Plant Community Elevations – Nisqually Delta
Salt Marsh

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Plant Community Elevations Within an Area Adjacent to the Nisqually Tribe’s Estuary Restoration Project

Abstract

The purpose of this study is to provide baseline information about plant species and their elevation preferences on a site adjacent to current restoration efforts. This information is suited for future evaluations of estuarine recuperation along the inner Nisqually Delta. The study began with a bias favoring strict elevation ranges for the salt marsh plants present on-site. Conclusions made from this study are strictly botanical and tidally influenced elevation information. This study did not take into account soil composition, weather, or any other environmental factor. Thirteen plant species were recorded for frequency, percent ground cover, and elevation. Three distinct plant communities were found with elevation and salt water influence determining broad boundaries. Increase in tidal flow is expected to shift the plant communities higher in elevation and kill some of the slough plants.

Site Background

The study site is generally located north of Interstate 5, east of the Nisqually River, south of Nisqually Reach (more specifically, the recent mitigation site for the Nisqually Tribe), and west of Red Salmon Slough (refer to aerial photos).

The history of the study site on the Nisqually estuary is shaped by geology, politics, and business. Each of these has helped to form the site, both metaphorically and literally. Geological activity formed the land with glaciers, rivers, and soil. Politics played an important role in land ownership and preservation. Also, business shaped the land with agriculture and other industries, such as DuPont and Weyerhaeuser. The history of the study site, as well as the entire Nisqually Delta, is intimately tied to these three attributes.

About sixteen thousand years ago, the area that is now the Nisqually Delta was completely covered in ice. A glacier with a depth of about 3000 feet crept across the land and as it receded it created many of the local waterways that exist today, including Puget Sound, the Nisqually River, and McAllister Creek (www.ecy.wa.gov).

The first evidence of human life around the Nisqually Delta points back in time about five thousand years (www.ecy.wa.gov). Native people freely roamed the Nisqually area until the 1800’s.

Laws were passed in the 1800’s that changed land use for the Nisqually Delta. In 1854 Medicine Creek Treaty was adopted. This treaty gave the Governor of Washington Territory, Isaac Stevens, control of the land adjacent to the Nisqually River and created
the soon to be Nisqually Indian Reservation (www.wshs.org). The Homestead Act of 1862, signed by Abraham Lincoln, allowed citizens to claim as much as 160-320 acres of public land (www.nps.gov). A young man named Joel Myers used this law to claim a homestead on the present day Braget farm and tribal land. Braget Sr. later purchased the property from Joel Myers.

The Braget farm is the most distinguishing, modern characteristic of the site. I had the opportunity to speak with Ken Braget, the son of Braget Sr. The following is from that monologue:

In 1905, Braget Sr. employed Chinese railway workers to help construct a dike to create freshwater grazing lands on his property. The land was used as grazing land for the Braget dairy farm until 2000 when the Nisqually Tribe purchased the property that the study site resides on. A portion of that purchase was then sold to the Nisqually National Wildlife Refuge, which is run by the U.S. Fish and Wildlife Service.

An estuarine restoration project, funded by the Nisqually Tribe, is presently underway just North of the study site. A dike in that area was removed in August 2002. The tribe will perform elevation and fish monitoring on the restoration site annually. Bird monitoring by the Nisqually Reach Nature Center is expected to begin soon and continue for many seasons. These studies, in conjunction, offer baseline data that can be used to assess the importance and effectiveness of dike breaching as a form of estuarine restoration.

Methods

Determining Variables

The methods I used to conduct my study were determined by unavoidable variables including available volunteer help, the natural characteristic of the site, and visual elevation discernment. I was forced to form my methods around these unavoidable variables.

Unfortunately, the much needed volunteer help for this project was dependent upon other peoples’ schedules. Without the help of the four volunteers, this project would be impossible, or close to impossible. I worked around my volunteer’s schedules, and when I had no available help I worked on what I could do alone. This variable altered the order of how I would have gone about the study if I had permanent help or did not need help.

The natural characteristics of the land were the determining factor in my site selection. Upon actually setting foot on the site, I realized that there were, unknown to me until then, large inter-tidal channels meandering throughout the study site. The center area of the site is surrounded on all sides by 3-5 feet deep channels that are filled and
emptied with the tides. The area had minimal cow feces and hoof prints, which plagued most of the land outside of the natural “cow buffers”. I chose the middle portion of the site mainly because of limited accessibility (I needed a plank to get onto the site), but also because it seemed to boast the greatest plant diversity.

Another factor that determined my methods was the visual elevation changes noticeable with the eye. The nature of my project requires me to have a wide range of elevation data. In a relatively flat area this is not easy. I originally planned to shoot straight transects into the site and obtain data from a half dozen transects. I had to deviate from this preconception in order to acquire pertinent data. I used my eye to sight areas of varying elevation and differing plant communities. With this method I was able to collect data displaying multiple environments at different elevations.

**Procession**

There are four different stages to my methods for this project. I first collected perimeter points with a GPS (Global Positioning System). I then used the autolevel to obtain an onsite elevation benchmark from a very distant, offsite elevation benchmark. The third stage involved the autolevel to mark elevation points throughout the site. The last stage was my data collection where I used the quadrat to determine percent coverage of plant species at the different elevation markers.

I used a Trimble Geo Explorer 3 model GPS to obtain my perimeter points. I began at the southeast corner of the site and walked along the inter-tidal channels collecting GPS points at 25 feet intervals (measured with measuring tape). I did this along the entire perimeter of my site, which is blocked on all sides, except the North side, by large channels. I arbitrarily cut off the north side of my site at a certain point where the plant communities stabilized into monoculture and there was little to no elevation change. A flag marker was placed at each data point for reference. I obtained 92 data points with this method (see orthophotos in the appendix). This not only gave me a good visual reference for the site, but also allowed me to collect data all around the site while minimizing impact to the vegetation.

Obtaining the onsite elevation benchmark was tricky. The elevation benchmark that is closest to my study site is on Nisqually tribal land. I estimate that it is about ¾ mile away from my site. This required multiple short-range shots with the autolevel to get accurate onsite results. After about 25 elevation shootings, I ended at one of my onsite markers with -.15 feet difference in elevation relative to the tribe’s benchmark. I used this reference to shoot all of my on-site markers.

A Topcon autolevel was used to find elevations for all the perimeter flag markers as well as other onsite points. I used the perimeter marker elevations as starting points for transects. As mentioned before the transects were crooked, zigzag, or random. Obtaining elevation markers this way produced a wider variety of samples.
The autolevel was used in the following way for each elevation measurement. I first set the autolevel atop a tripod directly above an elevation marker. I measured the distance from the marker to the center of the eyepiece with the stadia rod. An assistant then walked a specified distance with the stadia rod and held it as straight as possible. I sighted the number on the stadia rod and subtracted the stadia rod number from the height of the center of the eyepiece. This number gave me the elevation of the new point when added with the elevation of the marker beneath the autolevel.

In the last stage of my fieldwork, I used a 1.5 by 1.5 feet quadrat to obtain percent ground cover for the plants at each elevation marker. A volunteer and I randomly tossed quadrats around each elevation marker and recorded the data. Percent ground cover was visually estimated. The only exception to this is when the marker was on a slope and required more detailed analysis. In this rare case (only twice), I divided the quadrat into equal parts of three along the gradient and averaged their sums. There were a total of 127 data points covering the most diverse areas of the site with respect to plant communities and elevation.

Data

Vascular Species List, Mean Site Coverage\(^1\), and Frequency of Occurrence

Salt Grass (*Distichlis spicata*) .................................................60.8%......127  
Lyngby’s Sedge (*Carex lyngbyei*) ..............................................10.4%.......35  
Tufted Hairgrass (*Deschampsia cespitosa*) ................................0.08%.......2  
Grass X (Unknown, possible hybrid).............................................0.48%......7  
Meadow Barley (*Hordeum brachyantherum*) ..............................0.14%......4  
Sea Milk-Wort (*Glaux maritima*) .............................................0.33%.......10  
Jaumea (*Jaumea carnosa*) ......................................................11.6%.......42  
Alkali Heath (*Frankenia salina*) ..................................................0.24%......3  
Gum Weed (*Grindelia integrifolia var. macrophylla*) ....................1.10%......8  
Orache (*Atriplex patula*) .........................................................2.38%.......41  
Silverweed (*Potentilla anserina ssp. pacifica*) ............................1.42%.......24  
Glasswort or Pickleweed (*Salicornia virginica*) ............................3.29%.......17  
Bull Rush (*Scirpus americanus*)\(^2\) .............................................8.07%.......39  
and *Juncus effusus, Juncus sp.*

(see appendix for a graph of elevation ranges for the preceding plant species)

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\(^1\) The total of the mean coverage column is over 100% because each number was averaged to three significant digits.

\(^2\) All rushes found were compiled into this category.
Salt Grass (*Distichlis spicata*)

*Distichlis spicata* was by far the most common vascular species on the site. *D. spicata* was found at every quadrat measurement area with a minimum of 3% ground cover. The maximum ground cover for *D. spicata* was 100%. *D. spicata* was found in the elevation range of 13.52 to 16.47 ft. The percent ground cover of *D. spicata* at the 13.52 ft. elevation was 15%. The percent ground cover of *D. spicata* at the 16.47 ft. elevation was 100%.\(^3\) *D. Spicata* was found in association with every grass and plant on the list above.

Lyngby’s Sedge (*Carex lyngbyei*)

*Carex lyngbyei* was the only species growing near the bottoms of the muddy, inter-tidal sloughs. The minimum ground cover for *C. lyngbyei* was 2%. The maximum ground cover for *C. lyngbyei* was 95%. *C. lyngbyei* was found in the elevation range of 13.52 to 15.82 ft. The percent ground cover of *C. lyngbyei* at the 13.52 ft. elevation was 50%. The percent ground cover of *C. lyngbyei* at the 15.82 ft. elevation was about 5%. *C. lyngbyei* was found in association with *D.*

\(^3\) Although this would suggest a preference for higher elevations, which is true in most cases, the data gathered does not confirm this preference and it does not appear that *D. Spicata* is intolerant of any elevation surveyed in this report.

Tufted Hairgrass (*Deschampsia cespitosa*)

*Deschampsia cespitosa* was a sparse grass surveyed in only two locations. The minimum ground cover for *D. cespitosa* was 3%. The maximum ground cover for *D. cespitosa* was 5%. *D. cespitosa* was found in the elevation range of 15.27 to 15.47 ft. The percent ground cover of *D. cespitosa* at the 15.27 ft. elevation was 3%. The percent ground cover of *D. cespitosa* at the 15.47 ft. elevation was 7%. *D. cespitosa* was found in association with *D. spicata*, *C. lyngbyei*, Grass X, *H. brachyantherum*, A. patula, and P. anserina.

Grass X
Grass X avoided identification. I suppose it is a hybrid of the Barley tribe, but I’m not sure. The minimum ground cover for Grass X was 1%. The maximum ground cover for Grass X was 40%. Grass X was found in the elevation range of 15.37 to 15.92 ft. The percent ground cover at the 15.37 ft. elevation was 10%. The percent ground cover at the 15.92 ft. elevation was 40%. Grass X was found in association with D. spicata, C. lyngbyei, D. cespitosa, H. brachyantherum, G. maritima, J. carnosa, A. patula, P. anserina, S. virginica, and S. americanus.

**Meadow Barley (Hordeum brachyantherum)**

*Hordeum brachyantherum* is a common barley grass that was recorded four times. The minimum ground cover for *H. brachyantherum* was 1%. The maximum ground cover for *H. brachyantherum* was 10%. *H. brachyantherum* was found in the elevation range of 15.47 to 15.72 ft. The percent ground cover at the 15.47 ft. elevation was 5%. The percent ground cover at the 15.72 ft. elevation was 1%. *H. brachyantherum* was found in association with D. spicata, D. cespitosa, Grass X, G. maritima, and P. anserina.

**Sea Milk Wort (Glaux maritima)**
Glaux maritima is a fleshy, spreading herb found away from the sloughs and their edges. The minimum ground cover for *G. maritima* was 1%. The maximum ground cover for *G. maritima* was 10%. *G. maritima* was found in the elevation range of 15.52 to 15.97 ft. The percent ground cover at the 15.52 ft. elevation was 5%. The percent ground cover at the 15.97 ft. elevation was 5%. *G. maritima* was found in association with *D. spicata, C. lyngbyei, Grass X, H. brachyantherum, J. cariosa, A. patula, and P. anserina.*

Jaumea (*Jaumea cariosa*)

*Jaumea Carnosa* was the second most abundant species found on the site, especially on the southern end of the site. The minimum ground cover for *J. cariosa* was 2%. The maximum ground cover for *J. cariosa* was 75%. *J. cariosa* was found in the elevation range of 13.52 to 16.37 ft. The percent ground cover at the 13.52 ft. elevation was 40%. The percent ground cover at the 16.37 ft. elevation was 40%. *J. cariosa* was found in association with *D. spicata, C. lyngbyei, Grass X, G. maritima, F. salina, G. integrifolia, A. patula, P. anserina, S. virginica, and S. americanus.*

Alkali Heath (*Frankenia Salina*)
*Frankenia Salina* was found strictly in and around the single saltpan that occupied the site. The minimum ground cover for *F. salina* was 5%. The maximum ground cover for *F. salina* was 20%. *F. salina* was found in the elevation range of 15.07 to 16.07 ft. The percent ground cover at the 15.07 ft. elevation was 20%. The percent ground cover at the 16.07 ft. elevation was 5%. *F. salina* was found in association with *D. spicata, J. carnosa, and S. virginica*.

**Gumweed (Grindelia integrifolia)**

![Gumweed](image)

*Grindelia integrifolia* was found strictly along the slough edges on the east side of the site. The minimum ground cover for *G. integrifolia* was 5%. The maximum ground cover for *G. integrifolia* was 45%. *G. integrifolia* was found in the elevation range of 14.62 to 15.77 ft. The percent ground cover at the 14.62 ft. elevation was 5%. The percent ground cover at the 15.77 ft. elevation was 12.5%. *G. integrifolia* was found in association with *D. spicata, J. carnosa, A. patula, S. virginica, and S. americanus*.

**Orache (Atriplex patula)**

![Orache](image)

*Atriplex patula* was an abundant and highly variable species found mainly near the sloughs, but abundant in a surprising variety of environments as well. The
minimum ground cover for *A. patula* was 1%. The maximum ground cover for *A. patula* was 20%. *A. patula* was found in the elevation range of 13.52 to 16.37 ft. The percent ground cover for the 13.52 ft. elevation was 5%. The percent ground cover for the 16.37 ft. elevation was 10%. *A. patula* was found in association with *D. spicata*, *C. lyngbyei*, *D. cespitosa*, *G. maritima*, *J. carnosa*, *G. integrifolia*, *P. anserina*, *S. virginica*, and *S. americanus*.

**Silverweed (*Potentilla anserina*)**

*Potentilla anserina* was sparse, yet found widespread throughout the site. The minimum ground cover for *P. anserina* was 1%. The maximum ground cover for *P. anserina* was 40%. *P. anserina* was found in the elevation range of 14.92 to 16.07 ft. The percent ground cover at the 14.92 ft. elevation was 5%. The percent ground cover at the 16.07 ft. elevation was 2%. *P. anserina* was found in association with *D. spicata*, *C. lyngbyei*, *D. cespitosa*, Grass X, *H. brachyantherum*, *G. maritima*, *J. carnosa*, *A. patula*, *P. anserina*, *S. virginica*, and *S. americanus*.

**Glasswort or Pickleweed (*Salicornia virginica*)**

*Salicornia virginica* showed preference for salinity and took precedence on the southern side of the site. The minimum ground cover for *S. virginica* was 3%. The maximum ground cover for *S. virginica* was 60%. *S. virginica* was found in the elevation range of 15.07 to 15.92 ft. The percent ground cover at the 15.07 ft. elevation was 40%. The percent ground cover for the 15.92 ft. elevation was 50%. *S. virginica* was found in association with *D. spicata*, *C. lyngbyei*, Grass X, *J.*
Bull Rush and other rushes (*Scirpus americanus*)

*Scirpus americanus* and the *Juncus* species prominently occupied the entire center portion of the site. All data pertaining to *S. americanus* includes *Juncus* species as well. The minimum ground cover for *S. americanus* was 1%. The maximum ground cover for *S. americanus* was 90%. *S. americanus* was found in an elevation range of 15.22 to 16.02 ft. The percent ground cover for the 15.22 ft. elevation was 1%. The percent ground cover for the 16.02 ft. elevation was 30%. *S. americanus* and *Juncus* species were found in association with *D. spicata*, *C. lyngbyei*, Grass X, *H. brachyantherum*, *G. maritima*, *J. carnosa*, *G. integrifolia*, *A. patula*, *P. anserina*, and *S. virginica*.

### Data Reliability and Margin of Error

Several factors influenced my data reliability including: autolevel calculations, plant identification, and site impact (cows).

I used the autolevel to obtain an on-site elevation benchmark originating from the Nisqually tribe’s benchmark. The distance from the tribe’s benchmark to my on-site benchmark required me to take readings of varying distances. I estimate that my farthest sighting was about 200 feet. This distance poses some threat to elevation reliability.

The method of measuring the height of the autolevel was another factor influencing data reliability. The stadia rod, which was used to measure the height of the autolevel prior to each sighting, is broken into increments of 0.02 feet. In most cases I averaged the reading to the nearest 0.05 feet. This gives me a margin of error of about 0.025 feet for each elevation sighting.

On one particular day, I decided to double-check some of my elevation readings. I found error in the first three readings, with a maximum difference of 0.2 feet. I attribute the error to the heat that day compared to all the other days of autolevel use. The manual for the autolevel suggests using an awning on hot days. I was without an...
awning, but fortunately I discovered the inaccuracies early and was able to take short readings to insure data reliability. Of course, there is still some degree of error that could not be calculated or completely compensated.

Plant identification coupled with grass identification posed some threat to data reliability. *C. lyngbyei* and *G. maritima* are the two species identified that have uncertainty.

The interiors of the sloughs contained thick mats of muddy grasses, which I believe to be *Carex Lyngbyei*. Flowering heads were almost impossible to find and the ones I did find in the lower portions of the sloughs resembled *D. spicata* and *C. lyngbyei*. I rule out *D. spicata* because of its growth patterns and characteristics elsewhere on the site. I am left to believe that *C. lyngbyei* is the primary inhabitant of the sloughs, based on deduction and supporting evidence from several reference materials.

*G. maritima* is another flowerless, on-site find. I assume this is the correct species based on habitual information, although I have no flowers to confirm this assumption.

The one species surveyed that avoided identification was Grass X. The inflorescence is a single spike with one spikelet. This seems to resemble the barley tribe, but differs greatly from the barley tribe member, *H. brachyantherum*, found on-site. It is possibly a hybrid species. I will update this report upon proper identification.

Another challenge to data reliability was the variety of volunteer help. I required the help of four different volunteers. I had to train these volunteers for each of the tasks they performed. This poses the biggest problem with plant identification because different perspectives yield different results. I estimate that the percent ground cover data is reasonably consistent despite the dual viewpoints.

The cows proved to be a formidable source of data corruption. The site is fairly well trodden in some sections and clearly eaten in others. I found several piles of cow feces and I even saw some floating in the western slough. Apparently, most of my flag markers were ripped up, shredded, or vanquished by the cows near the end of this study. This accounts for the lack of interior site GPS data points. The cows are also the probable cause of on-site habitat destruction evidenced by the relatively low on-site presence of *G. integrifolia* compared with the “virgin” banks across the Red Salmon Slough.

**Discussion**

The on-site plant communities can be described by elevation. At the lowest and most tidally influenced elevations, which are in the sloughs, *Carex lyngbyei* is the predominant species. *Atriplex patula* and *Jaumea carnosa* are sometimes found in
thickets of Carex lyngbyei. The species that reside in the sloughs are immersed in salt water half of each day and consequently covered with silt. Silt, immersion, and salinity all contribute to the species specialization within the sloughs.

As the land slopes out of the sloughs and onto the slough banks, Distichlis spicata gains dominance. Other dominant species include Atriplex patula and Potentilla anserina. Secondary species include Deschampsia cespitosa, Salicornia virginica, and Jaumea carnosa. Carex lyngbyei is either scarcely present or not present in these areas. On some of the slough edges Grindelia integrifolia can be found growing prolifically, especially on the eastern banks of Red Salmon Slough.

The higher elevations beyond the slough edges are almost entirely dominated by Scirpus americanus and rushes. Other species found at the higher elevation salt marsh include Potentilla anserina, Jaumea carnosa, Distichlis spicata, and Frankenia salina. These species are generally uncommon among the thick, suffocating growths of Scirpus americanus and rushes.

Another area of interest on the site is a large saltpan, which is a temporal salt-water pool that has evaporated and left a residue of salt. This area was dominated by Salicornia virginica, but Frankenia maritima was also prolific. These were the only two species found growing in the saltpan.

The dike removal created a larger tidal flow in the sloughs on the study site, which will subject the study site to geomorphology. The increase in tidal flow is capable of carving out the existing sloughs. Tidal flow increase will also create more inter-tidal channels on-site as sediment is eroded from presently dormant sloughs. Erosion, soil expansion, and increase in sedimentation will create deeper, more narrow channels (Frenkel 180). Soil expansion allows the new tidal areas to slowly rise in elevation as the compacted and dewatered soils become hydrated (McDonald 173).

The study site is likely to change dramatically when the cows abandon the site and when the plants adapt to the geomorphological trends and the new input of slough water, via the Nisqually Tribe restoration project. A shift towards higher elevation is likely among the plant communities on-site. An on-site propagation of G. integrifolia is anticipated following the removal of the hoofed herbivores. It is possible that the northern-most portion of the study site, which is dominated solely by Distichlis spicata, will change into a more slough like environment. D. spicata is likely to become even more dominant as it is pushed south by tidal influences and as it inhabits the freshly brackish land that other, less tolerable species cannot utilize. Before this can occur, new growths of temporal, pioneering plants will invade until the soil and water conditions stabilize to a degree necessary for native colonization.
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Reference Materials


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