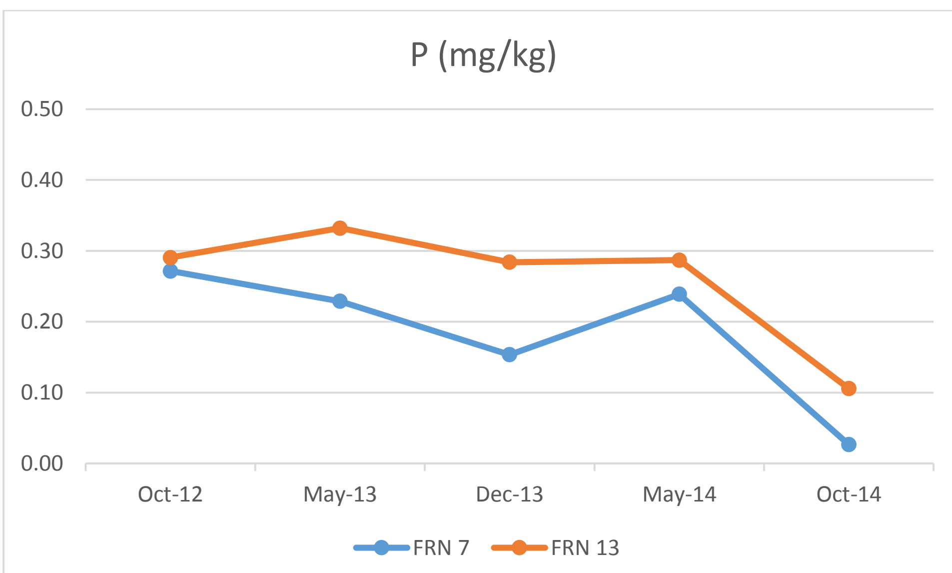
2.4.2.2 pH



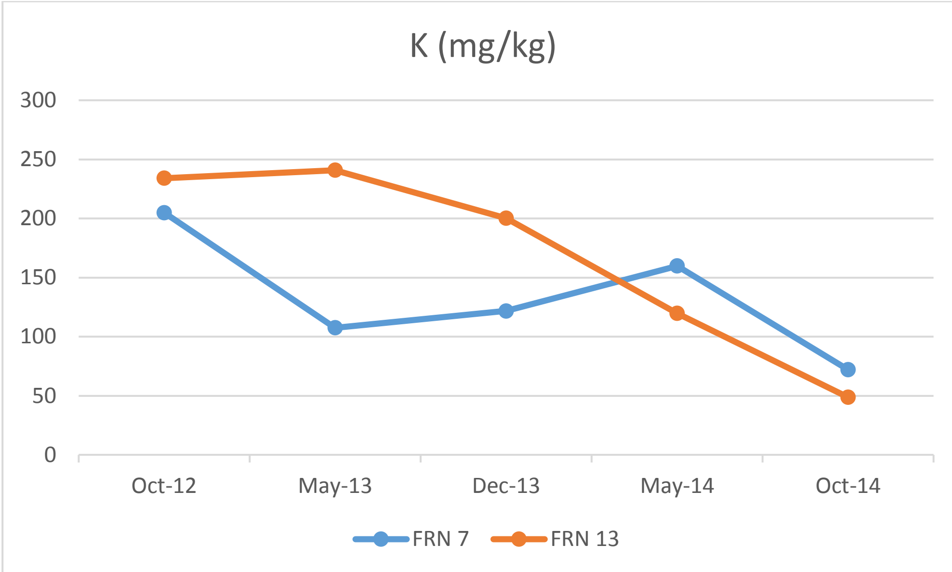
2.4.2.3 Soluble salts (mg/kg)



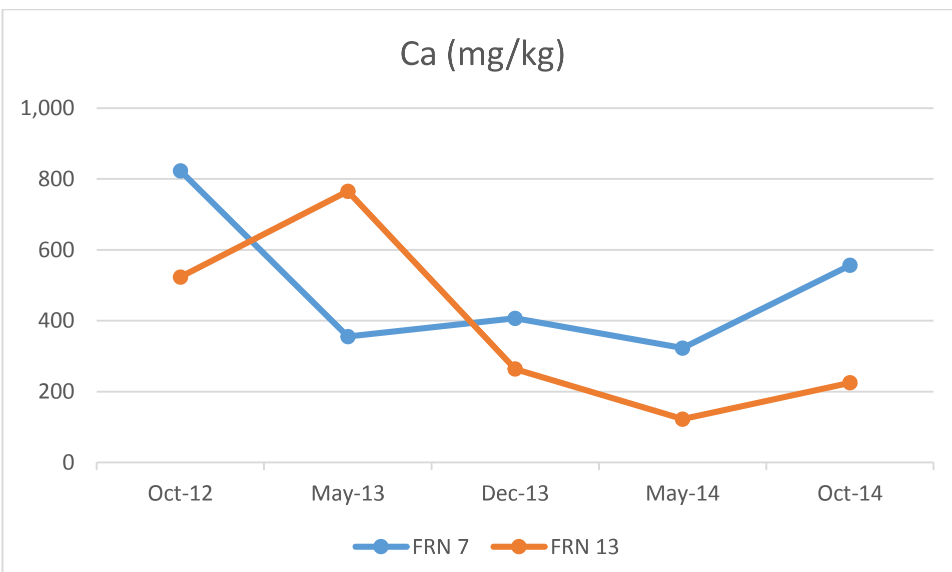
2.4.2.4 Soluble P (mg/kg)



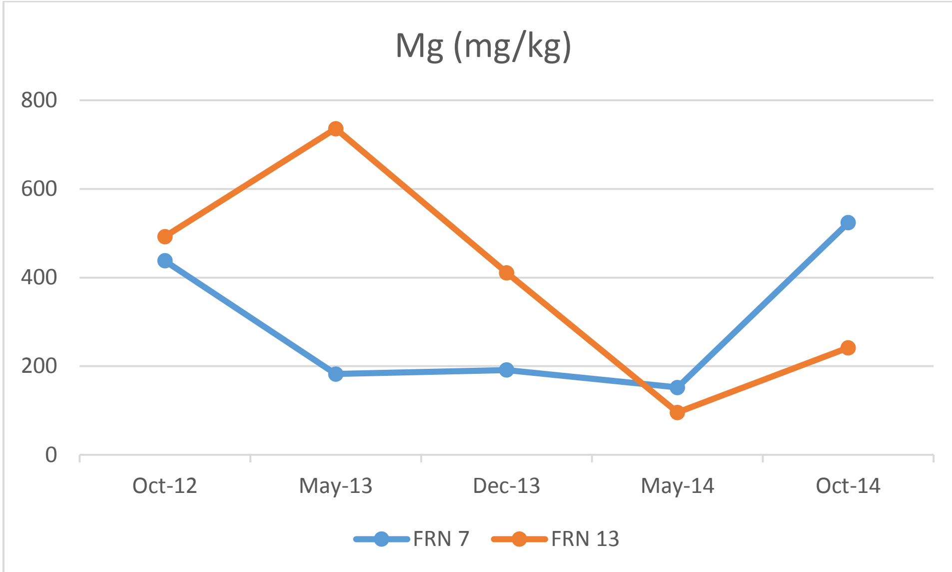
2.4.2.5 Soluble K (mg/kg)



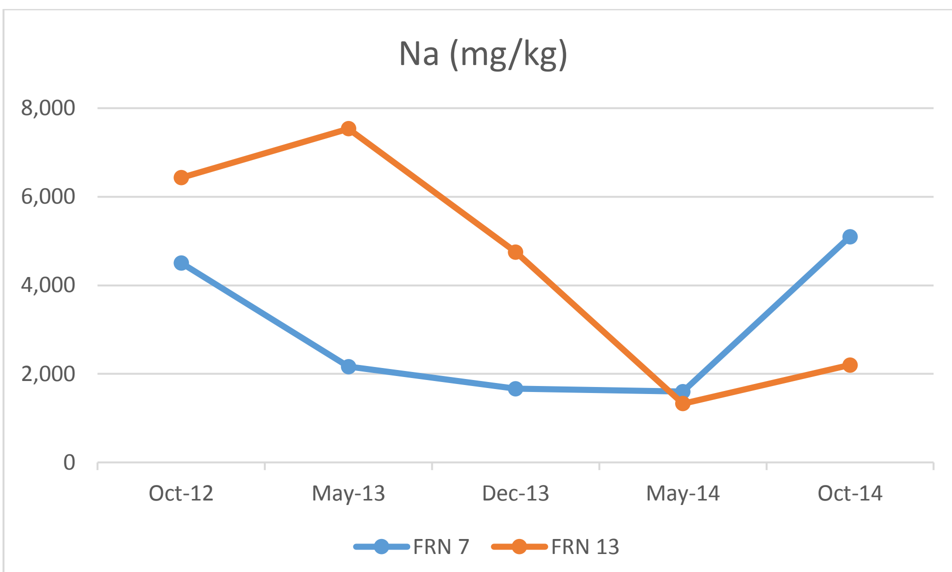
2.4.2.6 Soluble Ca (mg/kg)



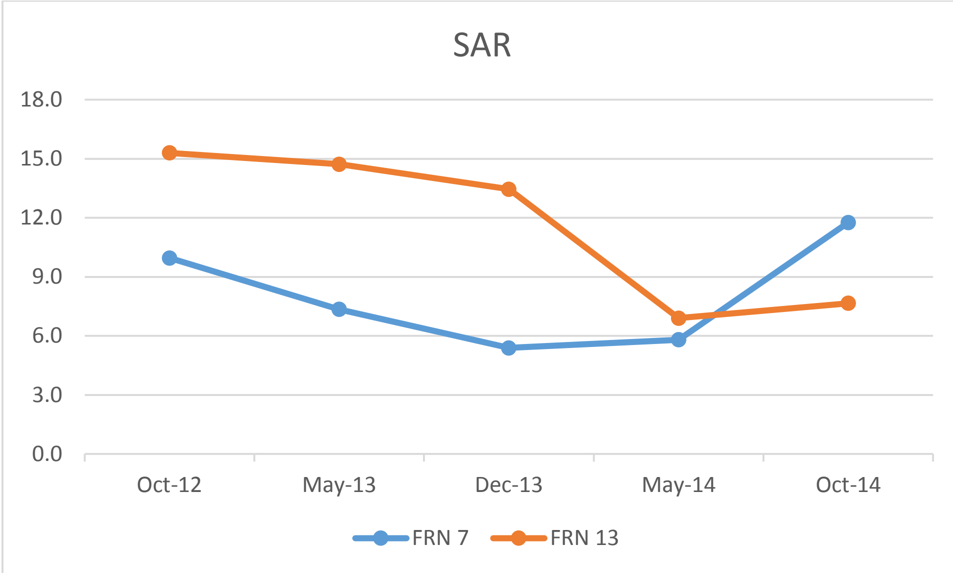
2.4.2.7 Soluble Mg (mg/kg)



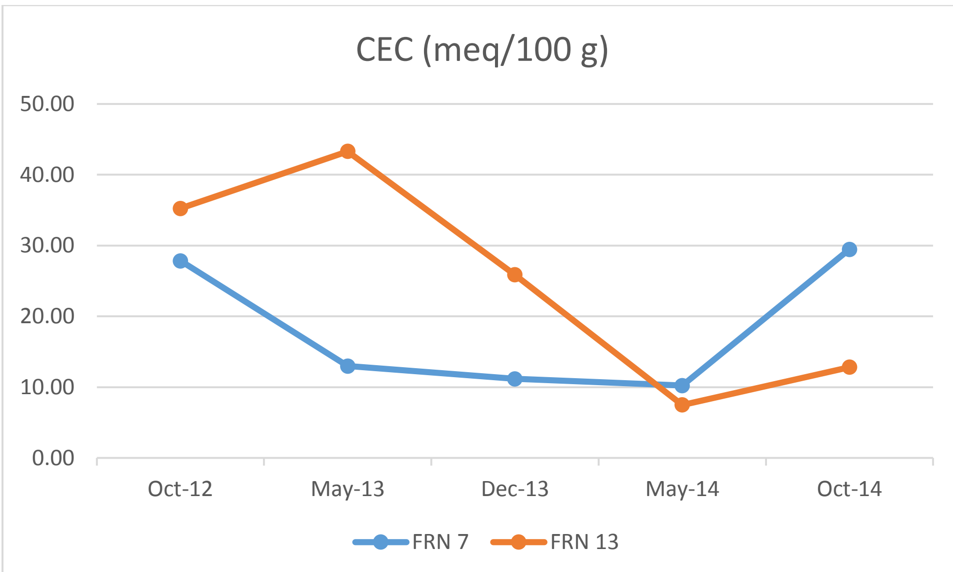
2.4.2.8 Soluble Na (mg/kg)



2.4.2.9 Sodium absorption ratio



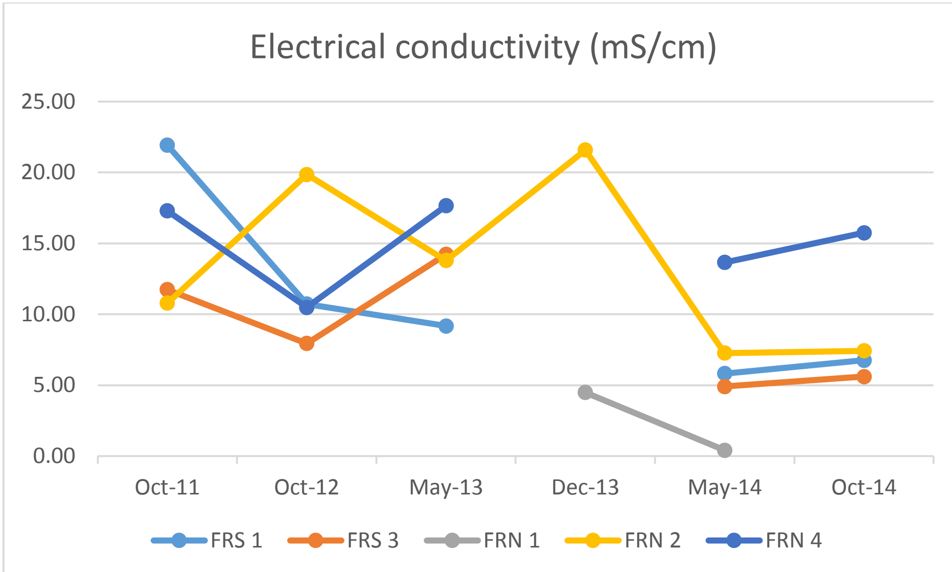
2.4.2.10 Cation exchange capacity (meq/100 g soil)



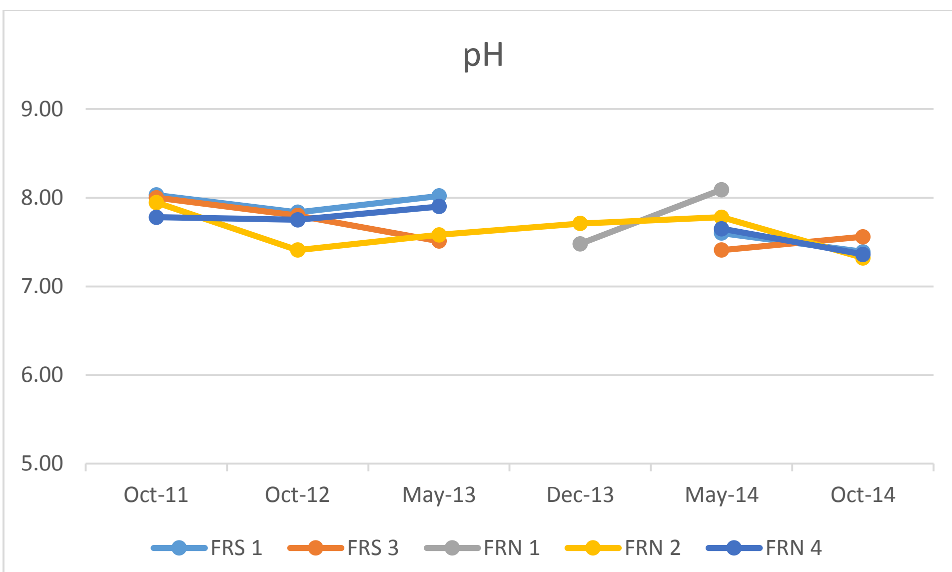
By topography, Ridge slope sites could be the place that accumulated washed-off elements from the Ridge top. The washed-off elements, such as Na can limit the plant growth where it passes through. Even though the salinity parameter seem to be not very high, the dynamic change would be a big variable. Therefore, these sites will be suitable for plant after Ridge top already has plant establishment.

2.4.3 Marsh (FRN 1-5 and FRS 1-5)

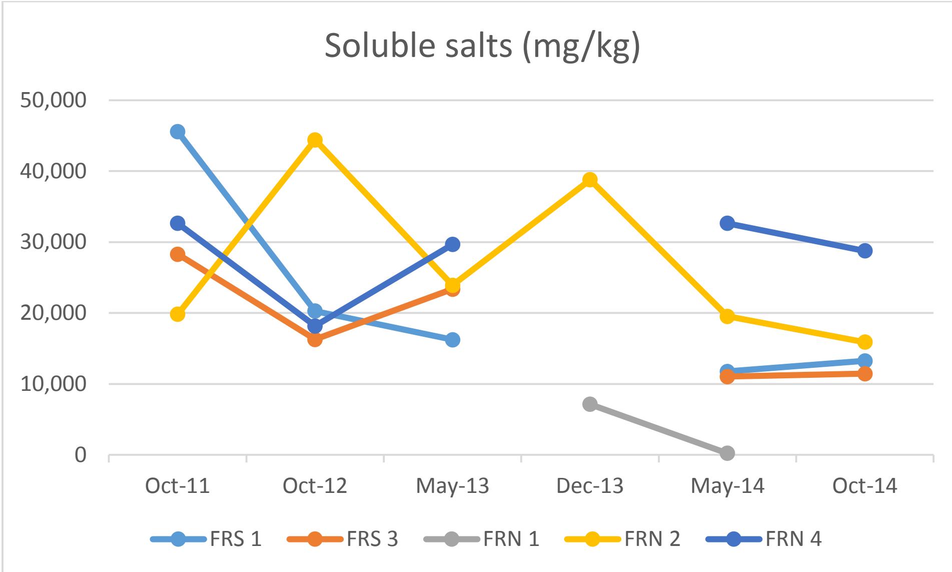
2.4.3.1 Electrical conductivity (mS/cm)



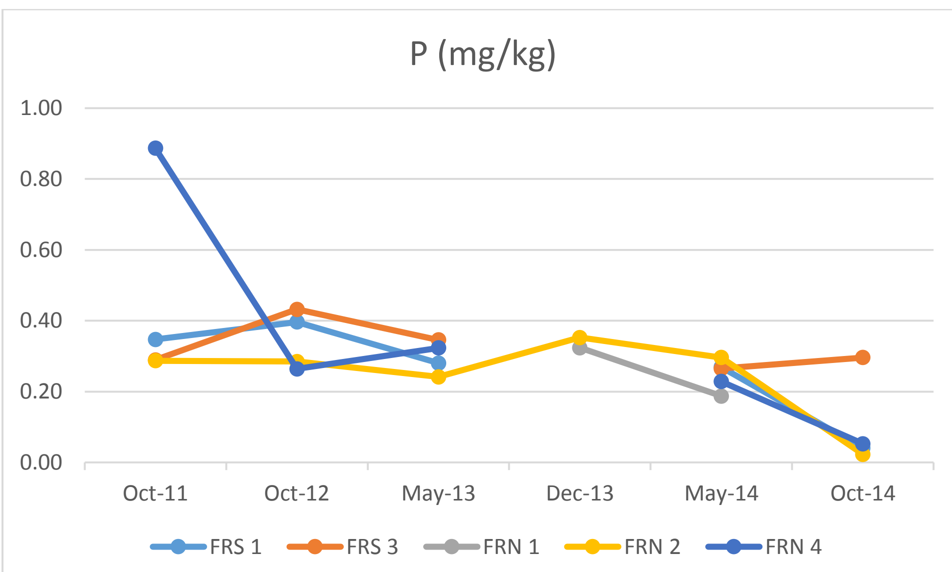
2.4.3.2 pH



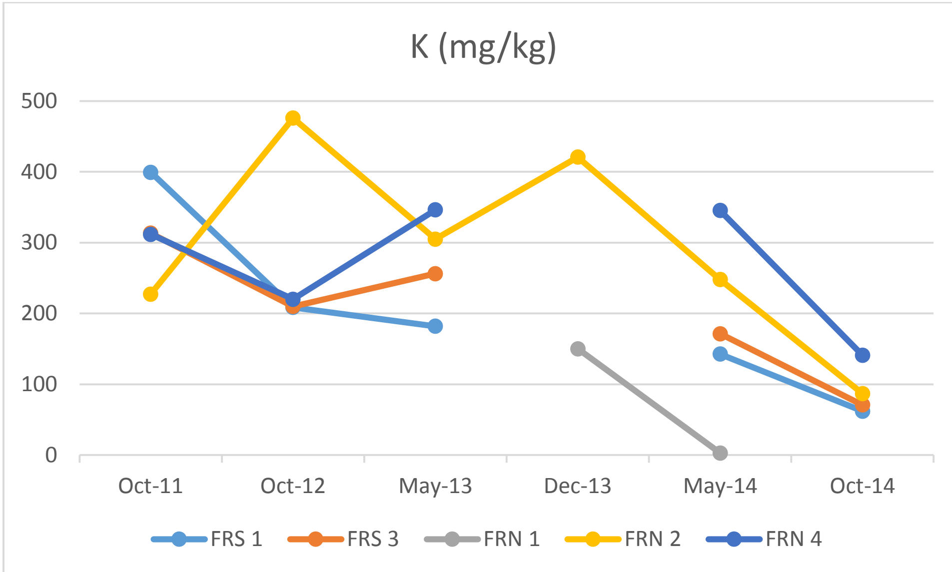
2.4.3.3 Soluble salts (mg/kg)



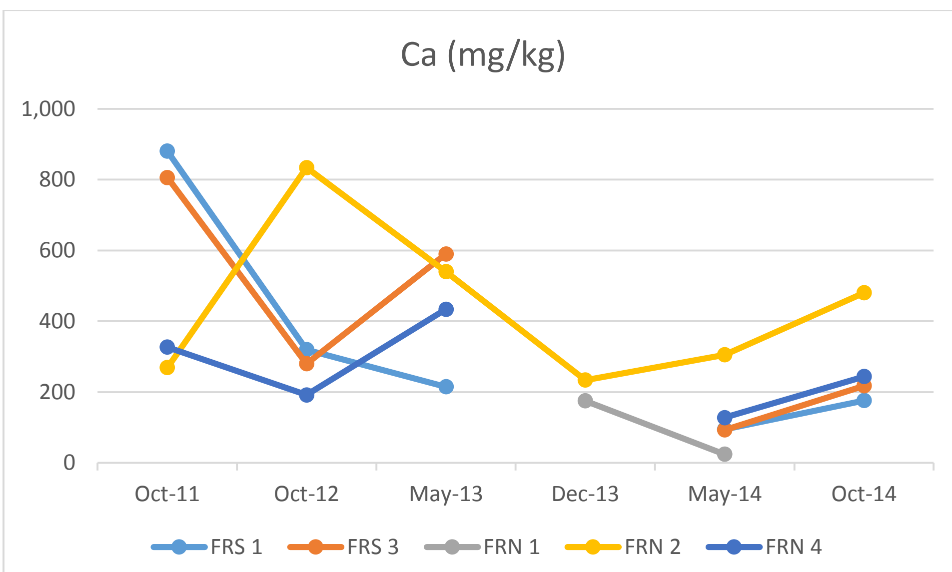
2.4.3.4 Soluble P (mg/kg)



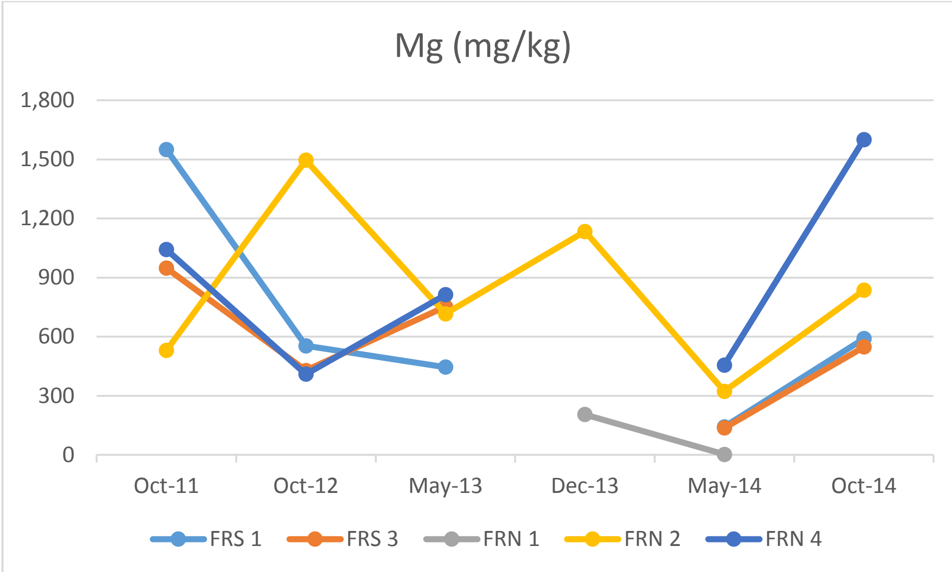
2.4.3.5 Soluble K (mg/kg)



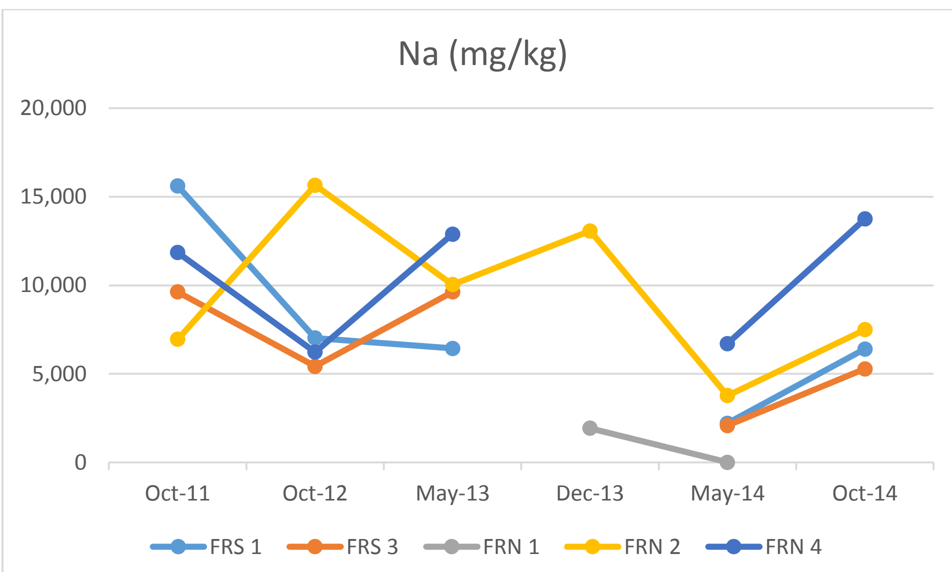
2.4.3.6 Soluble Ca (mg/kg)



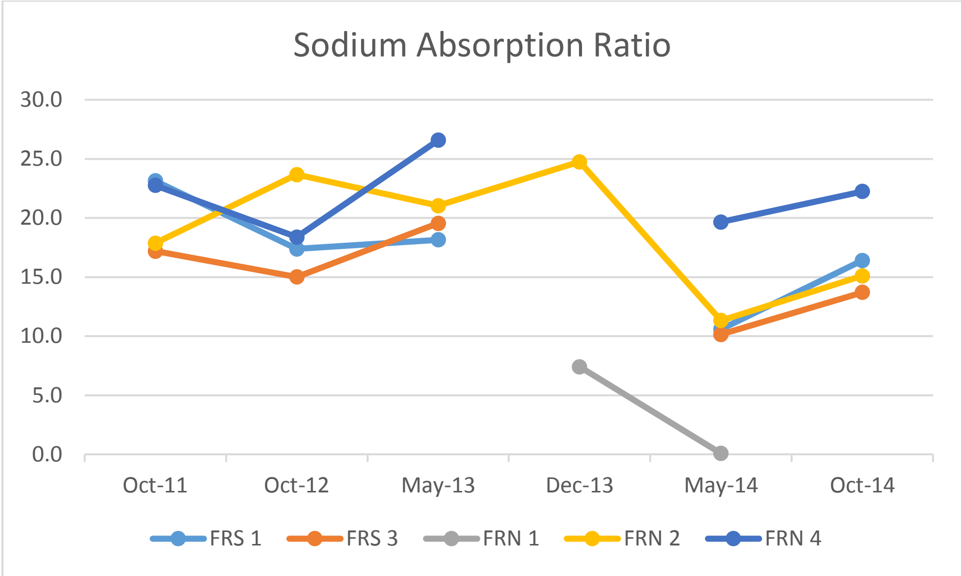
2.4.3.7 Soluble Mg (mg/kg)



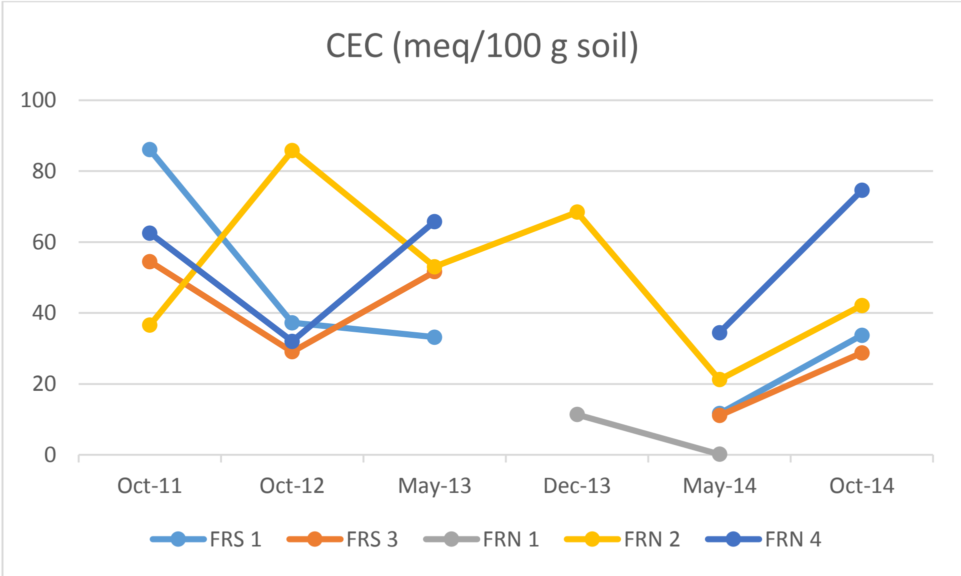
2.4.3.8 Soluble Na (mg/kg)



2.4.3.9 Sodium absorption ratio



2.4.3.10 Cation exchange capacity (meq/100 g soil)



The test results from these marsh sites were highly variation as compared to the marsh from mitigation area (MA9, MA10), and middle ridge area (MR2, MR4, MR7, and MR9). The data indicated that the dynamic change still far from equilibrium point. However, in the marsh which influenced by sea water would be related to quality of sea water.

Overall, soil pH within individual sampling sites were not highly different. The lower pH values were found in the marsh area and the lowest was 6.38, while the highest pH (8.45) was found in Middle Ridge North (MRN1). This site was created in 2011 using a pipeline slurry outfall consisting entirely of oyster shell which would explain the high pH value.

Water extractable phosphorus (P) levels were very low in all sites. The maximum was 6.9 mg/kg in Far Ridge area. The average was less than 1 mg/kg. However, it would not be a limiting factor for plant growth in the salt-affected environment because the method used for the analysis was based on a "water soluble" method.

Extractable potassium (K) was also based on a "water soluble" method. The lowest level was 6.8 mg/kg in Mitigation Area and the highest level was observed in Middle Ridge area (486 mg/kg). This level would not likely be a limiting factor for plant growth in a saltmarsh environment.

Extractable calcium (Ca) was lowest in Mitigation area (5.9 mg/kg) and the highest (954 mg/kg) in the Far Ridge area. The lowest concentration of water soluble magnesium (Mg) was observed in Far Ridge area (2.3 mg/kg) and the highest concentration was observed in Middle Ridge area (2,330 mg/kg). Sulfur concentration was lowest in Middle Ridge area (1.7 mg/kg) and highest in Far Ridge area (2,016 mg/kg).

Water soluble micronutrient (Fe and MN) and Cation Exchange Capacity (CEC). In this assay, soil micronutrient was limited to only two metals; iron (Fe) and manganese (Mn). The lowest Fe level was near 0 mg/kg in all sampling areas, and the highest concentration was observed in Middle Ridge area (130 mg/kg). The concentration of Mn has a similar trend as the concentration of Fe, where the lowest value was near 0 mg/kg in all sites and the highest value observed only in the Far Ridge area (13.2 ppm).

Cation exchange capacity was calculated based on the sum of cations method (Ca, Mg, K, and Na). Therefore, the CEC values were highly influenced by saline environment, which contain high sodium and calcium concentration. The lowest CEC was observed in Far Ridge area (0.2 meq/100 g soil), and the highest was found in Middle Ridge area (121 meq/100 g soil).

3 Comparison and correlation of results from the A&L lab (Mehlich III extraction) and the LSU Lab (1:2 water extraction).

This comparison between the results of the two extraction methods; a) the 212 samples were analyzed at the A&L Lab by Mehlich III extraction. These samples were collected from 6 different times in May 2008, January 2009, August 2009, January 2010, August 2010, and February 2011, with b) the 256 samples were analyzed at the LSU lab by water extraction method for macro and micro nutrient content. These 256 samples were also collected from 6 different times in October 2012, May 2013, December 2013, May 2014, and October 2014. Electrical conductivity and pH were analyzed based on soil slurry from both labs. The ratio of 1:1 of soil and water was used at the A&L lab and the ratio of 1:2 was used at the LSU lab. Due to the difference in the sampling times, the data for the comparison was calculated from an average of all the sampling times of each site. Although this comparison is not the best approach, it is the only way to compare the two methods from available data. Simple linear correlation coefficients and graphs were obtained for each pair of the results. Most of the test results from both labs were comparable, which could be used as a baseline information for future studies, particularly for monitoring salinity and nutrient content of the sites. The graphs below are some comparisons of the important parameters for soil in the saltmarsh environment.

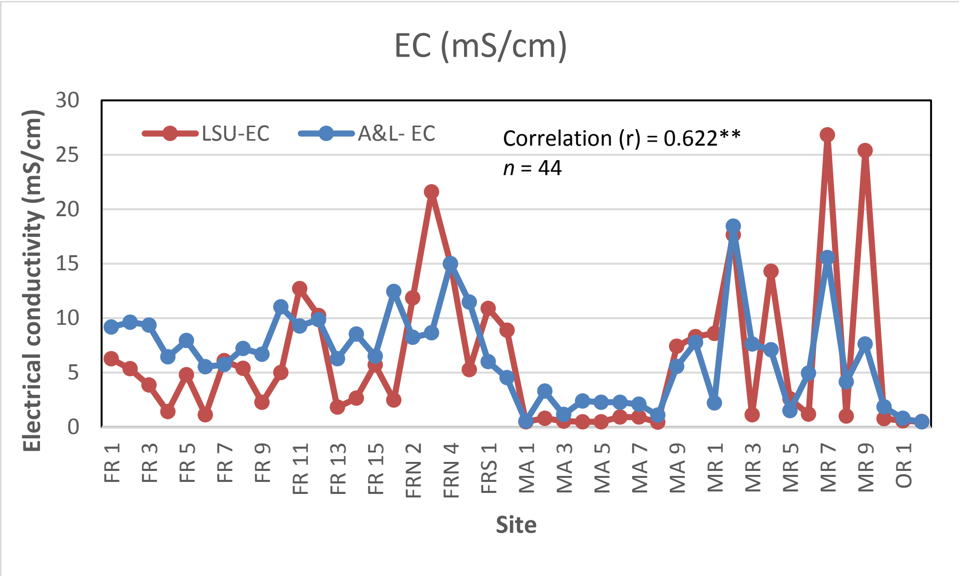


Figure 3.1. Correlation of EC between A&L and the LSU soil testing laboratory. Even though the time frame for sampling are different (2008-2011 for the A&L lab and 2012-2014 for the LSU lab), the trend of results are the same pattern.

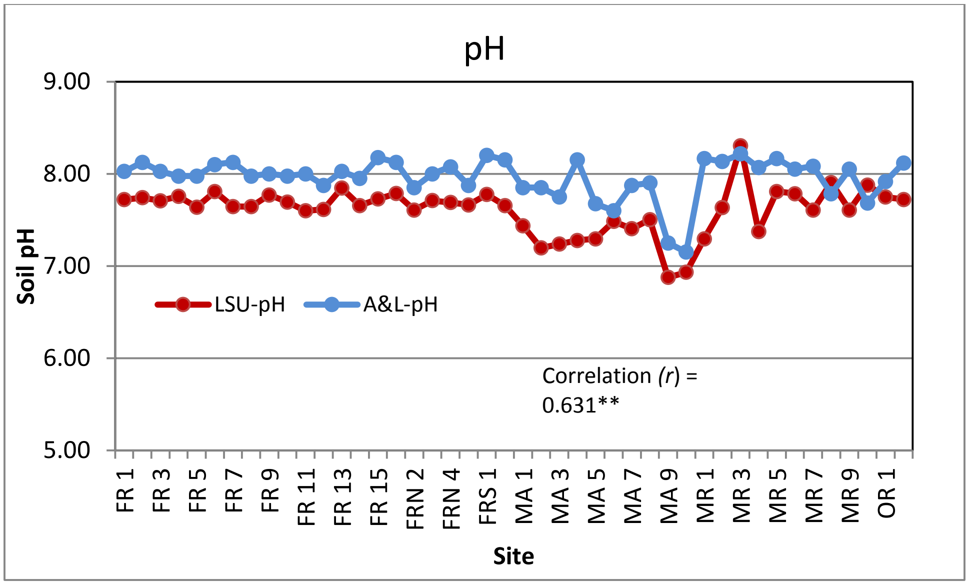


Figure 3.2. Comparison of pH between the A&L and the LSU lab. pH of the A&L lab were higher than the LSU lab that might be the deferent of the soil slurry of 1:1 of the A&L lab as compared to 1:2 of the LSU lab.

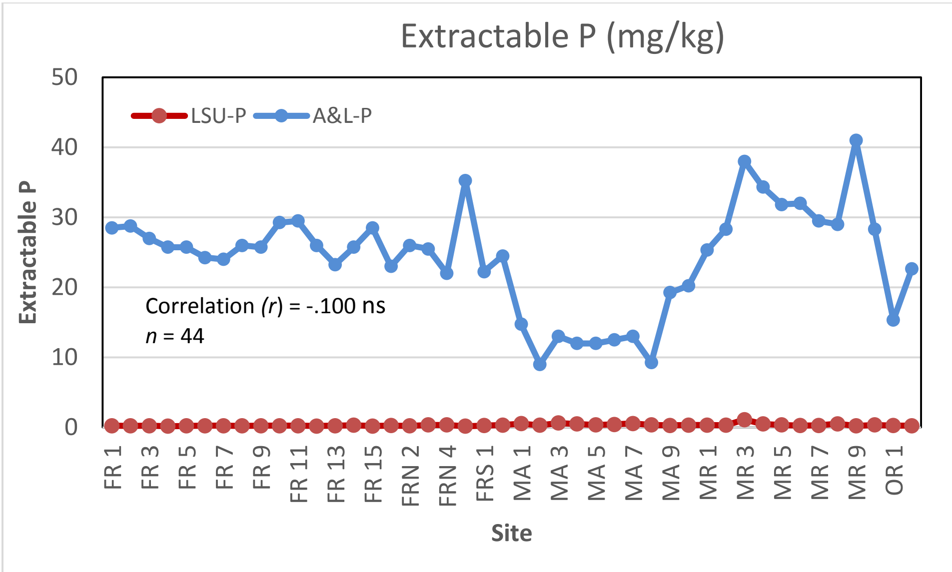


Figure 3.3. Comparison of phosphorus (P) concentrations between A&L and the LSU soil testing laboratory. The values from two labs were not related and the higher values were observed for the data from A&L lab because of the Mehlich III (an acid mixture) has a stronger potential to remove not only P in the pore water but also from the soil particles, while at the LSU Lab, only P in porewater can be released by water extraction.

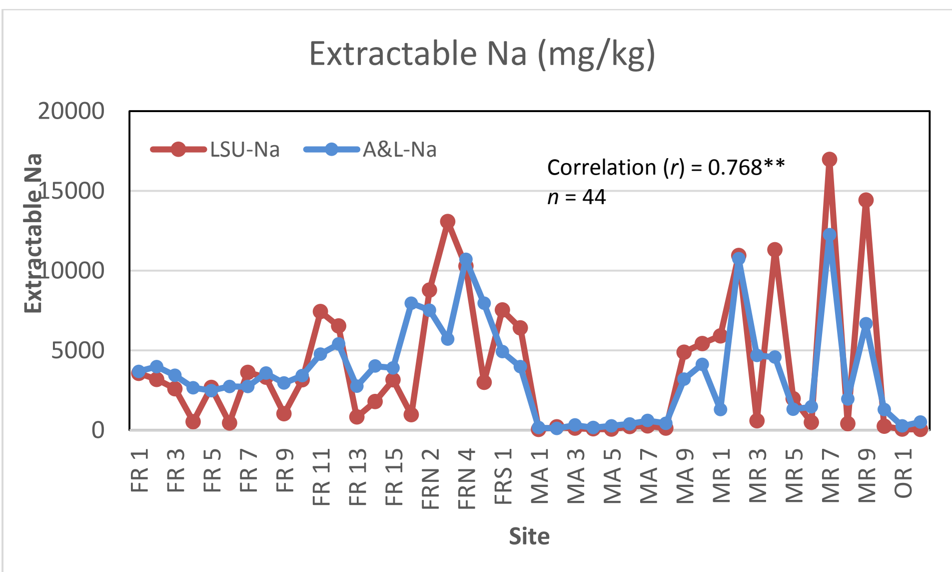


Figure 3.4. Comparison of extractable sodium (Na) concentrations between A&L and the LSU soil testing laboratory. Acid extraction and water extraction methods were similar in Na content. This because of the major portion of sodium were in porewater that can be removed either by water or acid reagents.

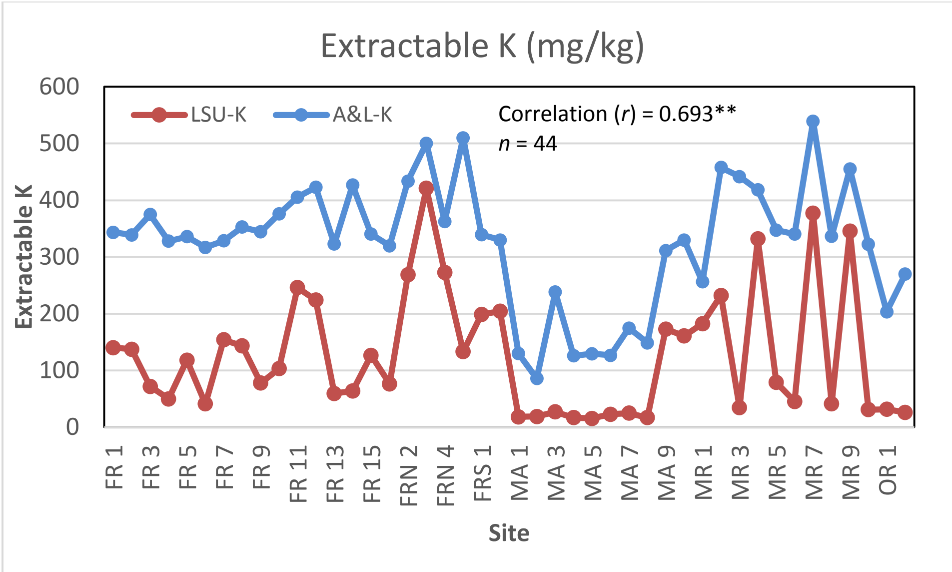


Figure 3.5. Comparison of extractable potassium (K) concentration between A&L and the LSU soil testing laboratory. K was higher with acid extraction. That might be because of K can bind with the soil particle and cannot be easily removed by water extraction.

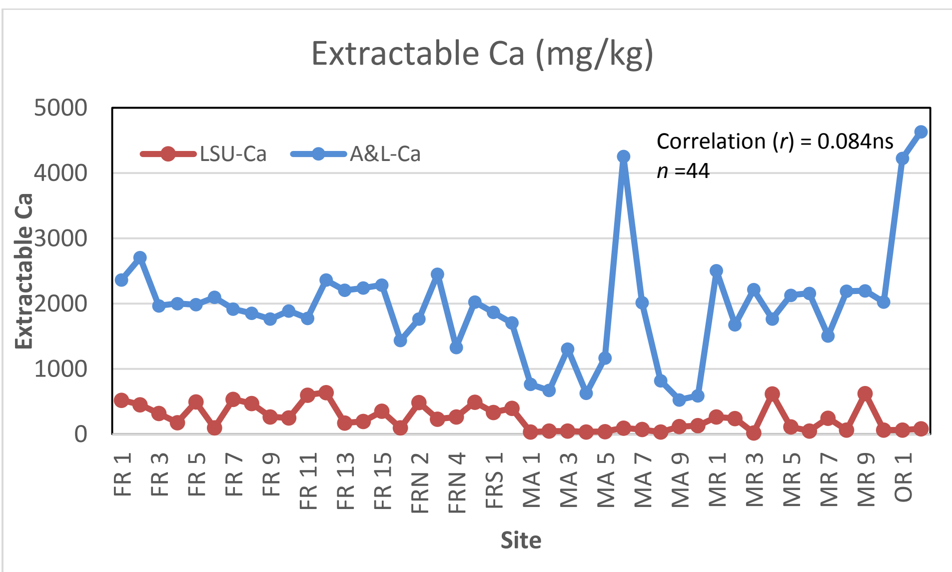


Figure 3.6. Comparison of calcium (Ca) concentrations between A&L and the LSU soil testing laboratory. Ca was higher when extracted with acid that might include the calcium from both oyster shell and Ca ions that bind with the soil particles.

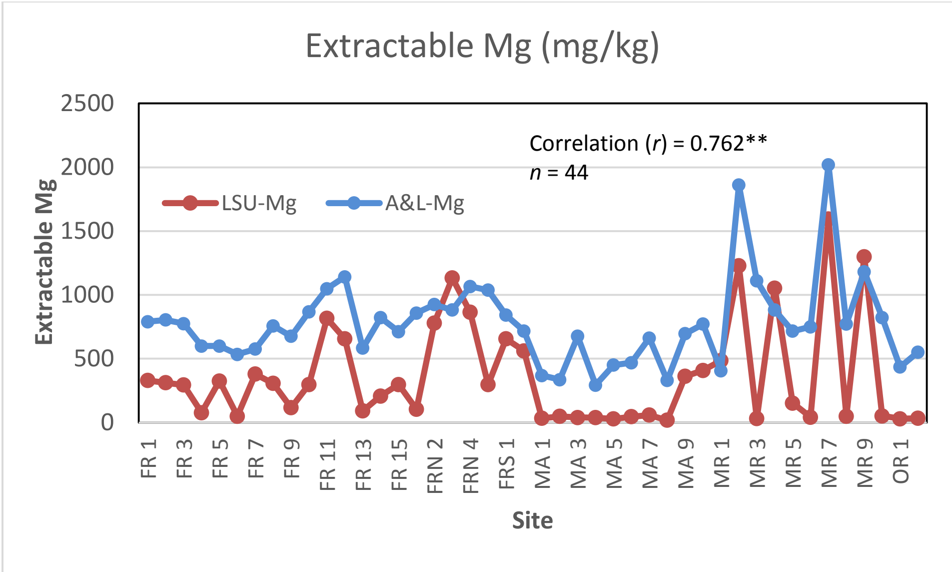


Figure 3.7. Comparison of magnesium (Mg) concentrations between A&L and the LSU soil testing laboratory. Extractable Mg were similar trend with K, and Ca. It was higher with the acid extraction.

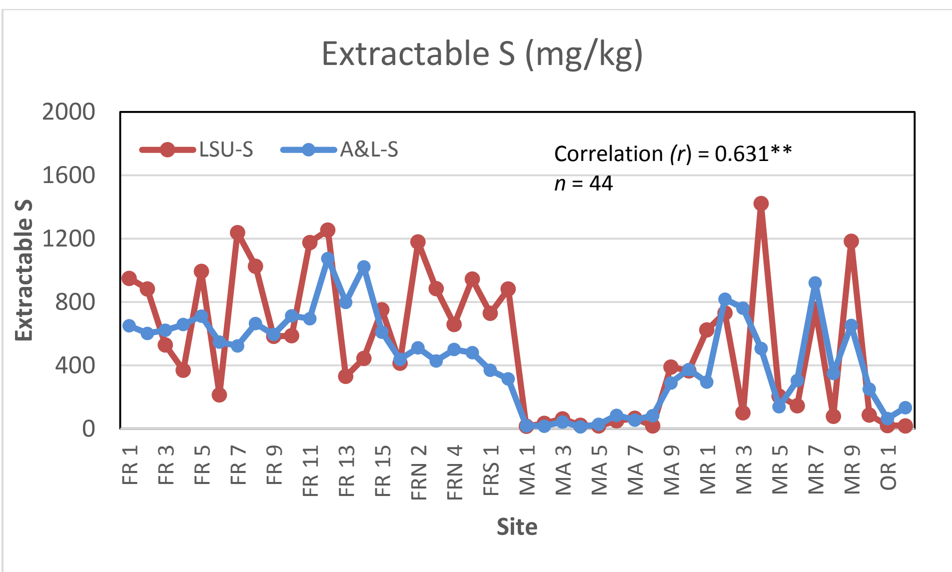


Figure 3.8. Comparison of sulfur (S) concentrations between A&L and the LSU soil testing laboratory. The concentration of S has the same trend with Na that indicated both Na and S were highly dissolved in the water and mostly hold in the porewater instead of binding with soil particles.

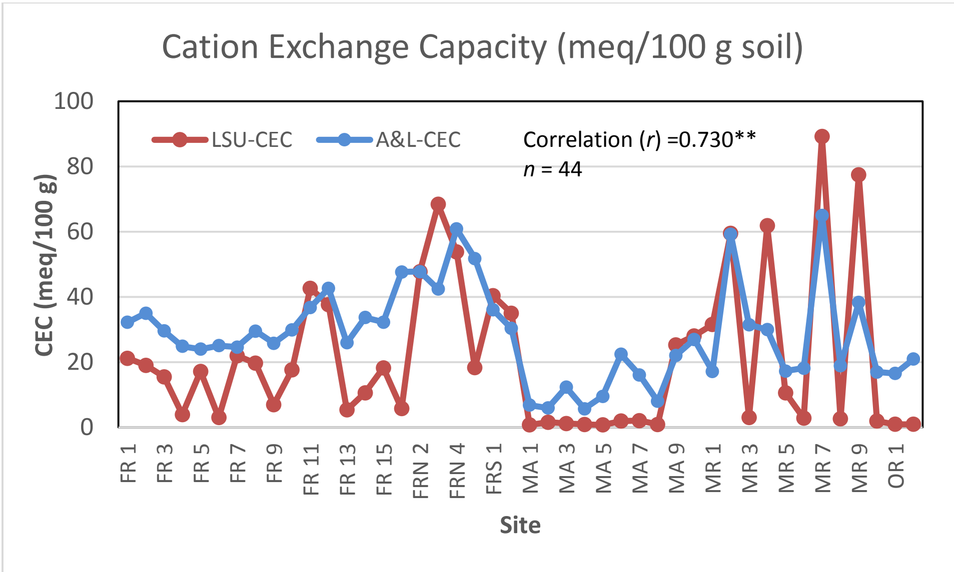


Figure 3.9. Comparison of CEC (cation exchange capacity) between A&L and the LSU soil testing laboratory. CEC was higher with acid extraction in most sites that because of the higher concentration of the cations.

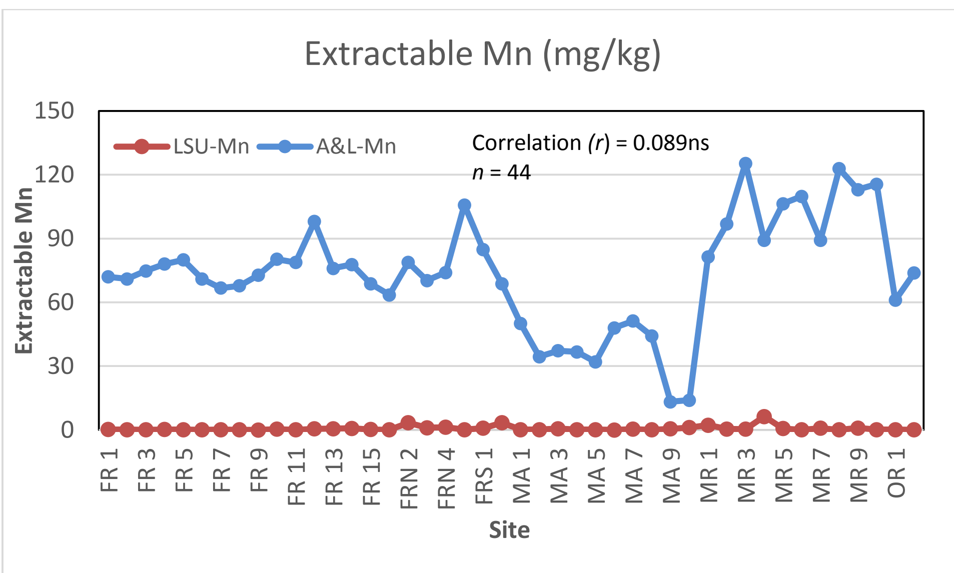


Figure 3.10. Comparison of manganese (Mn) between the A&L and the LSU soil testing laboratory. Mn were higher in the acid extraction than water extraction. This also can explain that Mn is mostly bind with soil particles and would not easily remove by water.

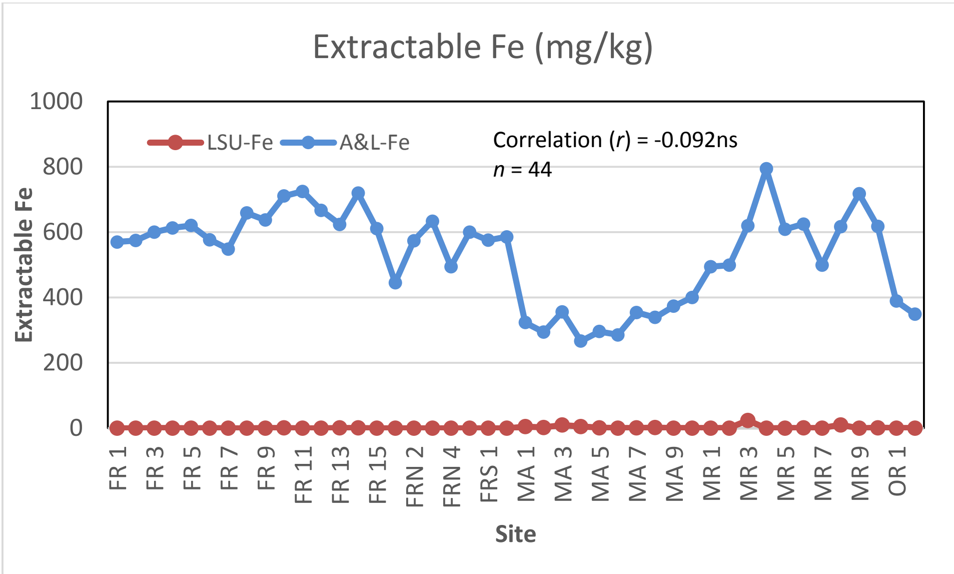


Figure 3.11. Comparison of Iron (Fe) between the A&L and the LSU soil testing laboratory. Fe were significantly higher with acid extraction method than water extraction. Fe is an oxidative element which can binding with other elements under different oxidation-reduction condition.

From the comparison charts above, pH and EC from both labs were determined in the same method (under soil slurry) but the ratio between soil and water might be different. From the pH value, the A&L lab would be used the ratio of 1:1 which the LSU lab used 1:2. The trend was the same with EC, except for some sites that the LSU lab has higher values that might be because of different in sampling times.

The macronutrient content i.e. phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) were significantly higher by acid extraction. However, sodium (Na) and sulfur (S) were not deferent from both methods. These macronutrients are important to plant growth and seem to be adequate for most plant species. These elements are not major limiting factors for plant growth for the coastal or saltmarsh environments. The limiting factors for the plant growth would be the high level of salinity, which includes sodium (Na), soluble salts, and electrical conductivity or salinity.

CEC by the sum of cation methods or also known as effective cation exchange capacity (ECEC) is generally high in coastal saltmarsh environments due to the high content of cations such as sodium (Na), calcium (Ca), Magnesium (Mg), and potassium (K). Usually, the direct CEC measurement will only include the sodium and other cations that bind to the exchangeable sites in the soil particles and would be a good indicator of soil fertility. However, these CEC values are not a good indicator for soil fertility status in coastal saltmarsh environments because this method of CEC calculation includes both the sodium that binds to the exchangeable sites in the soil particles and the free sodium in the porewater. Thus, the sodium amount can be very excessive and lead to higher levels of CEC than the actual amount. Unfortunately, both the A&L and LSU labs did not provide the direct CEC measurement, so this method should not be used to determine soil fertility.

Micronutrient (Mn and Fe) were significantly higher by acid extraction as compared to water extraction. However, at the beginning step for introducing plant species for saltmarsh restoration, micronutrient would not be a major factor for consideration. As soon as the salinity decreased (electrical conductivity or salinity) to certain level for specific plant species that would be the proper time to start restoration by planting.

SUMMARY

Soil test package from the A&L lab included several parameters, particularly for soil fertility evaluation and nutrient management for agricultural production The parameters included were organic matter, CEC, pH (and pH buffer), electrical conductivity, nitrate, macronutrients (P, K, Ca, Mg, S, Na) and micronutrient (Zn, Mn, Fe, Cu, B). Macro- and micronutrient analysis were based on the Mehlich III extraction method.

At the LSU lab, the “flood” package is an analysis method for soil in salt-affected environments such as levee, marsh, and constructed or restoration sites. The test parameters included pH, electrical conductivity (and salinity), soluble salts, CEC, SAR, macronutrients (P, K, Ca, Mg, Na, S) and micronutrients (Fe, Mn, Cl). Macro- and micronutrients were analyzed based on 1:2 (soil: water ratio) water extraction.

A comparison between the same test results from each lab (as shown in section 3 above), show a very close correlation to one another. The correlation between EC, pH, K, Mg, Na, S, CEC, and electrical conductivity are highly significant with the *r* values of 0.622**, 0.631**, 0.693**, 0.762**, 0.768**, 0.631**, and 0.730, respectively. However, the correlation between P, Ca, Fe, and Mn were not significantly related (-0.100ns, 0.084ns, -0.092ns and 0.089ns, respectively). The highly significant correlation indicated that either test results from the A&L lab or the LSU lab can be used for interpretation of the soil property status of each location.

Salinity (or electrical conductivity) of soils from the LSU Lab can be used as a standard for selecting a specific plant species which has a different degree of salt tolerance to grow in each location. SAR can be used as an indicator of the level of difficulty for reclamation of salt-affected soil. Although reclamation for the establishment of non-halophyte plants would not be the best option for saltmarsh restoration, the information for physical and chemical properties of the soil should be learned before introducing a specific plant species to each location.

Overall, the soil test results were highly related to the sampling locations from both labs, particularly, the salinity parameters. These salinity related factors are likely to be major limiting factors for plant growth. The older constructed marshes ridges would contain lower levels of these limiting factors due to the dynamic cycle that occurs over a long period of time. From a nutrient concentration standpoint, nutrient levels would be sufficient for the growth of most wetland plant species. Therefore, following marsh and ridge creation utilizing saline marsh sediments, non-halophytic plant species should not be immediately introduced to the area, because the higher salinity related parameters would restrict plant growth.

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APPENDIX

Appendix Figure 1. Map of the entire area of sampling sites.

Appendix Figure 2. Map of sampling sites for Mitigation Area.

Appendix Figure 3. Map of sampling sites for Middle Ridge area.

Appendix Figure 4. Map of sampling sites for Far Ridge area.

Appendix Table 2. Soil physical and chemical properties for samples collected in May 2008 (A&L Lab)

Sample ID	O.M. (%)	CEC (meq/100g)	pH	Buffer pH	EC (mS/cm)	P	K	Ca	Mg	S	Na	Zn	Mn	Fe	Cu	B	NO_3
						(mg/Kg)											
OR 1	1.3	30.7	8.50	6.98	2.07	18	396	12970	920	134	512	6.4	118	574	3.6	2.0	10
OR 2	1.6	26.9	8.50	6.98	0.36	30	448	9562	900	462	1838	6.6	130	558	2.6	3.0	12
MR 1	0.9	12.6	8.90	6.98	1.22	44	524	2370	648	330	2202	5.8	164	814	2.0	3.8	10
MR 2	0.5	57.0	8.30	6.88	26.00	36	708	1784	3182	1594	18598	4.0	108	682	1.4	7.4	10
MR 3	0.7	43.4	8.20	6.93	11.30	60	822	3982	2528	2280	11410	6.6	228	1078	3.4	5.2	12
MR 4	0.5	28.1	8.40	6.97	2.75	62	594	2580	1314	726	7918	5.4	152	1518	1.0	4.4	10
MR 5	1.0	19.1	8.30	6.96	2.73	54	614	3620	1400	352	2666	8.2	200	1210	3.8	3.4	10
MR 6	1.2	19.8	8.40	6.96	20.10	64	670	3550	1482	530	2880	8.0	232	1416	2.4	4.2	10
MR 7	0.6	65.9	8.10	6.85	6.61	42	762	2724	3746	2320	20800	5.0	158	854	1.8	6.2	10
MR 8	1.3	29.9	8.10	6.95	15.60	46	754	4162	1976	1082	6080	7.8	244	1342	2.4	5.6	10
MR 9	0.9	57.0	8.20	6.93	5.08	76	830	2978	3008	1680	17756	7.6	248	1308	2.6	8.2	10
MR 10	1.7	26.4	8.50	6.97	0.75	60	816	4308	2014	1126	4212	8.8	334	1614	1.4	7.6	10

EC = Electrical conductivity

Appendix Table 3. Soil physical and chemical properties for samples collected in January 2009 (A&L Lab)

Sample ID	O.M. (%)	CEC (meq/100g)	pH	Buffer pH	EC (mS/cm)	P	K	Ca	Mg	S	Na (mg/Kg)	Zn	Mn	Fe	Cu	B	NO_3
MA 1	2.1	8.0	8.00	7.00	0.33	13	164	867	378	31	304	4.3	50	327	1.1	1.2	7
MA 2	1.5	5.9	8.10	6.98	0.29	9	101	640	267	23	246	3.2	31	298	0.8	0.8	5
MA 3	2.5	11.2	8.30	6.96	0.23	12	213	1189	579	18	360	4.6	45	372	1.4	1.6	5
MA 4	1.1	6.7	8.30	7.00	0.40	13	172	719	267	20	324	3.4	42	279	0.7	0.6	5
MA 5	1.8	10.4	7.90	7.00	0.91	12	158	1263	362	34	526	3.8	38	313	0.9	0.7	5
MA 6	3.9	20.5	8.00	7.00	0.99	13	166	3567	462	94	575	3.9	43	380	1.1	1.7	5
MA 7	3.8	18.3	7.60	6.96	2.39	15	234	1742	598	105	1432	5.7	63	392	1.2	2.1	5
MA 8	0.8	8.0	7.90	6.99	1.11	9	154	842	315	95	439	3.1	38	353	0.7	0.9	5
MA 9	0.9	17.2	7.50	6.97	5.51	20	281	500	507	195	2452	3.7	11	345	0.9	2.0	5
MA 10	1.5	26.4	7.00	6.98	7.41	26	346	689	697	351	4035	5.0	14	483	1.2	3.0	5
OR 1	2.2	13.2	7.80	6.97	0.81	18	220	1753	464	109	499	5.1	42	472	1.3	1.5	5
OR 2	1.9	24.2	8.50	7.00	0.46	21	222	4850	387	51	344	4.1	64	261	1.5	1.0	5
MR 1	0.9	20.6	8.20	6.99	3.77	30	274	2171	403	423	1901	6.8	71	598	1.7	2.2	5
MR 2	0.6	65.1	8.30	6.96	19.90	34	468	2049	1666	689	9911	3.5	100	561	1.3	4.4	5
MR 3	1.1	59.9	7.90	6.97	14.60	40	534	2525	1575	940	8421	5.2	142	648	3.3	4.4	5
MR 4	1.4	39.1	8.10	7.00	10.10	33	447	1919	927	550	5361	4.6	102	782	1.1	3.9	5
MR 5	1.5	16.9	8.10	7.00	1.97	29	303	1805	559	233	1085	3.8	88	565	2.0	1.7	5
MR 6	3.0	17.8	8.00	6.98	2.09	32	296	1929	611	266	1094	4.5	83	520	2.0	2.0	5
MR 7	1.3	79.1	8.00	6.96	22.00	38	725	1640	1674	809	13340	4.4	89	457	1.3	5.0	5
MR 8	1.1	18.0	7.70	7.00	1.87	34	360	1907	576	293	1187	4.9	117	521	2.4	2.7	5
MR 9	0.6	33.1	8.00	6.99	8.45	49	397	1638	691	344	4687	4.1	91	669	1.0	3.1	5
MR 10	3.4	18.7	8.10	6.96	0.98	34	344	2081	783	168	835	7.1	94	514	2.8	2.5	5
FR 1	1.3	39.2	8.00	6.98	12.10	36	420	2881	859	717	4641	9.3	98	716	2.2	3.5	5
FR 2	1.0	37.9	8.10	6.98	9.55	35	367	2519	817	684	4786	8.4	90	719	1.5	2.9	5
FR 3	0.9	35.3	8.10	6.99	8.62	31	353	2532	750	589	4311	8.6	85	672	2.4	2.7	5
FR 4	0.9	32.0	7.90	7.00	8.51	30	337	2188	698	640	3950	8.1	96	649	1.9	2.9	5
FR 5	1.0	25.9	8.10	6.99	5.10	31	337	2107	630	662	2754	8.6	116	710	1.9	2.9	5
FR 6	0.7	30.4	8.00	6.99	5.92	26	324	2317	660	566	3537	6.9	90	591	1.6	2.3	5
FR 7	0.7	25.5	8.10	7.00	6.22	23	295	2045	546	469	2888	6.0	77	596	1.5	2.2	5
FR 8	1.3	29.7	8.00	7.00	6.47	29	361	2284	670	601	3374	8.8	86	756	1.6	3.1	5
FR 9	1.1	34.6	7.90	6.98	0.94	33	373	2270	757	699	4353	8.5	89	766	1.5	3.1	5
FR 10	1.5	45.9	8.00	6.97	12.90	38	462	2296	1121	736	6233	10.5	115	780	1.5	3.6	5
FR 11	1.3	44.8	8.00	6.97	11.80	33	431	2090	1105	620	6212	10.3	109	763	1.4	3.6	5
FR 12	1.5	50.3	8.00	6.98	11.80	27	485	2665	1199	963	6763	10.3	123	769	1.8	3.9	5
FR 13	0.9	34.9	7.90	7.00	9.80	27	353	2478	771	900	4218	8.3	96	693	1.9	2.9	5
FR 14	1.8	49.0	7.80	6.94	13.50	30	476	3015	1081	1365	6351	10.4	110	767	1.6	4.0	5
FR 15	0.7	33.6	8.10	6.99	8.15	35	342	2567	676	644	4008	7.3	85	726	1.3	2.6	5
FRN 1	0.8	46.4	8.10	7.00	14.70	25	378	1702	1044	599	7075	5.3	67	483	1.3	3.4	5
FRN 2	2.1	36.8	7.90	6.98	9.75	27	418	2046	871	523	4836	8.3	81	648	2.0	4.5	5
FRN 3	2.3	38.2	8.00	6.99	9.25	29	466	2369	909	538	4778	6.1	73	712	1.5	4.0	5
FRN 4	1.0	41.9	8.00	6.99	11.70	26	390	1833	822	441	6306	7.2	82	596	1.3	3.2	5
FRN 5	2.2	45.7	7.70	6.99	11.00	38	489	2213	1019	488	6422	12.4	115	702	1.8	4.5	5
FRS 1	0.9	42.8	8.10	6.99	11.80	26	405	2048	996	517	6006	4.9	75	675	1.6	3.5	5
FRS 2	0.7	39.1	8.40	6.99	10.50	26	353	2172	807	399	5406	6.1	83	547	1.4	3.1	5
FRS 3	1.3	31.3	8.30	7.00	6.89	32	395	2027	768	340	3780	5.4	74	724	1.2	3.5	5
FRS 4	1.0	59.1	8.40	6.98	16.50	32	503	2636	1331	648	8576	4.4	69	668	1.1	4.0	5
FRS 5	1.2	31.5	8.10	7.00	7.21	32	405	2088	688	483	3920	8.1	135	680	2.0	3.8	5

Appendix Table 4. Soil physical and chemical properties for samples collected in August 2009 (A&L Lab)

Sample ID	O.M. (%)	CEC (meq/100g)	pH	Buffer pH	EC (mS/cm)	P	K	Ca	Mg	S	Na (mg/Kg)	Zn	Mn	Fe	Cu	B	NO_3
MA 1	1.1	6.8	8.10	6.97	0.14	9	121	761	337	18	207	2.9	47	274	0.8	0.7	6
MA 2	0.8	5.4	7.90	6.98	0.10	8	88	598	289	20	149	2.5	37	263	0.8	0.6	5
MA 3	3.9	16.3	7.20	6.88	0.70	16	331	1633	771	111	724	5.7	39	314	2.1	2.3	6
MA 4	1.1	6.3	8.20	6.97	0.12	11	125	663	316	14	219	3.1	41	277	0.9	0.5	6
MA 5	3.6	10.2	7.70	6.93	0.23	13	127	1088	471	39	452	6.0	32	292	1.2	1.2	8
MA 6	3.6	23.9	7.40	6.90	0.87	16	124	4382	464	156	631	4.4	52	224	1.2	1.8	15
MA 7	5.2	16.8	7.70	6.90	0.55	10	129	2344	597	71	611	4.0	49	277	1.1	1.9	14
MA 8	1.0	9.0	7.60	6.97	0.73	9	150	808	357	122	628	2.8	53	302	0.7	1.2	5
MA 9	1.3	27.9	7.20	6.98	3.80	17	255	543	797	351	4370	4.2	15	299	1.1	2.9	5
MA 10	2.4	34.6	7.00	6.91	9.17	18	288	652	949	471	5540	4.8	16	357	1.3	3.8	5
OR 1	2.3	12.2	8.10	6.95	0.35	15	224	1741	414	61	364	3.8	52	484	1.5	1.5	5
OR 2	4.2	21.0	7.90	6.96	0.33	21	205	3940	512	54	239	5.8	64	282	1.7	1.8	7
MR 1	1.1	29.0	8.00	6.97	4.86	19	241	3384	555	503	2492	6.4	71	425	1.7	2.3	5
MR 2	0.8	68.7	8.00	6.89	13.80	19	434	1526	1993	688	10665	3.8	90	463	1.3	3.9	5
MR 3	0.8	21.7	8.30	6.98	2.73	31	287	1606	578	454	2359	3.3	88	484	1.5	3.0	5
MR 4	1.0	31.5	7.90	6.96	5.40	32	304	1494	746	350	4400	3.6	87	645	0.7	2.7	5
MR 5	1.4	15.8	7.80	6.93	0.84	30	297	1966	555	70	705	3.7	105	467	2.1	1.4	5
MR 6	1.5	19.5	8.00	6.96	1.26	22	286	1936	668	275	1387	4.0	92	466	2.0	1.9	5
MR 7	1.0	82.5	7.90	6.91	12.90	22	499	1337	2544	758	13007	3.4	83	462	1.1	5.4	5
MR 8	1.0	21.4	7.80	7.00	2.78	25	260	1751	645	355	2048	3.7	97	475	2.0	2.1	5
MR 9	1.8	40.4	7.80	6.95	6.52	31	336	1602	1042	502	5823	3.9	110	585	1.0	4.4	5
MR 10	3.3	13.0	7.80	6.95	0.59	21	208	1429	599	57	523	5.1	73	388	1.8	1.5	5
FR 1	1.7	26.7	8.00	6.96	12.50	25	293	2196	776	761	2619	7.9	63	450	3.6	3.4	8
FR 2	1.3	29.5	8.00	6.97	12.70	24	274	2910	740	594	2687	7.6	56	424	3.4	2.9	9
FR 3	1.1	25.8	7.90	7.00	13.00	26	293	1633	864	743	2755	7.1	62	450	3.4	3.1	8
FR 4	1.0	17.4	8.00	6.98	5.35	24	244	1396	379	462	1934	6.3	52	488	2.8	3.1	7.66
FR 5	1.0	21.7	7.90	7.00	9.91	25	267	1511	581	642	2456	6.8	57	468	3.3	3.3	15
FR 6	0.9	17.5	8.20	6.99	4.54	21	231	1810	335	348	1661	5.7	57	390	3.3	2.3	12.8
FR 7	1.2	19.7	8.00	7.00	2.88	22	254	1605	417	399	2199	4.3	57	387	3.1	2.8	7.64
FR 8	1.5	24.9	7.80	7.00	5.86	25	298	1515	796	734	2773	8.0	54	493	3.5	3.5	7.11
FR 9	1.3	24.2	7.90	6.95	13.80	25	287	1339	836	665	2727	8.1	64	508	2.3	2.6	7
FR 10	1.3	26.4	7.80	6.97	14.90	26	296	1508	987	834	2794	8.1	62	585	3.4	3.5	7
FR 11	1.4	26.1	7.90	6.95	14.90	26	312	1481	974	752	2765	8.9	74	594	2.6	3.5	7
FR 12	1.4	24.7	7.80	6.96	14.40	27	293	1372	873	768	2730	8.4	82	541	2.5	3.4	7
FR 13	1.6	22.9	7.90	7.00	7.71	24	279	2033	602	977	2198	8.4	70	540	2.8	3.2	7
FR 14	2.0	24.0	7.90	6.96	11.80	24	298	1752	663	808	2589	8.2	65	532	2.7	3.5	7
FR 15	0.9	20.5	8.20	6.97	6.49	24	238	1872	427	456	2126	5.5	61	472	2.7	2.4	8
FRN 1	0.8	34.3	8.30	6.96	14.40	21	289	1389	914	384	4845	4.1	72	447	0.9	3.1	6
FRN 2	2.6	41.8	7.90	6.96	13.90	27	430	1596	1121	482	5955	7.0	85	544	1.3	4.6	5
FRN 3	1.7	35.5	8.10	6.99	9.58	17	380	3136	789	340	3725	4.5	59	504	1.6	2.6	5
FRN 4	0.7	54.5	8.10	7.00	20.60	22	411	1239	1427	534	8669	4.8	74	476	1.1	4.0	5
FRN 5	3.3	45.4	8.00	6.98	15.00	28	514	1950	1254	497	6163	10.3	102	546	1.5	5.2	5
FRS 1	0.6	34.0	8.10	6.97	6.83	19	278	1575	926	383	4593	2.6	87	513	1.3	2.7	8
FRS 2	0.6	31.1	8.00	6.99	5.70	18	271	2020	718	514	3910	4.5	81	451	1.1	3.2	9
FRS 3	1.1	33.2	7.90	6.97	6.74	24	334	1696	830	389	4455	3.7	58	557	0.9	2.9	6
FRS 4	2.8	41.7	7.90	7.00	15.20	17	432	1747	1073	515	5881	3.9	81	563	0.9	4.6	6
FRS 5	3.3	55.2	7.80	6.97	17.00	27	665	2194	1369	517	7919	10.7	164	547	2.3	6.5	6

Appendix Table 5. Soil physical and chemical properties for samples collected in January 2010 (A&L Lab)

Sample ID	O.M.	CEC	pH	Buffer pH	EC	P	K	Ca	Mg	S	Na	Zn	Mn	Fe	Cu	B	NO_3
	(%)	(meq/100g)			(mS/cm)						(mg/Kg)						
MA 1	1.0	6.6	8.00	6.96	1.47	21	128	760	381	16	93	3.6	56	372	0.9	0.7	5
MA 2	1.9	6.1	7.60	6.97	12.60	10	77	735	363	15	45	3.0	37	282	0.8	0.6	5
MA 3	3.2	11.1	7.30	6.92	3.45	13	176	1324	656	25	96	5.6	24	333	1.3	1.4	5
MA 4	1.2	5.5	8.20	6.99	8.92	13	122	639	314	11	69	3.6	36	275	0.7	0.5	5
MA 5	2.0	8.5	7.80	6.95	7.75	14	131	1324	365	12	47	3.7	33	264	0.8	0.6	5
MA 6	4.9	19.3	7.60	6.96	6.92	13	110	3538	520	49	244	4.1	51	297	1.2	1.9	5
MA 7	4.9	16.6	8.30	6.93	4.93	13	205	2174	817	26	280	6.9	47	365	1.5	2.3	5
MA 8	0.8	9.9	8.00	6.99	2.03	10	179	1023	386	103	579	3.4	44	405	0.8	1.5	5
MA 9	1.5	15.7	7.20	6.95	6.65	24	346	546	687	242	1723	5.6	19	409	1.3	3.5	5
MA 10	1.0	16.8	7.40	6.95	8.37	18	344	518	673	307	2021	4.1	15	340	0.8	2.9	5
OR 1	2.5	16.7	8.00	6.96	0.34	14	161	3334	343	27	128	3.5	57	280	1.8	1.1	5
OR 2	3.1	18.6	7.90	6.93	0.83	17	417	2522	712	173	495	5.2	65	464	3.0	2.6	5
MR 1	0.8	14.5	8.20	6.98	2.23	19	209	2115	296	283	768	5.2	65	428	1.3	1.9	5
MR 2	0.6	43.7	8.20	6.93	18.60	24	381	1534	1254	523	6224	3.3	89	413	1.1	3.5	5
MR 3	0.8	31.1	8.00	6.94	11.20	28	436	1721	841	648	3856	3.5	103	498	1.9	2.8	5
MR 4	0.7	20.2	8.10	6.98	7.83	15	254	1183	484	136	2579	1.9	57	500	0.4	1.4	5
MR 5	3.6	15.2	8.00	6.95	0.12	26	258	1534	566	100	951	4.8	77	481	1.5	2.0	5
MR 6	2.3	16.6	7.70	6.95	2.76	22	261	1856	546	313	1030	3.7	85	453	1.9	2.0	5
MR 7	0.9	42.6	8.10	6.91	21.50	22	351	1011	1273	482	6447	3.2	65	384	1.1	3.4	5
MR 8	0.7	10.8	7.90	6.97	0.17	15	173	1589	346	77	335	2.2	84	430	1.0	0.8	5
MR 9	1.8	28.3	8.00	6.96	9.07	32	351	1676	742	422	3493	4.5	111	643	0.9	3.7	5
MR 10	3.0	10.4	8.00	6.95	0.92	16	187	1256	492	37	285	3.6	67	395	1.5	1.3	5
FR 1	0.7	22.7	8.20	6.97	7.54	27	315	2507	640	509	1649	7.5	60	596	1.4	2.4	6
FR 2	0.7	27.5	8.10	6.98	9.00	32	358	2941	767	559	2091	7.6	71	639	1.9	2.6	5
FR 3	0.9	22.8	8.10	6.97	8.72	29	390	1821	761	617	2023	7.8	76	701	1.5	2.9	5
FR 4	1.1	26.0	7.90	6.96	6.68	31	403	2471	824	978	2053	9.0	85	758	1.6	3.7	5
FR 5	1.0	21.3	7.80	6.93	9.00	27	356	2096	632	802	1682	8.0	70	708	1.9	2.9	14
FR 6	0.6	17.3	7.90	7.00	4.10	27	280	2143	433	585	1112	7.2	65	637	1.5	2.3	5
FR 7	0.8	21.3	8.30	6.97	7.10	23	326	2149	592	524	1726	4.8	66	522	1.3	1.8	5
FR 8	1.1	22.9	7.90	6.97	8.17	27	395	2178	689	696	1865	8.0	60	794	1.5	3.0	5
FR 9	0.8	19.0	8.00	6.97	6.16	25	330	1950	563	654	1426	7.5	67	674	1.6	2.5	7
FR 10	0.9	26.4	8.00	6.95	11.60	32	405	2227	833	758	2359	9.1	80	854	1.2	2.9	5
FR 11	1.0	29.5	8.00	6.94	0.23	31	434	1983	1052	686	2882	9.1	69	858	1.4	3.1	5
FR 12	1.1	30.8	7.70	6.95	0.21	26	441	2779	972	1281	2598	9.5	90	766	1.6	3.5	5
FR 13	0.8	16.7	7.90	6.97	0.31	23	274	2328	394	608	873	9.1	67	685	1.5	1.8	5
FR 14	0.9	21.9	8.00	6.98	0.15	24	390	1879	676	821	1911	8.5	67	777	1.5	3.1	5
FR 15	0.7	22.1	8.00	6.99	0.16	26	340	2199	611	492	1828	6.6	60	670	1.6	2.2	5
FRN 1	0.6	32.3	8.00	6.97	11.50	22	298	1662	751	394	4423	4.5	65	414	1.2	3.2	5
FRN 2	2.0	30.8	7.60	6.96	0.96	22	404	1811	770	533	3857	7.0	75	573	1.6	4.1	5
FRN 3	3.3	38.8	7.80	6.95	9.67	28	679	2820	1040	509	4162	6.5	93	620	1.5	5.1	5
FRN 4	0.8	36.1	8.10	6.95	14.70	19	345	1282	872	469	5405	5.1	72	485	1.1	2.9	5
FRN 5	2.4	36.5	7.90	6.95	11.50	40	570	2159	955	411	4437	12.3	114	603	1.6	4.6	5
FRS 1	1.5	28.5	8.30	6.98	0.85	19	376	2128	786	307	3019	4.2	93	584	1.0	2.8	5
FRS 2	1.1	23.8	8.30	6.98	0.63	24	361	2157	598	377	2249	7.3	99	577	1.4	3.4	5
FRS 3	1.2	25.4	8.10	6.99	0.69	23	323	1836	707	307	2737	4.6	69	545	1.2	3.3	5
FRS 4	1.1	28.7	8.50	6.98	8.64	21	372	1876	721	407	3408	4.4	77	605	0.9	3.4	5
FRS 5	2.0	28.1	8.10	6.98	6.48	24	445	2074	777	373	2968	8.7	116	628	1.6	4.8	5

Appendix Table 6. Soil physical and chemical properties for samples collected in August 2010 (A&L Lab)

Sample ID	O.M.	CEC	pH	Buffer pH	EC	P	K	Ca	Mg	S	Na	Zn	Mn	Fe	Cu	B	NO_3
	(%)	(meq/100g)			(mS/cm)						(mg/Kg)						
MA 1	1.5	6.0	7.30	6.96	0.13	16	106	671	380	15	43	4.1	47	321	0.9	0.7	5
MA 2	2.6	6.4	7.80	6.97	0.10	9	77	721	428	14	28	3.4	33	332	1.0	0.6	5
MA 3	3.9	10.7	8.20	6.97	0.13	11	232	1082	701	21	121	5.5	41	406	1.5	1.2	6
MA 4	1.0	4.4	7.90	6.98	0.10	11	84	490	279	8	29	3.3	28	235	0.5	0.4	5
MA 5	3.7	9.1	7.30	6.95	0.14	9	102	1009	603	31	57	5	25	315	1.1	1.0	5
MA 6	4.4	26.0	7.40	6.95	0.26	8	106	5542	431	46	126	3.4	46	241	1.2	1.2	5
MA 7	4.2	12.8	7.90	6.97	0.43	14	131	1811	639	21	106	4.7	46	383	1.1	0.9	7
MA 8	1.0	5.2	8.10	6.99	0.43	9	112	619	263	17	99	2.9	42	297	0.8	0.6	5
MA 9	2.1	27.6	7.10	6.96	6.23	16	363	518	793	373	4284	5.5	8	441	1.7	2.8	5
MA 10	1.7	30.1	7.20	6.97	6.01	19	341	505	768	370	4932	5.6	11	422	1.6	3.2	5
OR 1	1.6	14.2	8.20	6.98	0.57	14	109	2980	243	27	78	2.6	53	236	1.1	0.8	0
OR 2	2.7	17.4	8.00	6.97	0.30	18	149	3404	413	31	90	5.6	59	258	1.5	1.3	0
MR 1	0.7	9.2	7.50	6.99	0.40	16	90	1888	188	39	22	4	45	271	1.1	0.6	0
MR 2	0.8	100.0	8.20	6.92	18.40	27	420	1491	1631	741	18530	3.8	87	368	1.8	3.9	0
MR 3	2.3	20.7	8.30	6.96	1.90	34	284	1830	551	83	1976	4.3	94	473	1.9	2.0	0
MR 4	1.0	38.2	8.00	6.96	6.33	28	355	1213	657	419	6332	4	64	609	1.0	2.8	0
MR 5	1.3	25.1	8.70	6.96	1.35	29	421	2255	681	46	2301	4	100	496	2.7	2.1	0
MR 6	1.8	22.2	8.20	6.96	1.13	26	288	1725	618	162	2300	3.7	88	449	2.2	1.7	0
MR 7	1.2	97.1	7.90	6.95	14.20	24	458	1031	1190	425	19040	4.6	67	428	1.3	4.7	0
MR 8	1.4	21.3	8.10	6.95	2.10	27	259	1839	587	115	2049	3.5	100	488	2.6	1.6	0
MR 9	1.4	45.2	8.00	6.96	6.60	31	408	1392	721	429	7641	4.1	79	607	1.1	3.4	0
MR 10	2.7	18.3	8.20	6.97	6.26	17	191	1485	494	29	1874	3.6	60	383	1.7	1.3	0
FR 1	0.7	40.4	7.90	6.98	4.48	26	346	1884	887	614	5827	7.8	67	517	2.1	2.4	18
FR 2	0.6	45.2	8.30	6.98	7.23	24	357	2461	895	577	6394	6.7	67	515	2.4	2.3	5
FR 3	0.7	34.4	8.00	6.98	7.08	22	463	1894	727	539	4649	7	76	577	2.0	2.3	11
FR 4	0.7	24.1	8.10	6.99	5.13	18	328	1961	496	555	2701	6.5	79	558	1.8	2.1	5
FR 5	0.6	27.2	8.10	6.98	7.70	20	383	2232	557	742	3029	7.3	77	596	2.1	2.5	5
FR 6	0.7	35.2	8.30	7.00	7.56	23	433	2125	711	691	4661	7.6	72	690	1.8	2.2	5
FR 7	1.1	32.1	8.10	6.98	6.64	28	439	1877	746	705	4116	8.3	67	688	2.0	2.8	5
FR 8	0.8	40.6	8.20	6.98	8.30	23	357	1437	875	628	6290	7.2	71	592	1.7	2.6	6
FR 9	0.7	25.5	8.20	7.00	5.77	20	387	1500	550	367	3310	6.1	71	601	1.7	1.8	5
FR 10	0.7	21.0	8.10	6.99	4.64	21	341	1527	533	527	2309	6.6	64	623	1.7	2.1	5
FR 11	0.9	46.8	8.10	6.97	10.10	28	445	1555	1065	726	7218	9.6	63	684	1.8	3.1	5
FR 12	0.8	64.7	8.00	6.95	13.00	24	472	2640	1524	1289	9538	9.5	97	591	2.2	3.6	5
FR 13	0.6	29.3	8.40	6.99	7.17	19	385	1987	568	713	3724	7.5	71	578	1.7	2.2	5
FR 14	1.2	39.9	8.10	6.97	8.66	25	543	2320	868	1099	5231	8.9	69	801	1.8	3.5	5
FR 15	0.8	53.0	8.40	7.00	11.20	29	441	2511	1139	852	7664	6.8	69	574	1.8	2.8	8
FRN 1	2.1	77.7	8.10	6.96	9.10	24	314	994	722	382	15520	4.4	50	438	1.1	2.9	0
FRN 2	0.6	81.8	8.00	6.95	8.27	28	483	1620	935	507	15420	7.8	74	531	2.1	4.5	0
FRN 3	1.5	57.3	8.10	6.98	6.00	28	477	1492	788	331	10160	5.3	56	699	1.2	2.8	0
FRN 4	0.7	110.9	8.10	6.96	13.00	21	305	973	1143	560	22440	5.3	68	420	1.1	3.0	0
FRN 5	1.9	79.5	7.90	6.96	8.33	35	467	1790	922	528	14770	10.1	92	548	2.0	4.0	0
FRS 1	0.8	38.9	8.30	6.98	4.42	25	299	1727	659	272	6049	4	84	529	1.9	2.6	0
FRS 2	0.6	54.6	8.10	6.98	6.45	20	288	1823	577	429	9718	5.3	74	451	1.4	2.7	0
FRS 3	0.7	31.5	8.30	6.99	3.70	19	268	1267	565	225	4950	3.9	74	516	1.3	2.0	0
FRS 4	1.5	36.0	8.10	6.99	3.98	21	335	1829	639	289	5298	4.6	99	568	1.4	2.6	0
FRS 5	1.5	41.9	7.90	6.96	4.64	30	424	1573	745	426	6658	8.8	115	705	1.4	3.6	0

Appendix Table 7. Soil physical and chemical properties for samples collected in February 2011 (A&L Lab)

Sample ID	O.M. (%)	CEC (meq/100g)	pH	Buffer pH	EC (mS/cm)	P	K	Ca	Mg	S	Na (mg/Kg)	Zn	Mn	Fe	Cu	B	NO_3
OR 1	1.2	12.4	6.90	6.96	0.55	13	111	2579	229	35	9	3.7	44	288	1.5	1.0	0
OR 2	2.3	17.7	7.90	6.95	0.41	29	177	3531	385	39	85	4.4	61	270	2.1	1.3	0
MR 1	0.5	17.2	8.20	6.97	0.74	24	199	3101	348	191	419	6.4	72	432	2.4	2.0	0
MR 2	0.6	21.0	7.80	6.95	13.80	30	336	1690	1439	678	574	4.6	107	507	2.1	4.5	0
MR 3	0.7	12.1	8.60	6.98	3.93	35	287	1642	586	174	107	3.7	97	535	2.1	2.6	0
MR 4	2.0	22.8	7.90	6.96	10.00	36	556	2218	1164	869	879	6.1	73	710	1.4	6.2	0
MR 5	1.8	11.7	8.10	6.95	1.86	23	191	1610	538	43	174	4.3	68	433	2.1	1.5	0
MR 6	2.1	13.2	8.00	6.95	2.25	26	241	1962	579	289	96	4.3	79	445	2.6	2.2	0
MR 7	0.7	23.0	8.50	6.94	16.10	29	440	1312	1691	738	872	4.1	73	411	1.6	4.3	0
MR 8	1.0	12.1	7.10	6.96	2.32	27	213	1897	502	175	53.5	3.8	95	446	2.6	1.7	0
MR 9	1.6	25.8	8.30	6.97	9.90	27	409	3910	889	547	591	4.4	39	493	1.8	4.9	0
MR 10	2.2	15.0	5.50	6.92	1.52	22	189	1588	557	95	29.3	4.8	65	411	2.1	1.6	0

Appendix Table 8. Soil physical and chemical properties for samples collected in October 2011 (LSU Lab)

Site	pH (1:2)	EC	Salinity	Salts	P	K	Ca	Mg	Na	S	Cl	Fe	Mn	SAR	CEC (meq/100g)
		(mS/cm)	(ppt)						(mg/Kg)						
MA 1	7.99	0.2	0.1	370	0.23	27	50	31	19	11	113	0.30	0.09	0.2	0.7
MA 2	7.75	0.2	0.1	508	0.34	16	54	44	56	29	135	0.66	0.47	0.4	0.9
MA 3	7.50	0.6	0.3	1,320	0.44	62	159	102	138	221	270	0.71	2.40	0.7	2.4
MA 4	7.77	0.2	0.1	334	0.32	24	53	26	15	14	220	0.11	0.07	0.1	0.6
MA 5	7.63	0.2	0.1	333	0.36	17	48	30	21	13	167	0.35	0.52	0.2	0.6
MA 6	7.45	1.0	0.5	1,853	0.51	41	277	118	152	63	849	0.16	0.08	0.6	3.1
MA 7	7.77	0.4	0.2	897	0.36	22	122	83	78	77	252	0.28	1.92	0.4	1.7
MA 8	7.90	0.8	0.4	1,398	0.29	25	46	30	363	52	662	0.60	0.61	3.2	2.1
MA 9	7.30	7.0	3.9	16,358	0.35	187	174	486	5,830	477	11,002	0.24	1.50	16.2	30.7
MA 10	7.27	6.7	4.2	17,626	0.38	193	202	543	6,289	525	13,500	1.79	3.85	16.5	33.3
MR 1	8.23	0.5	0.3	750	0.22	33	85	26	120	88	187	0.08	0.12	0.9	1.2
MR 2	8.22	19.5	11.6	33,024	0.35	281	408	1,348	11,951	904	56,024	0.01	0.03	20.2	65.9
MR 3	8.37	1.2	0.6	3,290	0.36	48	58	53	744	177	942	0.04	1.31	5.4	4.1
MR 4	7.70	16.3	9.6	33,920	1.17	339	784	1,130	11,958	1,511	50,663	0.01	15.05	20.2	66.1
MR 5	8.36	0.8	0.4	1,879	0.46	42	48	38	390	91	622	0.02	0.02	3.2	2.4
MR 6	8.25	1.0	0.5	1,819	0.24	48	56	48	508	170	654	0.01	0.01	3.8	3.0
MR 7	8.19	29.2	18.1	47,232	0.29	391	362	1,597	17,066	844	99,830	0.00	1.57	27.1	90.2
MR 8	8.23	0.7	0.4	2,176	0.27	45	68	42	352	106	573	0.01	0.01	2.6	2.3
MR 9	7.78	13.7	8.0	20,352	0.18	240	766	697	6,380	1,228	14,894	0.01	2.64	12.7	37.9
MR 10	8.16	1.2	0.7	2,496	0.21	53	100	82	585	294	774	0.00	0.42	3.3	3.9
FR 1	8.15	6.4	3.5	13,517	0.50	175	607	428	4,312	1,144	3,099	0.04	0.11	10.3	25.8
FR 2	8.29	7.1	3.9	16,077	0.34	190	685	545	5,125	1,227	6,647	0.00	0.05	11.2	30.7
FR 3	8.10	2.5	1.3	4,531	0.30	85	193	94	1,324	528	1,516	0.00	0.01	6.2	7.7
FR 4	8.01	3.3	1.8	6,208	0.20	103	418	190	1,676	919	1,666	0.00	1.09	5.4	11.2
FR 5	8.05	9.4	5.3	18,086	0.30	204	947	654	5,454	1,687	7,445	0.01	0.25	10.5	34.4
FR 6	8.16	2.4	1.3	4,160	0.22	80	195	110	1,105	457	1,466	0.01	0.57	5.0	6.9
FR 7	8.01	10.6	6.0	20,122	0.30	227	898	699	6,375	1,719	12,173	0.00	0.48	12.2	38.6
FR 8	8.08	10.1	5.8	19,072	0.32	235	739	598	6,454	1,542	9,810	0.01	0.15	13.5	37.3
FR 9	8.28	1.1	0.6	2,043	0.20	52	144	67	471	281	744	0.00	0.22	2.6	3.5
FR 10	7.96	5.5	3.1	10,342	0.20	155	407	337	3,331	1,010	314	0.01	1.51	9.3	19.7
FR 11	7.95	12.5	7.2	22,054	0.38	241	579	787	7,215	1,101	19,471	0.01	0.16	14.5	41.4
FR 12	7.93	12.4	7.2	26,880	0.25	296	864	949	9,198	1,634	31,572	0.01	1.52	16.2	52.9
FR 13	8.07	5.2	2.8	9,984	0.30	145	450	292	3,157	1,060	627	0.01	2.97	9.0	18.8
FR 14	8.00	2.6	1.4	6,246	0.25	119	277	194	1,855	890	1,664	0.00	3.35	6.6	11.4
FR 15	7.98	10.4	6.0	18,739	0.25	212	820	659	5,928	1,336	11,525	0.01	0.68	11.8	35.9
FRS 1	8.03	21.9	13.3	45,568	0.35	399	880	1,549	15,607	1,673	84,474	0.01	3.59	23.1	86.1
FRS 3	8.00	11.7	6.8	28,288	0.29	313	806	947	9,625	1,522	33,016	0.02	13.19	17.2	54.5
FRN 2	7.95	10.8	6.2	19,814	0.29	227	269	530	6,953	691	16,475	0.01	4.80	17.9	36.5
FRN 4	7.78	17.3	10.4	32,640	0.89	312	327	1,042	11,846	840	53,516	0.01	4.85	22.8	62.5
OR 1	8.09	0.3	0.1	544	0.40	45	72	37	47	22	163	0.53	0.92	0.4	1.0
OR 2	8.12	0.3	0.2	367	0.20	32	113	36	39	19	177	0.05	0.23	0.3	1.1

Appendix Table 9. Soil physical and chemical properties for samples collected in October 2012 (LSU Lab).

Site	pH (1:2)	EC (mS/cm)	Salinity (ppt)	Salts	P	K	Ca	Mg	Na (mg/Kg)	S	Cl	Fe	Mn	SAR	CEC (meq/100g)
MA 1	7.56	0.3	0.1	594	1.21	11	12	7	142	27	107	6.80	0.13	2.6	0.8
MA 2	6.62	1.8	1.0	3,238	0.26	27	123	102	720	91	868	0.04	0.09	3.7	4.7
MA 3	7.36	0.2	0.1	276	1.13	7	6	5	66	12	37	10.87	0.15	1.5	0.4
MA 4	7.26	0.4	0.2	796	0.83	13	10	6	167	27	177	2.65	0.14	3.3	0.9
MA 5	7.36	0.6	0.3	982	0.47	14	59	28	188	44	208	0.86	0.09	1.6	1.4
MA 6	7.98	1.1	0.5	1,864	1.00	29	59	24	451	67	428	0.87	0.09	3.9	2.5
MA 7	7.77	1.1	0.6	2,100	0.88	30	62	40	514	88	481	0.66	0.04	3.9	3.0
MA 8	7.49	0.2	0.1	540	0.72	13	18	9	89	19	119	3.32	0.10	1.3	0.6
MA 9	6.60	6.7	3.7	12,851	0.37	173	108	293	4,581	436	3,152	0.16	0.10	16.4	23.3
MA 10	6.89	7.4	4.1	13,670	0.48	161	125	322	4,816	377	3,335	0.21	0.39	16.3	24.6
MR 1	8.11	0.3	0.1	458	0.26	12	42	9	40	16	71	0.53	0.03	0.5	0.5
MR 2	7.66	18.6	11.1	42,624	0.46	346	324	1,720	14,981	1,206	5,467	0.02	0.25	23.1	81.9
MR 3	8.58	0.9	0.4	1,946	0.73	28	17	17	554	98	442	0.26	0.00	7.3	2.7
MR 4	7.40	20.8	12.5	46,848	0.39	487	883	1,484	16,600	2,110	5,471	0.05	0.43	25.0	90.1
MR 5	7.86	0.7	0.4	1,340	0.26	29	87	44	247	91	292	0.18	0.01	1.7	1.9
MR 6	7.91	1.8	1.0	3,725	0.32	63	103	81	1,029	344	776	0.03	0.13	5.8	5.8
MR 7	7.77	21.6	13.0	42,752	0.30	370	256	1,445	15,762	778	5,480	0.02	0.35	26.7	82.7
MR 8	7.92	1.5	0.8	3,034	0.21	40	133	72	715	197	677	0.02	0.03	3.9	4.5
MR 9	7.82	18.8	11.2	35,200	0.25	351	564	1,143	12,781	1,233	5,252	0.02	0.12	22.4	68.7
MR 10	8.11	0.4	0.2	708	0.99	21	34	29	239	48	256	5.77	0.03	2.3	1.5
MRN 1	8.37	0.3	0.1	518	0.20	5	68	11	44	11	97	0.02	0.05	0.4	0.6
FR 1	7.90	8.2	4.6	14,451	0.23	172	570	416	4,386	1,101	2,832	0.03	0.09	10.8	25.8
FR 2	7.75	5.7	3.2	13,120	0.24	166	544	362	4,070	1,054	2,706	0.01	0.05	10.5	23.8
FR 3	7.94	4.0	2.2	9,229	0.25	113	393	197	2,753	871	1,812	0.03	0.01	8.9	15.9
FR 4	7.77	1.5	0.8	3,008	0.23	49	185	67	700	470	405	0.03	0.04	3.5	4.7
FR 5	7.47	3.8	2.0	9,062	0.23	115	502	279	2,432	1,024	1,703	0.03	0.04	6.8	15.7
FR 6	7.83	0.4	0.2	730	0.30	16	44	12	134	76	83	0.33	0.01	1.5	0.9
FR 7	7.77	4.7	2.5	12,864	0.31	158	801	395	3,673	1,482	2,365	0.04	0.11	8.4	23.6
FR 8	7.79	5.4	3.0	12,531	0.26	180	771	363	3,682	1,436	2,397	0.02	0.04	8.6	23.3
FR 9	7.98	3.1	1.6	7,002	0.24	102	449	167	1,873	983	1,165	0.08	0.13	6.0	12.0
FR 10	8.16	0.2	0.1	378	0.45	10	19	4	69	16	39	2.56	0.04	1.2	0.5
FR 11	7.54	14.1	8.2	27,008	0.22	310	955	999	8,452	1,676	4,603	0.01	0.13	14.4	50.6
FR 12	7.59	10.8	6.2	24,307	0.23	286	906	788	7,671	1,661	4,286	0.03	0.10	14.2	45.1
FR 13	7.76	1.7	0.9	2,931	0.25	64	272	77	569	408	481	0.24	0.02	2.5	4.6
FR 14	7.78	1.9	1.0	3,776	0.45	66	92	64	1,052	463	630	0.10	0.00	6.5	5.7
FR 15	7.93	5.1	2.8	9,190	0.24	120	355	221	2,760	760	2,012	0.02	0.05	8.9	15.9
FRS 1	7.84	10.7	6.1	20,275	0.40	209	320	554	7,023	743	4,112	0.02	0.09	17.4	37.2
FRS 3	7.80	8.0	4.4	16,282	0.43	210	280	428	5,424	762	3,482	0.02	0.35	15.0	29.1
FRN 2	7.41	19.9	11.9	44,416	0.28	476	834	1,496	15,652	2,016	5,430	0.02	7.66	23.7	85.8
FRN 4	7.75	10.5	6.0	18,176	0.26	220	192	409	6,228	551	3,787	0.02	0.33	18.4	32.0
FRN 7	7.62	7.0	3.9	15,040	0.27	205	823	438	4,503	1,507	2,894	0.01	0.11	10.0	27.8
FRN 13	7.60	8.5	4.8	19,213	0.29	234	523	492	6,432	1,103	3,802	0.04	0.13	15.3	35.2

Appendix Table 10. Soil physical and chemical properties for samples collected in May 2013 (LSU Lab).

Site	pH (1:2)	EC (mS/cm)	Salinity (ppt)	Salts	P	K	Ca	Mg	Na	S	Cl	Fe	Mn	SAR (1)	CEC (2) (meq/100g)
									(mg/Kg)						
MA1	7.46	0.4	0.2	558	0.77	19	25	21	88	23	206	11.08	0.41	1.0	0.7
MA2	7.39	0.8	0.4	951	0.43	16	25	21	179	25	167	2.08	0.03	2.0	1.1
MA3	7.30	0.6	0.3	745	1.16	25	34	28	179	68	202	32.23	0.56	1.7	1.2
MA4	7.85	0.3	0.1	332	0.91	15	18	12	56	11	187	22.09	0.51	0.8	0.5
MA5	7.42	0.7	0.4	855	0.42	16	52	33	130	30	235	0.26	0.34	1.1	1.1
MA6	7.51	1.5	0.8	1,908	0.41	20	90	50	392	96	82	0.16	0.03	2.6	2.6
MA7	7.23	1.0	0.5	1,073	1.13	28	51	32	227	42	114	1.53	0.02	1.9	1.6
MA8	7.68	0.3	0.1	357	0.33	13	32	13	36	13	240	3.42	0.08	0.4	0.5
MA9	7.10	6.8	3.7	11,942	0.43	164	104	274	4,523	370	2,131	0.10	0.36	16.7	22.9
MA10	7.00	9.8	5.5	13,197	0.51	161	129	320	5,031	372	2,431	0.13	0.86	17.1	25.6
MR1	7.90	0.3	0.1	322	0.26	15	48	8	14	11	215	0.28	0.01	0.2	0.4
MR2	7.90	27.5	16.9	34,406	0.52	281	242	1,308	14,638	701	5,683	0.02	0.27	26.0	76.4
MR3	8.40	1.3	0.6	2,182	1.25	40	21	26	664	129	273	0.21	0.01	7.2	3.3
MR4	7.59	12.3	7.1	26,061	0.53	320	462	770	10,945	1,026	4,445	0.01	3.88	22.8	57.1
MR5	8.00	0.7	0.3	1,041	0.51	27	30	18	215	38	222	0.20	0.00	2.4	1.3
MR6	7.70	1.6	0.8	2,629	0.36	52	71	49	668	206	120	0.16	0.34	4.7	3.8
MR7	7.75	32.6	20.4	46,080	0.42	389	259	1,428	19,680	635	6,888	0.25	0.75	33.4	99.7
MR8	Sample was contaminated during preparation														
MR9	7.63	34.4	21.6	44,672	0.29	429	835	1,264	19,212	1,484	7,250	0.09	1.04	30.9	99.2
MR10	8.10	0.6	0.3	929	0.30	29	47	27	148	50	147	0.28	0.05	1.3	1.2
MRN1	8.45	0.3	0.1	347	0.20	5	42	8	24	12	265	0.03	0.01	0.3	0.4
FR1	7.78	9.2	5.2	14,413	0.20	174	719	415	5,142	1,237	3,406	0.03	0.01	11.9	29.8
FR2	7.81	3.4	1.8	5,363	0.25	89	331	125	1,477	698	1,015	0.03	0.01	5.5	9.3
FR3	7.72	8.0	4.4	14,374	0.28	186	913	493	4,906	1,649	3,096	0.03	0.00	10.3	30.4
FR4	7.71	1.5	0.7	2,080	0.16	54	272	66	285	467	92	0.03	0.01	1.3	3.3
FR5	7.89	3.8	2.0	4,966	0.39	74	220	127	1,402	535	824	0.03	0.01	5.9	8.4
FR6	7.83	0.7	0.3	777	0.39	29	61	20	109	123	196	0.00	0.01	1.0	1.0
FR7	7.80	6.6	3.6	11,418	0.33	145	428	295	4,124	999	2,547	0.03	0.00	11.9	22.9
FR8	7.78	4.7	2.5	7,002	0.28	112	256	164	2,204	616	1,558	0.03	0.01	8.4	12.5
FR9	7.80	4.8	2.6	8,371	0.24	130	587	270	2,477	1,180	1,531	0.03	0.01	6.7	16.3
FR10	7.71	12.1	7.0	22,630	0.22	275	678	660	9,365	1,485	4,656	0.03	0.05	19.4	50.3
FR11	7.91	10.1	5.7	15,629	0.25	191	668	421	5,674	1,110	3,050	0.03	0.01	13.4	32.0
FR12	7.82	11.4	6.5	15,283	0.25	198	545	425	5,692	1,030	3,206	0.03	0.01	14.0	31.5
FR13	7.81	0.4	0.2	466	0.75	17	35	12	59	25	92	1.22	0.00	0.7	0.6
FR14	7.82	4.3	2.3	7,834	0.33	128	200	159	2,755	763	1,830	0.00	0.01	11.1	14.6
FR15	7.60	3.7	2.0	5,146	6.94	83	223	127	1,402	457	764	0.03	0.00	5.9	8.5
FRS1	8.02	9.2	5.2	16,218	0.28	182	215	445	6,435	502	3,585	0.03	0.01	18.1	33.2
FRS3	7.51	14.2	8.3	23,360	0.35	256	590	751	9,624	1,259	4,371	0.03	0.11	19.6	51.7
FRN2	7.58	13.8	8.0	23,910	0.24	305	540	716	10,040	1,242	4,693	0.00	2.32	21.0	53.0
FRN4	7.90	17.7	10.5	29,658	0.32	346	434	812	12,886	946	5,722	0.15	0.51	26.6	65.8
FRN7	8.00	4.2	2.2	7,155	0.23	108	355	182	2,164	823	1,320	0.01	0.01	7.3	13.0
FRN13	6.42	11.1	6.3	19,597	0.33	241	765	736	7,538	1,964	3,603	0.14	1.21	14.7	43.3
OR1	8.06	0.4	0.2	545	0.38	23	60	19	61	21	239	0.29	0.00	0.6	0.8
OR2	7.80	0.5	0.2	595	0.30	23	66	25	56	38	251	0.26	0.13	0.5	0.8

Appendix Table 11. Soil physical and chemical properties for samples collected in December 2013 (LSU Lab).

Site	pH (1:2)	EC (mS/cm)	Salinity (ppt)	Salts	P	K	Ca	Mg	Na (mg/Kg)	S	Cl	Fe	Mn	SAR	CEC (meq/100g)
MA 1	7.12	0.5	0.2	311	0.70	23	14	19	28	11	136	7.45	0.15	0.4	0.4
MA 2	6.96	0.5	0.3	896	0.30	21	22	26	145	23	994	2.14	0.15	1.6	1.0
MA 3	7.05	0.4	0.2	666	0.33	24	22	24	93	32	564	0.70	0.01	1.0	0.8
MA 4	7.17	0.2	0.1	247	0.48	16	18	13	13	5	115	3.22	0.07	0.2	0.3
MA 5	7.28	0.3	0.1	315	0.50	17	26	23	13	11	75	3.06	0.08	0.1	0.4
MA 6	7.54	0.4	0.2	508	0.34	14	38	22	54	22	168	1.08	0.04	0.5	0.6
MA 7	7.55	0.8	0.4	1,236	0.49	26	34	29	252	66	895	1.16	0.15	2.4	1.6
MA 8	7.34	0.2	0.1	285	0.46	15	22	14	20	6	156	2.72	0.04	0.3	0.3
MA 9	6.72	8.8	4.9	13,402	0.26	230	94	330	4,411	441	762	0.00	0.35	15.2	23.0
MA 10	6.82	8.3	4.7	14,682	0.31	200	91	336	4,878	336	1,306	0.01	0.68	16.7	25.0
MR1	7.60	0.2	0.1	314	0.16	15	32	10	14	9	206	0.72	0.01	0.2	0.3
MR 2	7.61	8.2	5.2	16,038	0.41	176	83	257	3,087	464	5,134	0.03	0.01	11.9	16.4
MR 3	8.29	1.2	0.6	2,086	1.99	45	9	14	572	98	1,748	0.40	0.05	8.7	2.8
MR 4	7.46	13.5	7.7	30,694	0.39	442	508	992	10,218	1,692	21,179	0.04	3.74	19.2	56.3
MR 5	7.72	0.4	0.2	552	0.44	31	21	16	70	14	277	0.56	0.04	0.9	0.6
MR 6	7.54	0.9	0.4	1,422	0.37	44	29	28	285	65	1,287	0.20	0.00	2.9	1.7
MR 7	7.72	21.4	12.9	49,152	0.30	422	199	1,558	15,922	695	55,305	0.03	0.20	26.3	84.2
MR 8	7.70	1.0	0.5	1,411	0.40	42	30	27	262	55	1,345	0.27	0.00	2.6	1.6
MR 9	7.70	25.1	15.2	48,384	0.25	446	537	1,469	15,375	1,300	50,807	0.03	0.28	24.5	82.8
MR 10	7.40	0.4	0.2	554	0.34	25	38	33	37	24	350	0.39	0.02	0.3	0.7
MRN 1	7.82	0.2	0.1	206	0.25	3	29	4	7	4	92	1.07	0.03	0.1	0.2
FR1	7.71	3.9	2.3	8,205	0.23	122	248	101	1,402	979	2,682	0.03	0.07	6.0	8.5
FR 2	7.75	5.3	2.9	9,216	0.24	150	274	233	2,564	736	4,671	0.03	0.00	8.7	14.8
FR 3	7.80	0.4	0.2	594	0.42	26	24	16	79	46	362	1.05	0.02	1.0	0.7
FR 4	7.42	1.1	0.5	1,910	0.17	58	180	79	212	426	313	0.03	0.01	1.0	2.6
FR 5	7.60	4.0	2.2	6,784	0.24	117	266	208	1,671	768	4,363	0.03	0.06	5.9	10.6
FR 6	7.80	0.4	0.2	550	0.38	25	26	12	73	48	190	2.04	0.03	0.9	0.6
FR 7	7.68	3.9	2.1	7,296	0.26	126	227	170	2,063	914	4,354	0.03	0.01	8.0	11.8
FR 8	7.51	3.9	2.1	7,680	0.18	136	370	202	1,898	901	4,579	0.03	0.00	6.2	12.1
FR 9	7.52	0.3	0.2	385	0.41	26	27	14	26	14	187	0.82	0.02	0.3	0.4
FR 10	7.58	11.5	6.6	17,805	0.22	256	415	534	5,727	1,323	1,967	0.02	0.09	13.8	32.0
FR 11	7.33	15.7	9.2	28,493	0.28	340	598	1,040	8,964	1,399	20,627	0.03	0.14	16.2	51.4
FR 12	7.60	10.1	5.7	15,373	0.20	205	445	415	4,614	1,087	580	0.02	0.03	11.9	26.2
FR 13	7.68	0.3	0.2	460	0.26	25	30	13	47	20	246	1.78	0.03	0.6	0.5
FR 14	7.60	0.6	0.3	927	0.49	38	28	18	157	85	514	1.68	0.04	1.8	1.1
FR 15	7.70	3.8	2.0	6,131	0.21	113	217	146	1,563	639	4,303	0.03	0.06	6.3	9.4
FRN 1	7.48	4.5	2.2	7,117	0.32	150	175	205	1,929	826	4,386	0.01	0.26	7.4	11.3
FRN 3	7.71	21.6	13.0	38,784	0.35	421	234	1,134	13,068	886	44,052	0.03	1.07	24.8	68.4
FRN 7	7.52	3.7	2.0	7,194	0.15	122	407	191	1,666	869	4,516	0.04	0.20	5.4	11.2
FRN 13	7.37	8.6	4.8	15,066	0.28	200	264	411	4,748	883	257	0.02	0.46	13.4	25.9
OR 1	7.50	1.1	0.5	1,554	0.22	43	101	44	188	54	1,604	0.01	0.01	1.2	1.8
OR 2	7.62	0.5	0.3	732	0.38	32	50	23	80	25	579	0.12	0.00	0.7	0.9

Appendix Table 12. Soil physical and chemical properties for samples collected in May 2014 (LSU Lab).

Site	pH (1:2)	EC	Salinity	Salts	P	K	Ca	Mg	Na	S	Cl	Fe	Mn	SAR	CEC (meq/100g)
		(mS/cm)	(ppt)						(mg/Kg)						
MA 1	7.50	0.5	0.3	273	0.31	11	16	11	9	11	39	2.69	0.02	0.1	0.2
MA 2	7.60	0.6	0.3	529	0.52	15	13	9	57	32	114	7.61	0.08	0.9	0.4
MA 3	7.39	0.5	0.3	374	0.69	20	15	12	36	21	48	12.08	0.19	0.5	0.4
MA 4	7.25	0.4	0.2	230	0.37	13	13	10	5	10	59	4.31	0.09	0.1	0.2
MA 5	7.11	0.4	0.2	313	0.28	9	23	12	9	9	47	0.64	0.00	0.1	0.3
MA 6	7.61	0.5	0.3	436	0.26	8	29	9	24	21	76	0.10	0.00	0.3	0.3
MA 7	7.30	0.5	0.3	489	0.45	18	21	12	41	13	52	1.41	0.03	0.6	0.4
MA 8	7.45	0.4	0.2	397	0.27	13	29	9	18	13	51	0.26	0.00	0.2	0.3
MA 9	6.92	6.1	3.8	14,490	0.31	196	79	196	2,717	396	4,845	0.02	0.21	11.8	14.3
MA 10	7.00	6.3	3.9	12,224	0.35	163	68	152	2,361	336	4,562	0.04	0.14	11.5	12.3
MR 1	7.30	0.5	0.3	313	0.24	14	28	7	7	16	48	0.02	0.01	0.1	0.3
MR 2	7.61	22.2	15.1	59,392	0.33	374	166	1,239	10,542	1,196	5,314	0.03	0.91	19.5	57.9
MR 3	8.20	1.0	0.5	1,736	1.10	43	9	13	307	85	508	11.50	0.21	4.8	1.6
MR 4	7.05	10.8	6.9	26,266	0.31	314	292	446	5,201	1,247	5,739	0.02	4.47	14.1	28.6
MR 5	7.50	0.5	0.3	466	0.34	27	26	13	23	13	105	0.58	0.02	0.3	0.4
MR 6	7.59	0.8	0.4	1,230	0.26	36	24	15	140	79	382	0.02	0.00	1.7	0.9
MR 7	7.40	28.7	19.9	73,088	0.38	479	193	1,416	12,819	1,211	4,797	0.03	0.88	22.1	69.6
MR 8	7.88	0.5	0.3	622	1.65	48	17	23	72	19	168	50.40	0.50	0.8	0.7
MR 9	7.45	26.6	18.3	55,936	0.23	420	352	891	10,245	1,195	5,282	0.03	0.71	20.9	54.7
MR 10	7.58	0.8	0.5	1,356	0.27	31	37	22	143	65	473	0.01	0.04	1.5	1.1
FR 1	7.60	4.4	2.7	9,075	0.25	134	254	137	1,510	856	3,113	0.03	0.28	6.0	9.3
FR 2	7.55	4.8	2.9	9,741	0.24	134	269	147	1,609	920	3,310	0.03	0.06	6.2	9.9
FR 3	7.59	1.2	0.7	1,292	0.22	41	68	17	111	241	170	0.02	0.01	1.0	1.1
FR 4	7.70	0.5	0.3	341	0.27	15	22	6	18	26	53	1.12	0.01	0.3	0.3
FR 5	7.41	3.0	1.8	6,426	0.23	108	252	116	915	916	1,874	0.03	0.00	3.8	6.5
FR 6	7.62	0.8	0.5	1,608	0.27	52	79	23	157	331	125	0.02	0.01	1.3	1.4
FR 7	7.23	8.0	5.0	19,162	0.30	213	469	366	3,537	1,660	5,097	0.03	0.03	9.4	21.3
FR 8	7.40	3.1	1.8	6,272	0.27	128	193	86	1,026	1,004	1,640	0.03	0.01	4.9	6.5
FR 9	7.35	3.2	1.9	7,347	0.26	126	320	129	1,060	1,012	2,236	0.03	0.00	4.0	7.6
FR 10	7.65	0.6	0.3	382	0.27	18	23	6	21	28	78	1.42	0.01	0.3	0.3
FR 11	7.72	10.2	6.5	19,840	0.27	234	218	302	3,829	1,156	5,317	0.03	0.01	12.4	20.8
FR 12	7.39	8.0	5.0	18,982	0.25	248	464	285	3,533	1,333	5,155	0.03	0.32	10.0	20.7
FR 13	7.82	1.0	0.5	1,445	0.31	38	23	10	187	156	376	1.19	0.01	2.6	1.1
FR 14	7.55	0.5	0.2	424	0.36	20	20	9	30	26	61	2.02	0.02	0.4	0.4
FR 15	7.69	4.5	2.7	9,869	0.25	140	215	151	1,676	783	3,479	0.03	0.41	6.8	10.0
FRS 1	7.60	5.8	3.6	11,750	0.27	143	95	142	2,212	477	4,226	0.03	0.18	10.6	11.6
FRS 3	7.41	4.9	3.0	11,034	0.26	171	93	136	2,081	536	4,021	0.03	0.85	10.1	11.1
FRN 1	8.09	0.4	0.2	214	0.19	3	24	2	5	5	42	0.00	0.00	0.1	0.2
FRN 2	7.78	7.3	4.5	19,520	0.30	248	305	323	3,770	1,275	5,310	0.03	1.17	11.3	21.2
FRN 4	7.65	13.7	9.0	32,653	0.23	345	128	456	6,709	600	5,819	0.03	0.37	19.7	34.5
FRN 7	7.59	5.0	3.0	9,856	0.24	160	323	152	1,598	1,022	3,208	0.03	0.44	5.8	10.2
FRN 13	7.31	3.7	2.2	7,744	0.29	120	122	96	1,329	741	2,611	0.02	1.02	6.9	7.5
OR 1	7.37	0.4	0.2	300	0.27	17	26	9	7	7	56	1.05	0.01	0.1	0.3
OR 2	7.55	0.4	0.2	402	0.31	21	42	11	7	9	51	0.06	0.01	0.1	0.4

Appendix Table 13. Soil physical and chemical properties for samples collected in October 2014 (LSU Lab).

Site	pH (1:2)	EC	Salinity	Salts	P	K	Ca	Mg	Na	S	Cl	Fe	Mn	SAR	CEC (meq/100g)
		(mS/cm)	(ppt)						(mg/Kg)						
MA 1	6.98	1.0	0.5	768	0.05	17	95	117	59	15	149	0.06	0.42	0.3	1.7
MA 2	6.86	0.8	0.4	635	0.07	19	67	88	92	9	122	0.16	0.21	0.5	1.5
MA 3	6.82	0.9	0.4	837	0.06	24	63	69	244	28	131	1.20	0.46	1.6	2.0
MA 4	6.38	1.3	0.7	1,302	0.01	20	118	163	246	71	183	0.06	0.12	1.1	3.1
MA 5	6.97	0.6	0.3	277	0.13	18	50	46	14	6	83	2.67	0.05	0.1	0.7
MA 6	6.82	1.0	0.5	1,000	0.01	25	89	56	316	35	120	0.70	0.01	2.0	2.3
MA 7	6.81	1.5	0.8	1,798	0.02	24	159	154	514	118	194	0.05	0.13	2.2	4.4
MA 8	7.16	0.7	0.3	645	0.05	21	59	41	201	10	90	1.73	0.03	1.5	1.6
MA 9	6.63	8.9	5.0	14,605	0.06	87	150	597	7,295	224	1,746	0.19	0.76	18.8	37.6
MA 10	6.62	11.2	6.4	18,010	0.03	86	183	782	9,224	248	2,057	0.11	0.82	20.9	47.7
MR 1	7.55	0.8	0.4	447	0.07	19	82	35	51	11	89	0.13	0.13	0.4	1.0
MR 2	6.83	17.8	11.3	29,760	0.04	96	282	1,742	13,567	380	2,615	0.01	1.28	21.0	75.0
MR 3	7.98	1.0	0.5	1,207	1.17	3	20	65	723	21	170	130.18	1.07	5.6	3.8
MR 4	7.06	12.1	6.9	26,432	0.15	88	779	1,502	12,969	943	2,410	0.03	10.65	19.7	72.9
MR 5	7.83	0.7	0.4	572	0.17	24	41	38	182	10	109	0.08	0.11	1.6	1.4
MR 6	7.71	0.8	0.4	740	0.00	31	34	34	278	12	120	3.93	0.07	2.5	1.7
MR 7	6.82	27.3	16.8	46,336	0.04	211	221	2,125	20,628	384	3,040	0.02	1.18	29.4	108.9
MR 8	7.80	1.3	0.7	1,729	0.06	32	73	88	632	18	276	0.18	0.16	3.7	3.9
MR 9	7.26	33.7	23.0	52,864	0.06	188	708	2,330	22,491	667	3,116	0.02	0.89	29.0	121.1
MR 10	7.93	1.1	0.6	1,554	0.04	28	124	121	400	46	226	0.37	0.60	1.9	3.4
MRN 1	7.61	0.6	0.3	324	0.01	19	98	12	13	2	88	0.02	0.01	0.1	0.7
FR 1	7.18	3.1	1.6	5,990	0.06	46	458	257	2,467	417	634	0.03	0.91	7.2	15.3
FR 2	7.30	3.7	2.0	6,195	0.04	46	500	275	2,544	485	615	0.03	0.58	7.2	15.9
FR 3	7.10	11.0	6.2	19,738	0.02	94	917	1,152	8,753	962	1,866	0.00	0.30	14.3	52.4
FR 4	7.92	0.7	0.3	534	0.05	25	91	44	51	10	104	0.22	0.24	0.3	1.1
FR 5	7.41	3.8	2.0	7,206	0.07	47	515	371	2,969	581	672	0.03	0.62	7.7	18.7
FR 6	7.60	1.5	0.8	2,222	0.04	33	150	95	817	163	208	0.02	0.02	4.1	5.2
FR 7	7.39	3.2	1.7	5,709	0.05	46	291	268	2,475	421	551	0.02	0.25	7.9	14.5
FR 8	7.31	5.1	2.7	9,971	0.04	69	498	432	4,631	658	1,011	0.08	0.49	11.6	26.4
FR 9	7.69	0.9	0.5	916	0.05	30	72	54	276	30	126	0.10	0.01	1.9	2.1
FR 10	7.11	7.2	4.0	13,350	0.02	77	395	611	6,614	565	1,498	0.01	0.21	15.4	36.0
FR 11	7.14	11.0	6.3	19,174	0.06	105	650	954	8,704	553	2,016	0.03	0.21	16.0	49.2
FR 12	7.36	9.8	5.5	16,576	0.07	85	528	844	7,646	558	1,775	0.06	0.65	15.2	43.1
FR 13	7.93	0.9	0.4	835	0.05	25	101	68	152	16	135	0.14	0.32	0.9	1.8
FR 14	7.18	7.6	4.2	12,979	0.05	76	566	753	5,850	758	1,294	0.03	0.41	12.0	34.7
FR 15	7.47	4.7	2.5	7,910	0.04	48	164	317	3,855	240	1,062	0.02	0.17	12.8	20.3
FRS 1	7.39	6.8	3.7	13,248	0.04	62	176	590	6,399	252	1,625	0.00	0.33	16.4	33.7
FRS 3	7.56	5.6	3.3	11,430	0.30	71	218	548	5,283	337	1,383	0.03	2.61	13.7	28.8
FRN 2	7.32	7.4	4.1	15,885	0.02	87	481	835	7,493	676	1,665	0.03	1.03	15.1	42.1
FRN 4	7.36	15.8	9.2	28,762	0.05	141	244	1,600	13,747	354	2,621	0.00	0.49	22.2	74.6
FRN 7	7.58	6.4	3.5	11,584	0.03	72	556	524	5,098	507	1,298	0.04	0.11	11.8	29.5
FRN 13	7.73	2.3	1.2	4,915	0.11	49	225	242	2,200	323	527	0.02	0.20	7.7	12.8
OR 1	7.72	0.6	0.3	426	0.05	29	76	44	25	3	98	0.09	0.00	0.2	0.9
OR 2	7.52	0.7	0.3	684	0.05	24	153	72	31	10	95	0.19	0.27	0.2	1.6

1) SAR =Sodium Absorption Ratio
2) Effective Cation Exchange Capacity (sum of cations)