Background information for Data Analysis for Mass Audubon's Salt Marsh Science Project*

Where is the salinity the greatest, in the shallow, medium, or deep well?

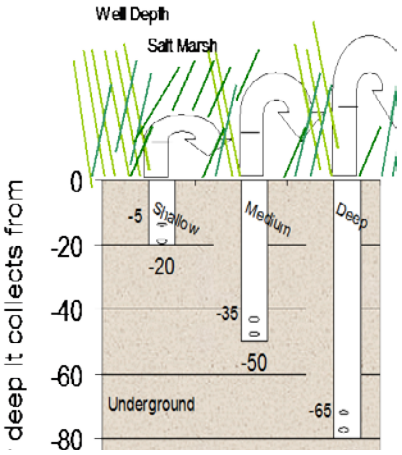


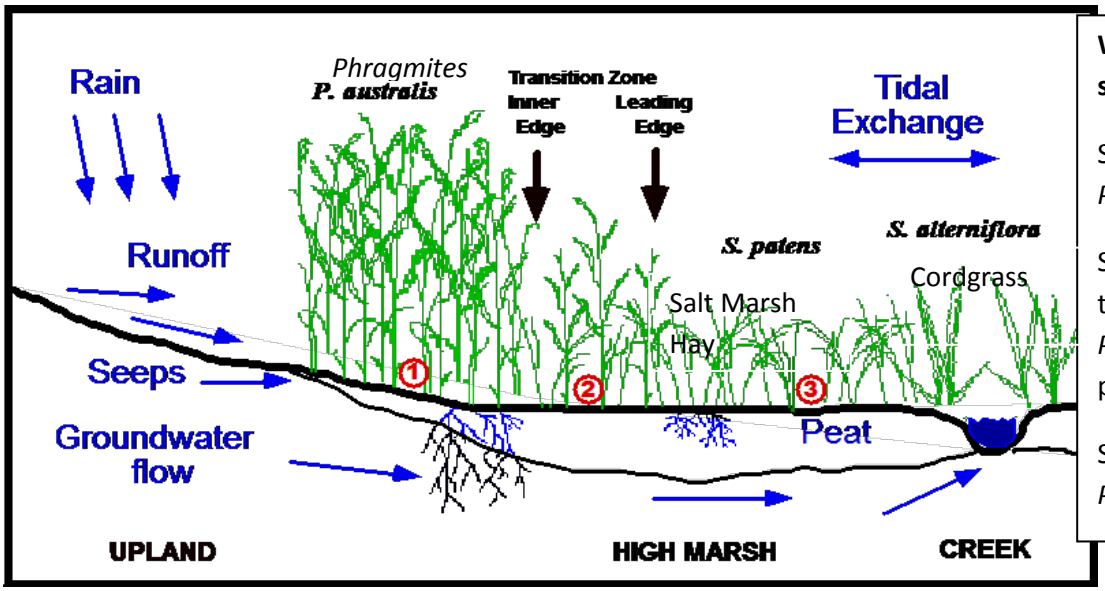
Figure 1 Shallow, Medium, and deep well. Depth is in CM

The answer to this question is not simple. This is why we are taking measurements! These salinity measurements are often different than our predictions.

Physical Properties of water:
Salt water is denser than fresh water, so, we might expect the deepest well to therefore have the greatest salinity.

The impact of the water cycle:
The water cycle also has an impact on salinity The shallow well seems to change the most seasonally. In the spring, following a lot of rain and snowmelt, the shallow well often has the lowest salinity. However in the fall, following a lot of evaporation during the summer, the shallow well often has the highest salinity. Evaporation increases salinity, as water evaporates, leaving more concentrated salt. Precipitation decreases salinity, as increased water dilutes the salt.

The impact of groundwater:
The soil type and proximity to the upland also impact salinity levels. If we get the lowest salinity measurements in the deep well, then it is likely that groundwater is coming into play. A freshwater lens may be impacting the deep well.



Where do we expect salinity to be highest?

Station 1: In *Phragmites*

Station 2: In the transition between *Phragmites* and other plants

Station 3: Where no *Phragmites* is growing

Figure 2 Graphic by David M. Burdick Jackson Estuarine Laboratory Department of Natural Resources University of New Hampshire

*Collect and analyze your own data, or go to http://www.massaudubon.org/get-outdoors/wildlife-sanctuaries/endicott/salt-marsh-project/results-data for data collected by other students.

Where do we expect salinity to be highest? Station 1, 2, or 3?

Salt marshes are flooded twice daily by tidal water from the ocean. This salty water advances up the creeks. Thus we expect that salinity is highest closest to the creek, at station 3. Also, *Phragmites* has a harder time growing in higher salinities. It typically grows taller, closer to the upland edge, and shorter *Phragmites* in the transition zone may be an indication that the *Phragmites* is being stressed by salinity. Based on these ideas, one might typically expect that the station 1 would have the lowest salinity, and station 2 is in between.

Is salinity high, medium, or low on this transect?

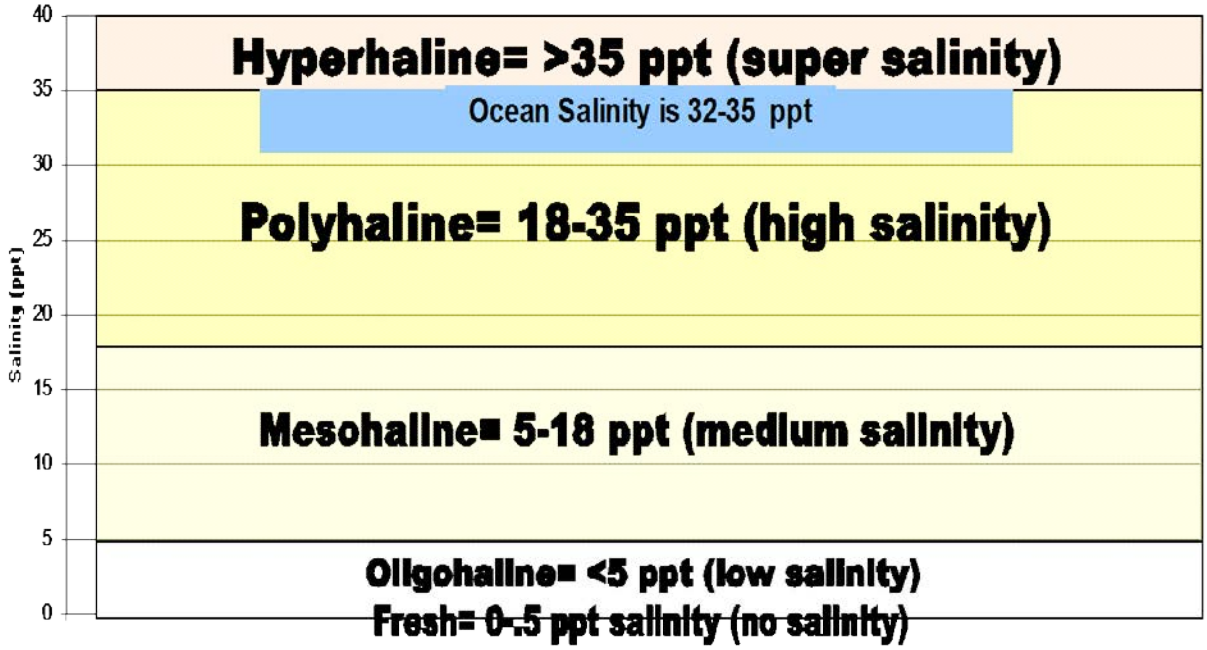


Figure 3 Salinity Scale

Ocean salinity in New England, is 32-35 ppt. Fresh water is zero. *Phragmites* typically thrives in salinities between 0 and 18 ppt. If salinity is 20 ppt or above, *Phragmites* may be present, but may be stunted, or not grow well enough to produce seeds, or tassels at the top. Students record *Phragmites* with no tassels as "immature" and *Phragmites* with tassels as "mature".

Based on the salinity levels, do you think *Phragmites* will spread slowly, rapidly, stay the same or retreat, or stay the same along this transect?

We think that *Phragmites* is stressed at levels of 20 parts per thousand (ppt) or higher. We might expect the lower the salinity levels, the faster the spread rate.

Example of a High Salinity Site: Danvers, MA, Mass General North Shore, (Osram Sylvania)
Examples of Low Salinity Sites:

- Newburyport, MA, Joppa Flats
- Salisbury, MA Railroad bed/Bike path off Mudnock Road

Is the *Phragmites* stressed or thriving at this site?

If *Phragmites* is stressed, we might expect it to grow shorter, and not produce seeds. We might expect taller *Phragmites*, producing seeds are healthier *Phragmites*. Compare the *Phragmites* heights to the scale below. "Monster" and "Grande" heights are typically thriving. Short and puny *Phragmites* are typically stressed by salinity, or other environmental stressors such as flooding.

Figure 4

Monocultures:

Phragmites is an invasive species. It can grow really densely, and block out the sunlight so other plants have a hard time growing. Often *Phragmites* patches become a monoculture, where it is the only plant species growing. This is a threat to biodiversity. People are working to reduce *Phragmites* so more native plants can grow. One way to improve the health of a salt marsh is to notice where tidal restrictions such as roads and railroads are blocking the flow of the incoming tide. Increasing the size of culverts can help increase tidal flow, improving the health of the salt marsh. We have begun graphing percent monoculture along the transects. This shows what percent of a transect line is only *Phragmites*. Land managers are hoping for more biodiversity and less monocultures. Is the percent monoculture of *Phragmites* increasing or decreasing at your site? How does this correlate to salinity levels?

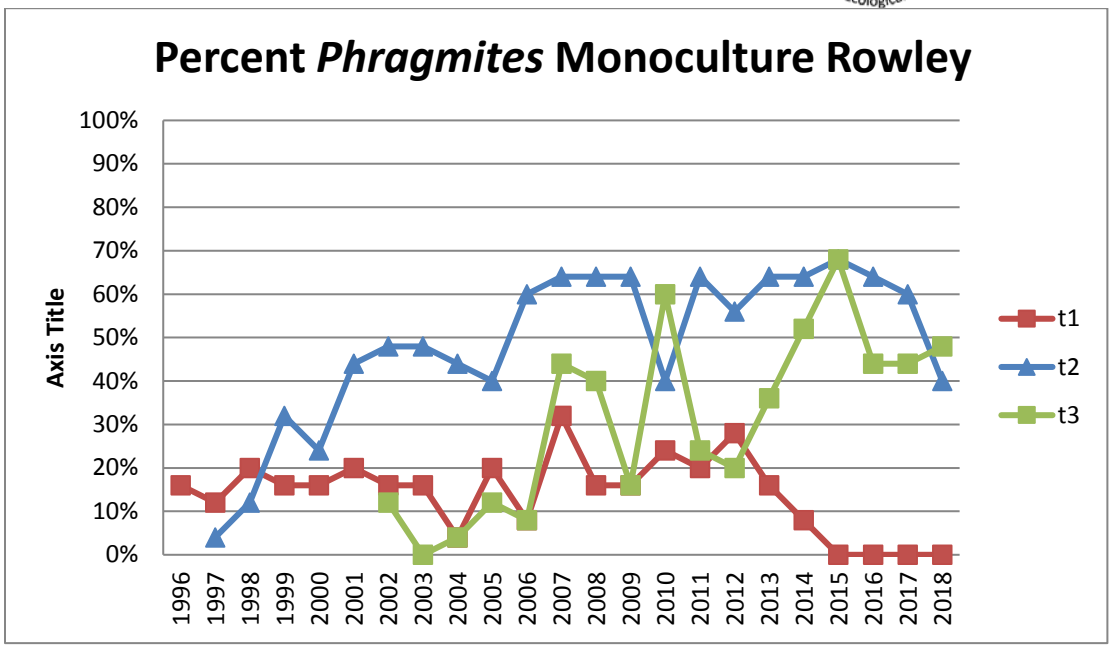


Figure 5 Percent monoculture is increasing dramatically at transect 2 at this reference site in Rowley.

Restoration:

When a culvert is too small it blocks the flow of the incoming tide. Widening a culvert, or adding additional culverts can allow for increased tidal flow. We expect this to increase salinity levels and reduce *Phragmites*. Sites that we are monitoring that have had tidal flow restoration occur include:

- Boston, MA: Thompson Island
- Essex, MA: Conomo Point Road
- Gloucester, MA Eastern Point
- Gloucester, MA, Mill Pond
- Ipswich MA, Argilla Road
- Ipswich MA, Cedar Point
- Ipswich MA, Littleneck Road
- Ipswich MA, Town Farm Road
- Rockport, MA, Seaview Street

Herbicide:

At some sites land managers have resorted to using herbicide to control *Phragmites*. The purpose is to reduce Phragmites, without harming the native plants. Look at the data from the following sites to see whether herbicide has reduced Phragmites, and whether native plants are increasing.

Sites where herbicide has been used include:

- Gloucester, MA Eastern Point
- Newburyport, MA, Joppa Flats
- Rowley, MA, Parker River National Wildlife Refuge: North Pool

New Questions:

Salt Marshes and Sea Level Rise

We are concerned about warming climates, and rising sea level. We are wondering whether local salt marshes will keep up with sea level rise.

Salt marshes are categorized "low marsh" and "high marsh" depending on how often they get flooded. Low marshes are flooded with every high tide. One plant is adapted to this daily flooding, that is salt marsh cordgrass (Spartina alterinflora). The high marsh is flooded during the highest of high tides which occur when the sun and the moons gravitational pull is working together, creating "spring" tides. Salt marsh hay and other shorter grasses and plants grow in the high marsh. *Phragmites* typically grows on the upper edge of the salt marsh, near the upland. As sea level rises, salt marshes will exand inland. Phragmites may spread into the woods, and trees and shrubs will die as they are flooded by salt water. Cordgrass grows taller when in the low marsh, and shorter when in the high marsh.

Predictions: We predict that as the salt marsh gets flooded more, with increased sea level, the low marsh will expand into the high marsh. We predict that the area where cordgrass is growing will increase, and cordgrass heights will increase with increased sea level. 2013 is the first year we measured the heights of cordgrass. We will need to compare this to future date. We predict there will be an increased number of dead trees and shrubs.

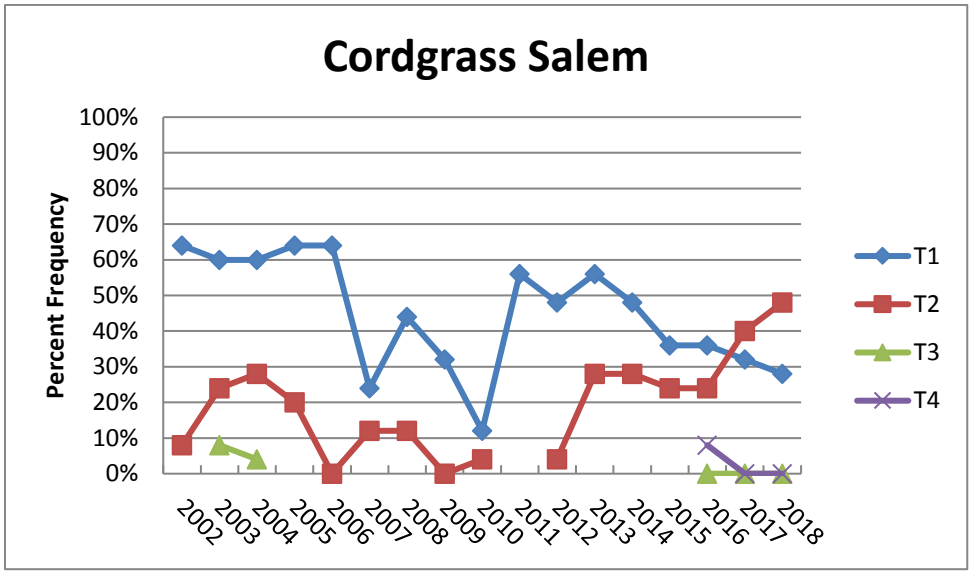


Figure 6 Percent frequency of cordgrass has fluctuated a great deal at Transect 1 in Salem.

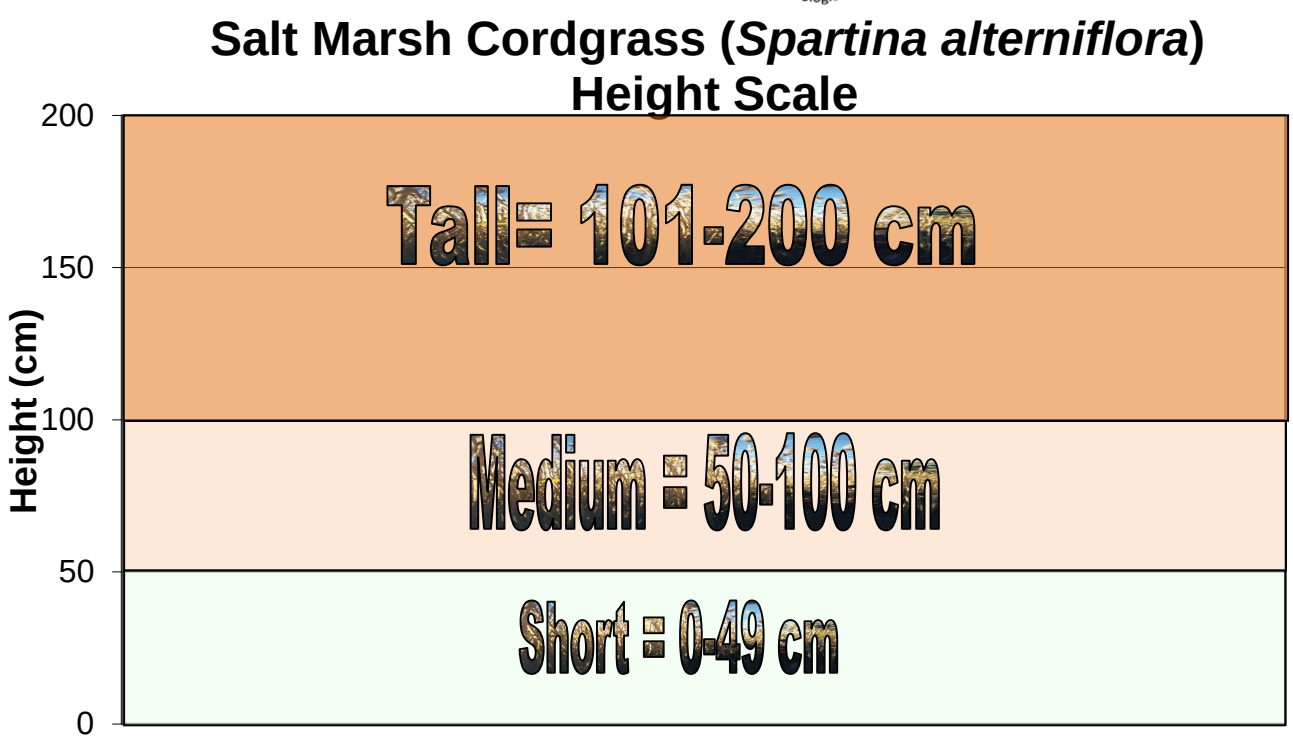


Figure 7 Height Scale for Salt Marsh Cordgrass

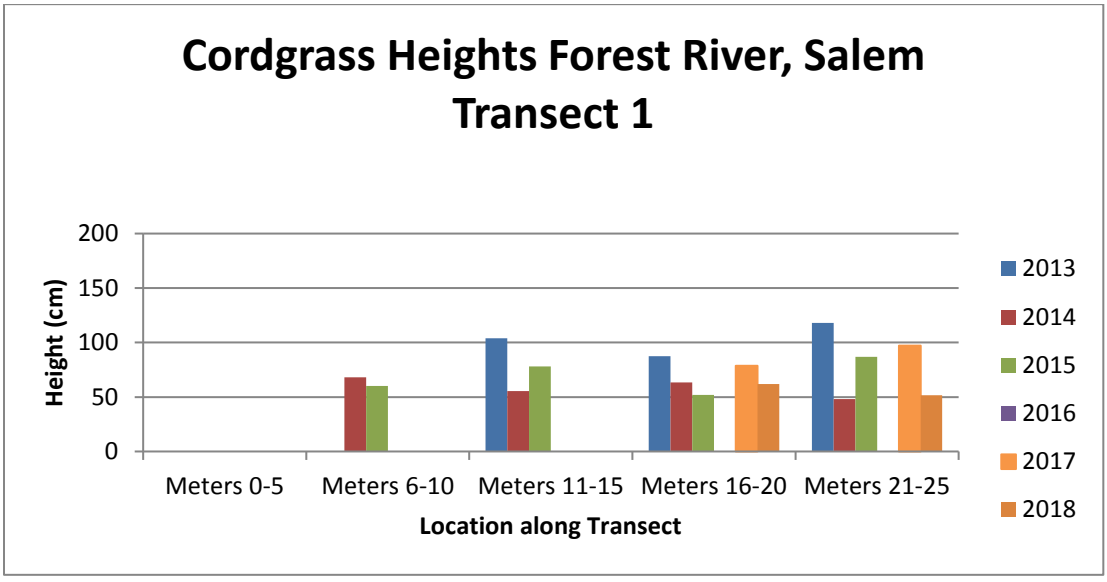


Figure 8 Cordgrass Heights From T1, Salem 2013-2018

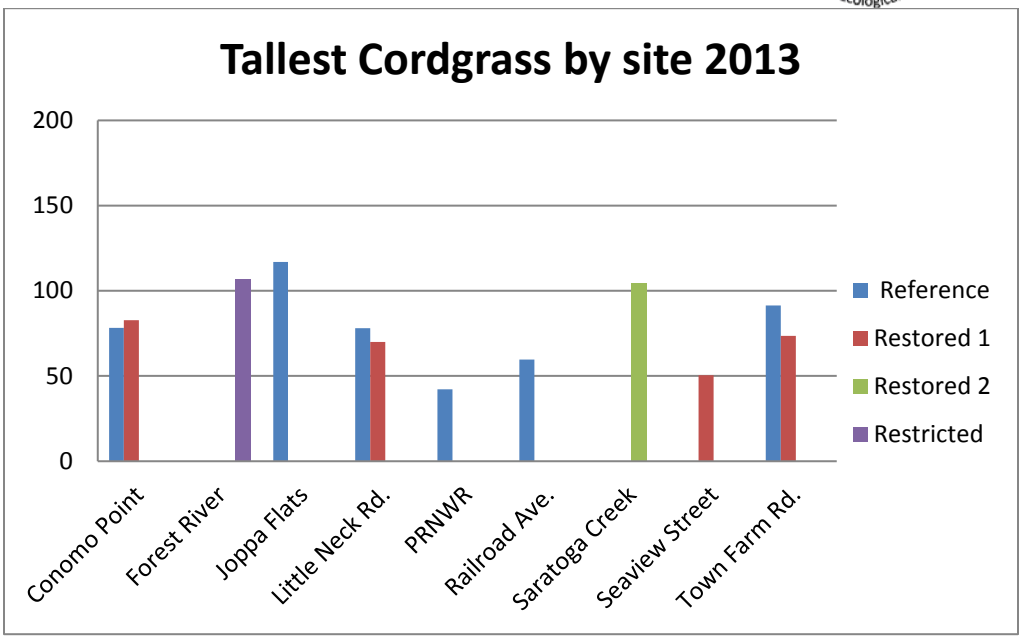


Figure 9 Of the sites that have cordgrass, Forest River, Salem is one of the tallest.

Glossary:

Biodiversity: The variety of life in the world or in a particular habitat or ecosystem.
Culvert: A pipe or opening that allows water to flow under a road.
Invasive Species: A plant or animal that moves in and takes over an ecosystem to the detriment of other species.
Monoculture: Dense stands of one plant species
Salinity: The degree of saltiness, usually referring to water.
Does the data fit these predictions?

Transect Data Analysis
by Lori La France

Site_____

Was this site restored? If yes, what year? _____ Herbicide used? _____

Circle whether the *Phragmites* has spread or retreated from previous years.

Transect #

T __ Spread Retreated Stayed the Same Comments:

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Does this site have a reference transect? If yes, this should remain the same because it was unaffected by the culvert. Has it remained the same?

Look at the Phragmites % monoculture graph. Is the % monoculture increasing or decreasing?

Increasing Decreasing

Look at *Phragmites* height graphs. Based on these graphs, would you say *Phragmites* are stressed or thriving here? Stressed Thriving

Because:

Look at the salinity data from the same site.

Overall, Is salinity High Medium or Low

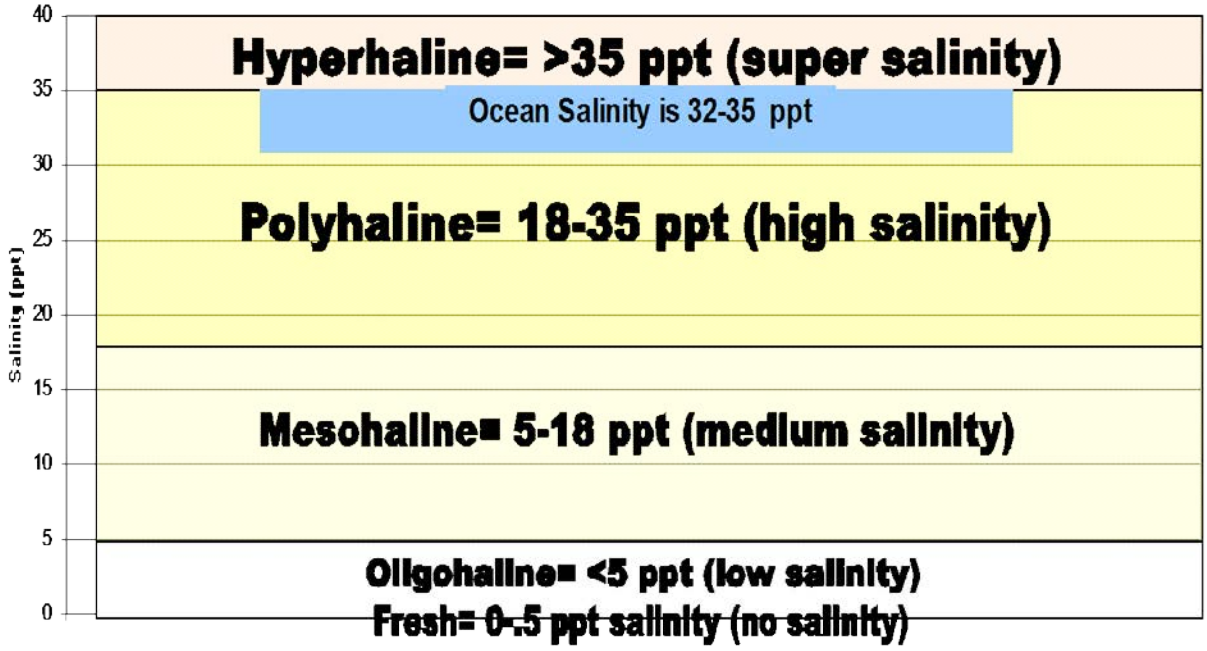
There are lots of ways to analyze this… What patterns do you see?

Please give some possible explanations for the salinities we found.

Is there any relationship between salinity and spread or retreat of Phragmites at this site? Compare all the transects.

Has there been any significant change in the distribution of native plants (all plants except *Phragmites*, purple loosestrife, and perennial pepperweed)?

Describe your predictions for next year for cordgrass, salt marsh hay and Phragmites. Explain your prediction.



Phragmites Height Scale