The Restoration of ka'qsx^{w}, also known as sweetgrass (Schoenoplectus pungens), in the Nisqually Delta: The case study of a culturally significant plant

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"That is not to say that people cannot use the productive natural resources of the Nisqually River Watershed. There is room for the farmer, rancher, and forester, as well as for the Indian fisherman. However, those who use these natural resources also must accept the responsibility for good stewardship. Decisions made today must insure a healthy and productive natural resource base for the future"
- Billy Frank Jr. *Nisqually Watershed*

Abstract

In 2009, the Brown Farm Dike was removed in the Nisqually Delta resulting in the largest estuary restoration project in the Pacific Northwest through the reconnection of 308 hectares of reclaimed farmland with the natural tidal flow of the Puget Sound. The Nisqually Indian Tribe is an important partner in the restoration effort focusing on the restoration of 52 hectares on the east side of the Nisqually River.

Schoenoplectus pungens is a culturally significant plant used in basketry that is common in wetlands across the United States. Typically, factors such as edibility and material use are not considered in restoration projects. The restoration of *S. pungens* in the Nisqually Delta is highly desired by the Nisqually Indian Tribe to reestablish a local gathering ground for this plant. This study aims to evaluate the restoration potential for this plant within the estuary through the monitoring of planted stands in the area. Vegetative and site analysis of the estuary were done identifying local plant communities and the conditions for further site restoration. Interviews with native and non-native weavers were conducted focusing on experiences with *S. pungens*. Historical maps of the Nisqually Delta were also analyzed to determine environmental change in the Delta in its recent history post-contact.

This research aims to provide a current report of the health of planted *S. pungens* stands in the Nisqually Delta, as well as a look at the cultural significance of the plant and Nisqually Delta to the Nisqually people. Continued monitoring of the planted stands is advised with potential harvest possible in future years.

Keywords

Nisqually Delta, sweetgrass, *Schoenoplectus pungens*, estuary, restoration, culturally significant plants, ethnobiology, traditional ecological knowledge, assisted migration

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I. INTRODUCTION

Purpose of Study

The purpose of this project is to identify, monitor, and interpret planted stands of Sweetgrass (*Schoenoplectus pungens)* in the Nisqually River Delta located in the southern Puget Sound (figure 1). Emphasis is placed on the cultural significance of individual plants and the possibility of restoration plantings in the Nisqually Delta successfully developing so that harvests can be conducted by the Nisqually people in the future. Incorporating Traditional Ecological Knowledge (TEK) and values into the restoration process is also emphasized in this study.

Study Site

For my project I wanted to focus on the restoration of a native, culturally significant plant. I approached Joyce McCloud, Cultural Programs Coordinator, and Hanford McCould, Leschi Heritage Foundation Director, and asked if there was a particular project the Nisqually Indian Tribe was interested in that I could focus on for my thesis work. Their response was to focus on the basketry plant, sweetgrass-*Schoenoplectus pungens*, and the potential for harvesting this plant in the Nisqually River Delta in the future.

For this project, I focused on looking at the health of previously planted sweetgrass stands to evaluate the possibility of harvest in the Nisqually River Delta.

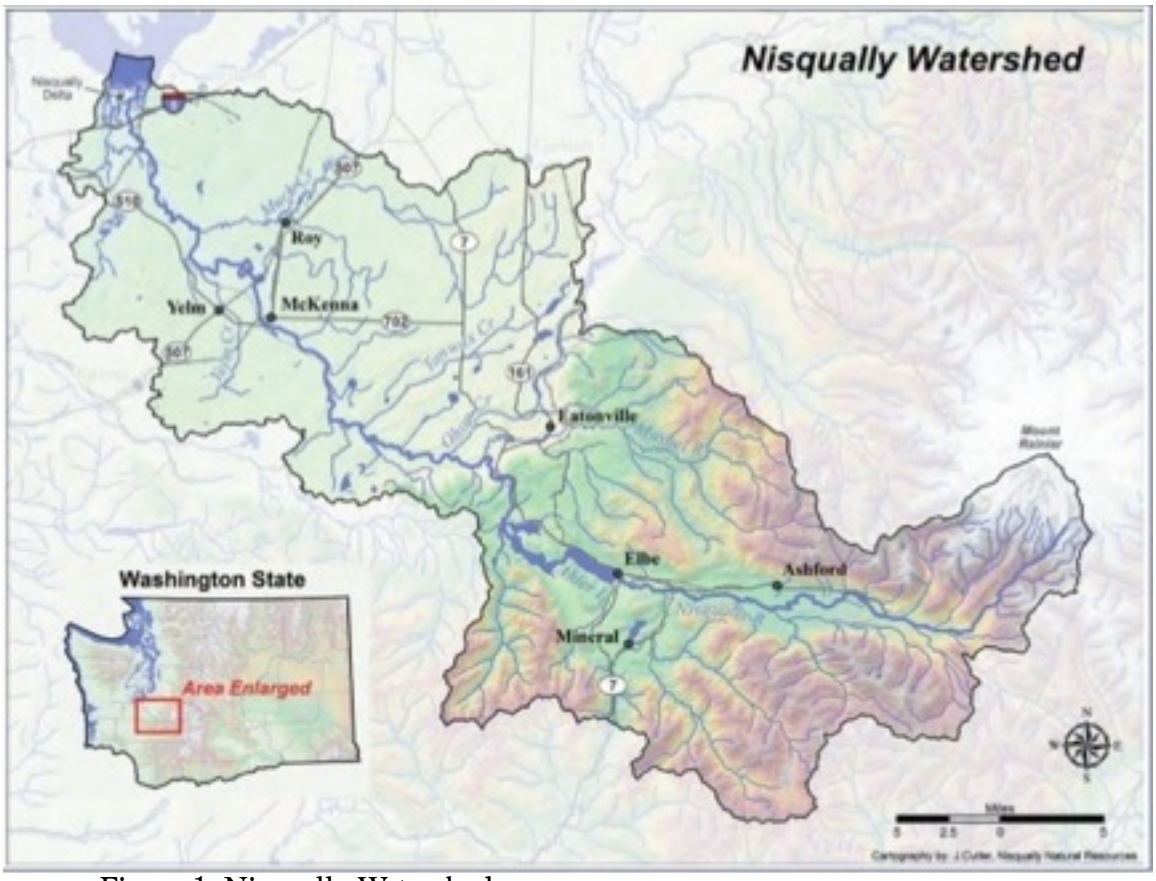


Figure 1. Nisqually Watershed

A. History/Background

1. Key to Nisqually Place Names

Tacobet= Mount Rainier, means "nourishing breasts" after the life-giving waters

Whugle= Puget Sound

Squalli= Nisqually

Squaleabc= Nisqually Estuary, Nisqually people called the drainage system this, referring to the fall migration of the salmon into the Nisqually river which came later than any other place on the Puget Sound (Larson and Kermann 1978; Kennedy et al. 1983). There are other definitions for this term (see B.3 below).

She-nah-nam= Medicine Creek

Figure 2. Indigenous map of the Nisqually Delta (Carpenter 2008)

2. Traditional Ecological Knowledge (TEK)

"We cannot solve our problems with the same thinking we used when we created them."
-Albert Einstein

Specialized and complex knowledge accumulates over time in groups of people who are living in geographic spaces and rely on local resources that are available in that space. This knowledge includes seasonal, climactic, geographic, and species specific knowledge all relating to place in order to survive and thrive and use the available resources in ways that do not diminish them or cause them to deteriorate (Turner v. 1, 2014). This body of Knowledge is commonly referred to as Traditional Knowledge (TK) or Traditional Ecological Knowledge (TEK). Berks (2012) describes TEK as a body of culturally transmitted knowledge and beliefs regarding the relationships of living beings with each other and their environment.

Recently more people are looking at TEK as a valuable, complementary science to Western Science. TEK is a predictive science, many land management teams are now looking at how indigenous people have managed the land successfully for thousands of years as we are forced to face the reality and challenge of climate change, over exploitation of resources, and increased population (Mason et al. 2012). Ethnobotany and Ethnoecology are fields of western scientific study that focus on how people relate to plants and their environment- incorporating TEK systems.

2.1. *Culturally Significant Plants*

This project looks at the possibility of incorporating culturally significant plants into restoration projects for increased involvement with the community and environment. Culturally significant plants are plants that are important to a group of people. These plants have medicinal, edible, material, or spiritual use/importance. I believe that reintroducing humans to the natural cycles that in the past people have been a part of is an important component in reconnecting and restoring ecological cycles and systems

.

3. Assisted Migration

Assisted migration is not a new concept or activity. For thousands of years people have been moving plants and cultivating the land (Nancy Turner 2014). The current definition of the term assisted migration is in terms of keeping endangered/threatened plants alive in response to climate change, perhaps in this specificity we limit the definition of assisted migration to the purposeful movement of species to facilitate or mimic natural range expansion, as a direct management response to climate change (Vitt 2010), but when removing its relation to climate change, western society too has been practicing assisted migration in the form of the horticulture industry for the past hundred years or so as the ability to move around the world

with ease has increased with technology. We are constantly moving and exchanging plants globally to suit our needs.

3.1. *Fiber Sovereignty*

Food sovereignty is the right for a people to determine their own food and agriculture policies. An essential component of food sovereignty is restoring the relationship between people ad the land. I want to apply this same term to fiber materials = fiber sovereignty.

This is what the Nisqually people are doing. They are interested in cultivating a culturally significant basketry plant, Sweetgrass, in their "backyard" in order to harvest the plant for use in basket making. Actively replanting the area with thoughts of the future in mind has been the driving influence behind this project. Though not specifically fitting into today's definition of assisted migration, there are documented cases where people have transplanted *S. pungens* in the past for basketry materials (Turner 2014). This idea of planting plants with how people interact in the landscape and restoring past communities could be incorporated in the definition as we are moving plants back into space where they may have been pre-contact, or perhaps we could relabel what we are doing as *re-introduction.*

4. Ideas of Plant Management

From what I have seen, involvement of community is key in a successful restoration project. Success depends on continued management and evaluation. This can best be completed by someone that knows and cares about the area being restored. The unique position of culturally significant plants as part of a restoration project are important ties to unique communities of people that help to ensure the long-term success of a project. I propose partnering with the people who want to see the success of the system (weavers and community members) as their way of life depends on it. This would reestablish a care-taking relationship for the restoration site with repeat follow up surveying to document the health of the restored plant community.

5. Estuaries

Estuaries are highly productive ecosystems (Kruckeberg 1991). Dethier (1990), defines estuaries as waters that are semi-enclosed by land but have access to the ocean. Typically in estuaries, the seawater is diluted by freshwater runoff from land. These ecosystems are also referred to as coastal marsh (Woodhouse 1979), salt marsh (Eilers 1975), or wetlands (Ehrlich 1987).

Estuaries are neither marine nor terrestrial - due to daily tidal inundation. They exist in the vegetated areas that occur on coasts between the limits of tidal fluctuation (Eilers 1975). Salinity and elevation/inundation have an important role in controlling community composition in estuaries. In the Puget Sound, salinity varies from very low (near 0ppt) occurring near river channels, to higher salinities alongshore. These max salinities are usually lower than seawater salinities due to the large amount of freshwater inflow into the Puget Sound (Ewing 1983).

Brackish intertidal wetlands in the Puget Sound can be poor examples of species responding uniformly due to the fact that they occur at the mouth of a fresh water source where salinities, sediment distribution and soil texture can all vary. River currents, flooding tides, coastal currents and storm energy contribute to many different effects in the marsh resulting in variation of plant community establishment based on differences in accretion, erosion, organism deposition, and soil oxygenation (Ewing 1986).

Anne and Paul Ehrlich describes the importance of wetlands [read: salt marsh] further:

> ...Marshes swamps and [other saturated soil] are among the Earth's most productive ecosystems. These wetlands are important providers of ecosystem services, especially in the cycling of nutrients. They also protect shore areas against severe storms, function as storage areas for excess water, thereby alleviating flood problems, and as natural reservoirs in time of drought. Wetlands, moreover, serve as nurseries for many important fish species and as way stations for migrating wildfowl, while harboring an abundance of permanent plant and animal residents. (1987: 54).

Since European contact, wetlands have been shrinking in the Americas as these habitats were viewed as useless "wastelands" and prime areas for development to occur (Figure 2).

Figure 3. Puget Sound Watershed and the area where urbanization has occurred. At one time wetlands tidally influenced Puget Sound, today much of the Urban Area is now concrete development.

Due to this, the draining, filling and development of wetlands have occurred at an alarming rate. It is only recently that we have begun to recognize the value and importance of wetland ecosystems and are allocating resources to the restoration of these unassuming places.

The ecosystem services described above all apply to the Nisqually Estuary. Though the Nisqually River is one of the more pristine rivers that flow into the Puget Sound forming estuaries, there has been many environmental changes to the estuary since European settlement 150 years ago (Downing 1983).

6. Estuary Classification (Appendix 1):

In this work I use Dethier's "Marine and Estuarine Habitat Classification System for Washington State" (1990). I have decided to use this classification system in place of others due to its specific connections to Puget Sound in Washington State. The Nisqually Delta was one of the sites surveyed and used in determining classifications for estuary habitat. The classes listed below were specifically identified habitat found in the Nisqually Delta. Based on these classifications, the Nisqually Delta is a diverse community providing many different habitat types for a wide range of species.

Estuarine Intertidal Sand: Partly Enclosed, Eulittoral, polyhaline (Marsh) - Common Habitat associated with deltas and along shorelines having some freshwater influence. Waves current, tides, or freshwater flows are sufficient to prevent siltation. Strata often have some peat or silt.

Estuarine Intertidal Sand: Partly Enclosed Eulittoral, Mesohaline (Marsh)-Bays and deltas with significant freshwater influence and high enough energy to prevent siltation. Salinities range from oligohaline to polyhaline.

Estuarine Intertidal Mixed-Fines: Partially Enclosed-These habitats occur in backwaters or on deltas away from large distributary channels. They consist of mixed sand and mud with small amounts of gravel or with some clay and peat. Productivity is high due to eelgrass, micro and macro algae, and salt marsh vegetation. Drift algae and sea grass may be abundant seasonally.

Estuarine Intertidal Organic: Partly Enclosed, Backshore, Polyhaline (Marsh)-This habitat is intermediate between true low and high marsh. Salinities as high as 28 ppt have been measures. it can occur as a band between high and low marsh, along the edges of tidal sloughs, or in slight depressions in the high marsh.

Estuarine Intertidal Organic: Partly enclosed, Backshore, Mesohaline (Marsh)- This habitat includes the high marsh and occurs on peat soils. Interstitial soil salinities can drop below 5 ppt.

7. Cultivation of Estuaries

"...when the world was still dark, chaotic, and devoid of human mortals, there was no water for the ancestral beings to drink; these beings survived on the moisture inside of starchy estuarine roots." - Douglas Deur, *Northwest Coast Estuarine Gardens (2005).*

The above quote illustrates the relationship Coast Salish people have with native estuarine plants that is not widely known. Though a big focus is on salmon in the Pacific Northwest, root crops were also a large staple food. With the use of rock barriers, the intense cultivation of Pacific Silverweed (*Potentilla ansarina var. pacifica)* and Springbank Clover (*Trifolium wormskioldii)* in the Pacific Northwest for their edible roots has been documented. As shown in Keeping it Living (2005), Coast Salish people have developed intensive cultivation technology in a variety of ecosystems. The burning of prairies is also a common practice discussed when talking about First Peoples and their role in tending the wild, which indirectly speaks to the time and care that was taken in the maintenance of these foodscapes.

Deur uses the phrase "lost to time" when referring to estuary cultivation methods due to the fact that 200 years of colonization has seen the disappearance of cultivators and their knowledge. I have also experienced this when trying to gather information regarding First peoples in the Nisqually Delta. Unfortunately due to systematic forced cultural assimilation and the sending of an entire generation of Nisqually people to boarding schools, some of this knowledge is lost. Despite this traumatic history the Nisqually people are reclaiming their heritage and restoring valuable traditions and connections with the land and to their culture. Though a lot of traditional ecological knowledge has been lost, what is still known is cared for and passed down by the Nisqually people and other Coast Salish groups. For instance, the elders that Turner and Deur interviews in the late 1990s have heard of these estuary cultivation practices, but few have actively participated in or seen these garden plots. That being said, I

believe that there is high potential to revive these practices for maximum root production and material harvests in native communities.

Kat Anderson (2005) talks about the caring for the land by Northern Californian First Peoples in order to grow and harvest the best materials to be used for weaving-specifically sedges and grasses. When these ideas of cultivation of plants for food and fiber use are applied to first peoples it is safe to assume that many of these practices were also applied by the Nisqually people. Indigenous methods of land use and cultivation are a more sustainable option than diking and draining and clearcutting for access to lands and rich estuary soil.

B. Location and Description of Nisqually Delta

1. The Path of the River

The Nisqually River is located in Western Washington where a mild, Mediterranean climate predominates along the whugle, also known as the Puget Sound (Carpenter 2008). The Growing season typically begins in late March and lasts until late August. The headwaters of the Nisqually River begins at the Nisqually Glacier on a south facing slope of Tacobet, also known as Mount Rainier. The river flows 78 miles down the mountain and into the whugle (figure 1&2). Along its path, the Nisqually River is joined by many tributaries as it makes its

Figure 4. La Grande Dam

Figure 5. Alder Dam

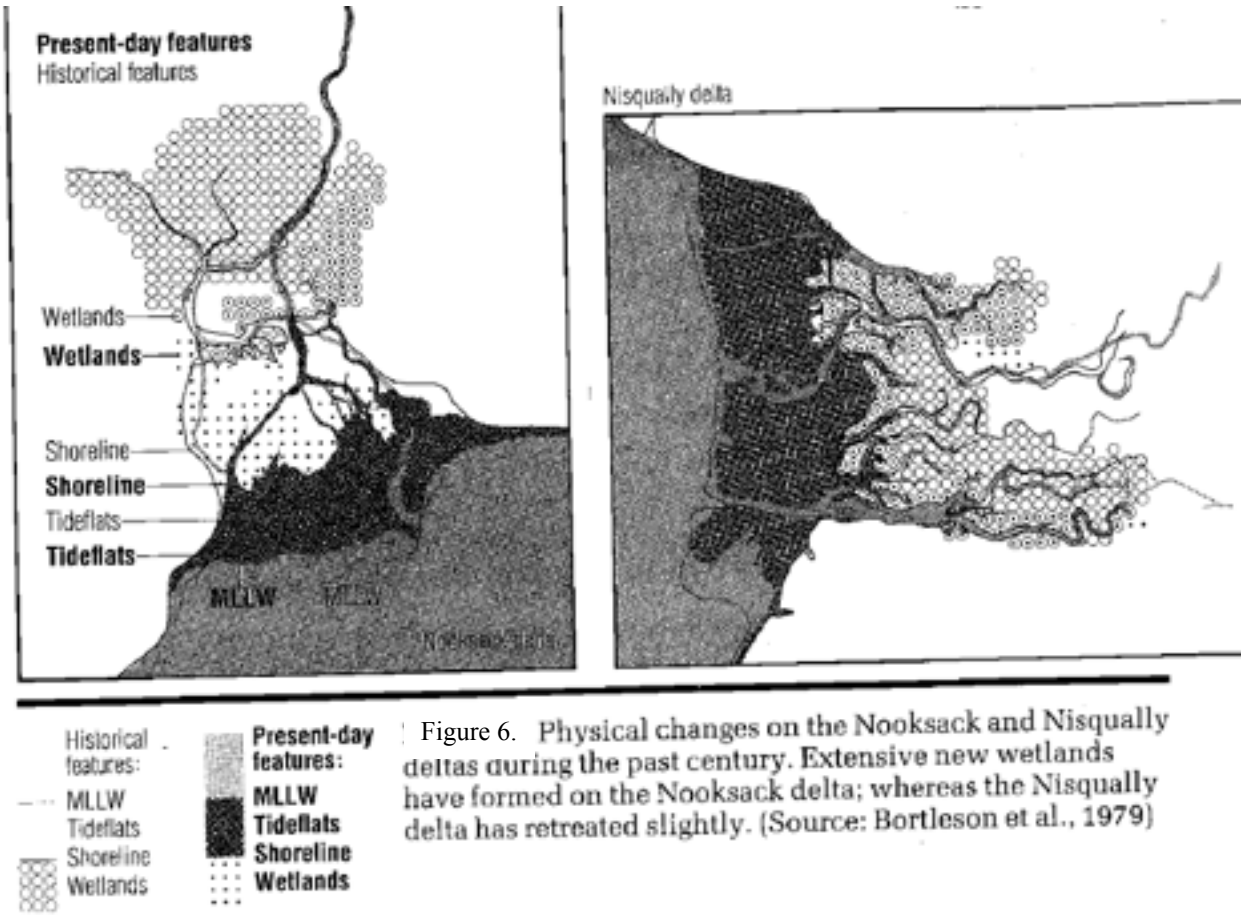


Figure 6. Physical changes on the Nooksack and Nisqually deltas during the past century. Extensive new wetlands have formed on the Nooksack delta; whereas the Nisqually delta has retreated slightly. (Source: Bortleson et al., 1979)

way down to the sound. The river is bisected by two dams- Alder Dam (Figure 5) river mile 44.2, forming Alder lake, a 7.4 mile storage reservoir. The La Grande Dam , river miles 42.7, (Figure 4) is located 2 miles downstream.

The LaGrande dam's purpose is hydropower production, while the Alder dam serves two purposes, producing hydropower as well as providing an accessible lake for recreation. Both dams were constructed in 1945, only two miles apart. The LaGrande dam feeds water to a powerhouse built in 1912. Between the LaGrande Dam and the powerhouse, a continuous flow of water is maintained for the enhancement of salmon spawning habitats a term of condition for the dams relicensing in 1997.

The two dams affect downstream discharge by altering the natural flooding cycle of the river and trapping sediment upstream. Spates, large pulses of water, are prevented by dams which prohibits the flushing of the tidal wetlands (Kentula, 1996). The source of the Nisqually

River is the Nisqually glacier on the south side of Mount Rainier, a volcano. The volcanic sediment is deposited into the Nisqually River as water moves through the watershed. As the delta shoreline advances out into deeper water with time, increasing amounts of sediment are required to produce new surface area in the delta. So, the rate of advancing shoreline as the delta grows in volume will decline without this constant supply of river sediment (Downing 1983). As a result of the dams, the lower Nisqually River is currently a sediment-poor system, only receiving influxes of sediment when there is a flood (figure 6).

The Nisqually Delta is located in the southern Puget Sound (Figure 1), marking the transition from Pierce to Thurston County. Here in the delta, the Nisqually River joins with the Puget Sound creating an estuary where salt and fresh water meet. A place of high productivity with many different organizations and people groups acting in the area (figure 7). These groups include the Nisqually Indian Tribe (NIT), Nisqually Land Trust (NLT), the Nisqually Wildlife Refuge (NWR), Nisqually River Council (NRC), Washington state, United States Geo-

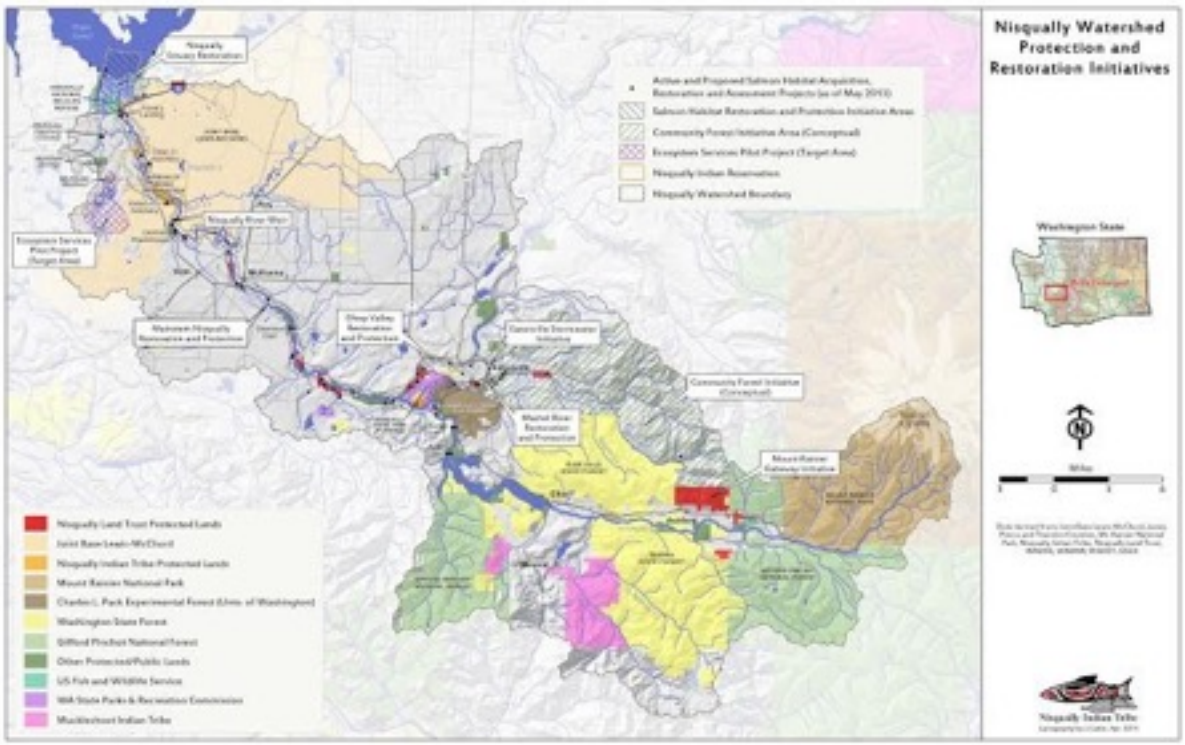


Figure 7. Nisqually Watershed Protection and Restoration Initiatives

logical Survey (USGS), local farmers, community fisherman, birders, and recreationists. The Nisqually Indian Tribe is the longest resident of the area, caretaker of this place since time immemorial.

2. Historical Vegetation

There is little information of the historical vegetation of the Nisqually Delta pre-contact. This means that there is no written record of what was lost. All we can do is look at the vegetation surveys available today (Belleveau 2012, Burg 1985, Mason 1974) and compare to what we know to grow in tidal salt marshes in the Pacific Northwest. We do know based on historical accounts of land size that erosion is occurring along the Northwestern edge of the Nisqually mudflats due to the presence of the dams, and upsetting the balance between deposition and tidal current erosion (Berg 1984). In less than 150 years over 539 hectors of land has been lost in the Nisqually Delta (table 1).

Table 1- Summary of habitat change in the Nisqually Delta and Estuary since the mid-1800s (Berg 1984)

Habitat	historical 1878 (hectares)	Present day 1984
unconsolidated shore	740	580
emergent wetland	570	250
forested wetland	95	36

3. Nisqually village sites

Figure 8. Nisqually Village Sites (Smith 1940)

The Nisqually River has been home to the Nisqually people since time immemorial. Smith (1940) lists a total of 34 villages identified within the Nisqually watershed. Directly in the Delta was a large permanent village site #22. Along the river towards Tacobet were other village sites of varying sizes, #21-26. (Figure 8). Six permanent village sites (Numbered 20-26) are documented along the Nisqually River. These sites demonstrate the close ties Nisqually

people had to the area. Though the Nisqually people considered themselves "up river people" instead of saltwater people (Carpenter 2008), the relative closeness to the mouth of the delta as well as the transit route of the river ensured close ties and active use of the entire drainage

Figure 9. Historical 1937 map overlaid with current location of plantings of *S. pungens*

basin. Cecelia Svinth Carpenter, Nisqually historian, defines *Squalli-abash* as people of the *Squalli*. The name S*qualli* was given to the prairie grass which use to be abundant in the area, the river then took its name from the prairie grass which lined both sides of the river. The people then took their name from the river and the grass- *Squalli-abash*, "the people of the grass country, the people of the river" (2008).

4. "Discovery"

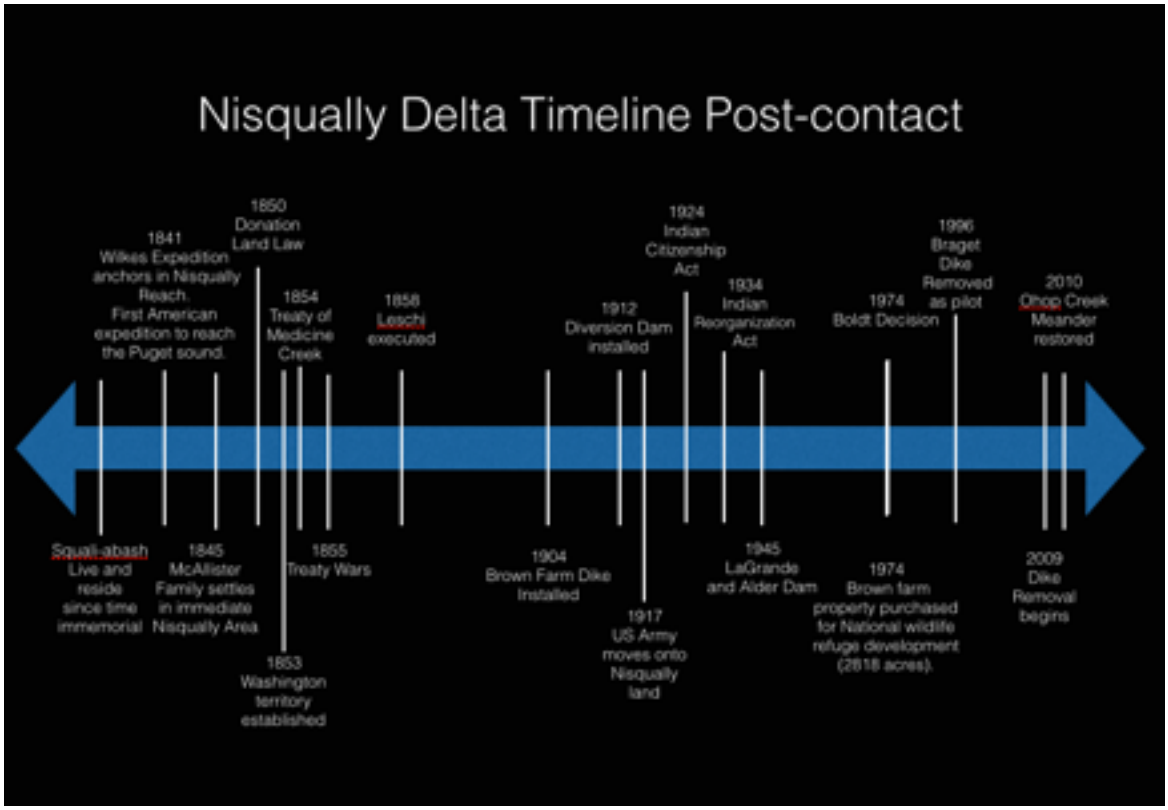


Figure 10. Timeline in the Nisqually Delta (Appendix VIII).

In 1792, the British expedition the "Discovery", led by Captain Vancouver, was sent to explore the Puget Sound. The closest the group came to the delta was to camp overnight on Anderson Island. 50 years later, the Wilkes expedition anchored in Nisqually Reach, being the first American expedition to reach the Puget Sound (Berg 1984).

5. Brown Farm Diking 1904

The Medicine Creek Treaty of 1864 moved all groups of the Nisqually (villages listed above) to a consolidated location and turned over traditional lands to European settlers. This began the intensified agricultural use of the area and dramatic change to the river. In 1904 Brown decided to install a dike to prohibit the regular tidal inundation of the land in order to use the productive soils for agriculture (Berg 1984). The farm's peak agricultural activity listed below:

> "The Brown dairy maintained 300 milking cows, a milking barn capable of accommodating 250 cows at once, a calf barn for 100 young stock and 50 milk cows, and a creamery...small beekeeping operation...chicken operation (20,000 birds/year)...two laying houses (4,000 hens)...hog department (1200)...for the farm products destined for sale, a small factory produced shipping boxes."

With this lengthy list one can imagine the effect to the land. Not only did all of these creatures need a place to walk on dry land, but also the waste produced by over 5,000 animals is a force to be reckoned with.

In terms of land use and ownership, it is hard to understand how settlers could ignore the very deliberate landscapes and cultivated plots marked and cared for by the first peoples. The obvious benefit of not acknowledging these systems is that one did not have to feel guilty to be taking someone's land. For instance, in the land grab that happened around the Nisqually River, what is now the Lewis-McChord Joint Base, was appropriated from the Nisqually people based on the fact that they were not using the land to its "full potential". This was done despite the many place-based names Native Americans had for the area and their society's dependence on the ability to move around and harvest seasonally from the land.

Figure 11. Treaty Trees. Washington State Historical Society

6. United States v. Washington (Boldt Decision)

In 1850, the Nisqually-along with other tribes in Washington Territory- signed the Treaty of Medicine Creek (Appendix IX). This treaty was designed by Gov. Isaac Stevens and took place in the Nisqually Delta (Fig. 11). From 1854 to 1857 Stevens made seven treaties with various Washington Tribes in order to gain lands for the United States development. These treaties ceded traditional indigenous lands and assigned reservation lands to individual tribal groups. Often the terms of the treaty and assigned reservations were not suitable to people's needs/survival. This resulted in the Treaty Wars. The Treaty Wars resulted in the relocation and enlargement of the Nisqually Reservation to a location and size better suited to a "prairie and river people".

Partially in result of the increasing commercial fishing industry and partially due to other discriminations and injustice faced by indigenous peoples in the Puget Sound, the Fish Wars broke out. Beginning as early as the 1950s and coming to a head in the 1970s, Nisqually and other indigenous peoples continued to exert their treaty fishing rights despite physical harm and oppression by the Washington State government. In 1974, this was brought to court in the United States v. Washington. The United States was representing Washington Tribes in defense of their treaty rights being denied to them by the state.

A decision was reached by Judge George Boldt. Boldt is quoted, "The treaties were not a grant of rights to the Indians, just a grant of rights from them, and a reservation of those not granted." It was decided that Washington tribes were allowed to fish "at all usual and accustomed grounds", which meant both on and off assigned reservations. Boldt did not stop there, Washington Tribes were also promised 50% of the annual salmon catch- to be split equally between native and non-native fishermen.

Estuaries are an important habitat for salmon with the Nisqually Delta being home to the endangered Chinook salmon. Much of the restoration that occurs in the estuary today is done with the habitat of juvenile salmon in mind. A result of the 1974 Boldt decision was the co-management of the shared salmon resource between the State of Washington and Tribes. Due to this the Nisqually Indian Tribe (and other Washington Treaty Tribes) have a large presence in habitat management, fisheries, and restoration. In the Nisqually Delta, much of the restoration efforts are a direct result of this resolution as the Wildlife Refuge and the Nisqually Tribe, with various other organizations, work together to successfully manage the Nisqually estuary and watershed.

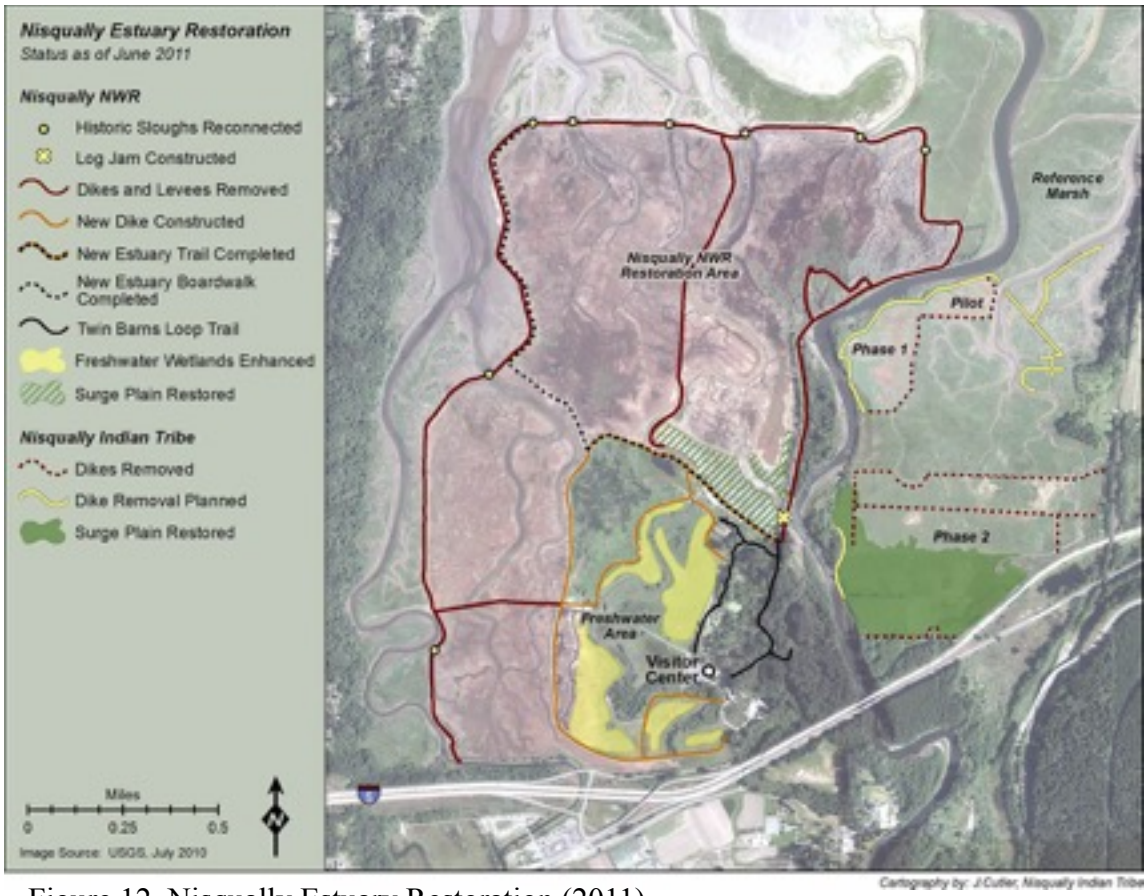


Figure 12. Nisqually Estuary Restoration (2011)

Nisqually National Wildlife Refuge Restoration 2009

Figure 13.

Beginning of Nisqually National Wildlife Refuge outer dike removal June 2009.

Figure 14. Nisqually Delta, Post-dike Removal, low tide

Figure 15. Newly inundated wetlands at Nisqually Delta

7. Buy up by United States and Nisqually Tribe

In the late 1970s wetlands were beginning to be seen as important ecosystems to protect for wildlife and valued for the important ecosystem services they provide. In 1972, the Department of Wildlife and Fisheries bought land on the west side of the Nisqually River in order to develop a Wildlife Refuge, recognizing the importance of protecting the estuary habitat.

In 1999, the Nisqually Tribe began to buy up land along the Nisqually River corridor in order to secure traditional lands along the river and allow them to take a more active role in the management of the Delta. The Braget Farm is now home to the Nisqually Cultural Center and Nisqually Community Garden, as well as providing access to the delta for the community.

8. Dike Removal and Restoration (Figures 12-15)

In 2009, efforts to remove the dike began. This restoration effort to restore the natural tidal influences to the estuary has occurred in a series of phases (Guthrie 2012). Today, 365 ha are inundated by natural tidal cycles.

9. Present day ownership and potential use

For thousands of years the area has been inhabited and actively used by the Nisqually people. There are many factors contributing to the present day disconnectedness of people to the Delta. One reason for the inactivity found now can be contributed to access. The Nisqually Tribe is continuing to purchase land in the Nisqually Watershed with the hope of restoring people's relationship to the land, gaining access and rights to a piece of their traditional territory, and partnering in the healing of the landscape.

Presently, much of the restoration to the delta can only be accessed on foot. Reestablishing traditional harvest methods by canoe could allow many different people of varying physical skill access to the Nisqually Delta. The Nisqually Canoe Family is a great resource

to the tribe to access these places in the estuary, where traversing on foot can be both hazardous and physically taxing.

Today, the delta is primarily designated as a wildlife refuge with the majority of land set aside for wildlife habitat. Recreation occurs on designated walking paths at the Wildlife Refuge. Birders and hikers regularly enjoy access to the estuary on boardwalks and walkways built on the remaining dike. The Delta is also a popular local fishing spot. The closest access point with a boat ramp is Nisqually Reach. A few Nisqually fishermen utilize their fishing rights here at the mouth of the Nisqually, though access can be difficult.

The Nisqually Canoe Family regularly paddles in the Nisqually River and Delta. In 2016, the Nisqually Tribe will host Tribal Canoe Journey. More than a 100 canoes from as many as 90 US Tribes, Canadian First Nations, and New Zealand, with an estimated 12,000 total people participate in the annual Tribal Canoe Journeys (Squaxin Island Tribe 2015). The 2016 canoe journey will make the Nisqually estuary a much more visible place. Sequalitchew Creek will be the launch site with access for the 12,000 people that are estimated to attend. The potential of adding a boat ramp to access the River on the Nisqually Tribal land on the east side of the river has been discussed, but was later refuted due to the delicate nature of the distributaries flowing into the estuary. Looking at other ways to increase access to the river would benefit the fisher people of the tribe, the canoe family and other tribal members and community who would want to recreate and harvest on their traditional lands.

C. Schoenoplectus pungens (Appendix VI)

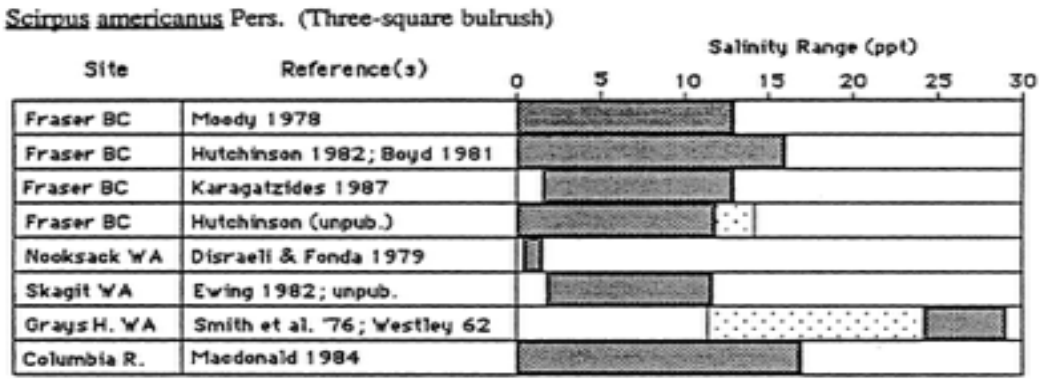
1.Habitat

Species Code (as per USDA Plants database)	SCPU10
GENERAL INFORMATION	
Geographical range	Found throughout North America. It can also be found in South America, Europe, Australia and New Zealand [4] 
	 Distribution in Washington State [5]
Ecological distribution	estuaries, freshwater and brackish marshes [2] *S. pungens* is found in flood plains, ditches, streams and marshy areas and along margins of ponds and lakes [1,6]
Climate and elevation range	low elevations [3,6]

Figure 16. Geological Range of *Schoenoplectus pungens* in North America and Washington State.

S. *pungens* is found in wetlands all across North America (Figure 16). Typically occurring in saline environments, on the outer edge of sandy marches (Jefferson 1975). In the Skagit River delta, Ewing (1983) identified *S. pungens* communities as being a low elevation, moderate-

ly to highly saline, silty to sandy “with a moderate amount of clay” environments.



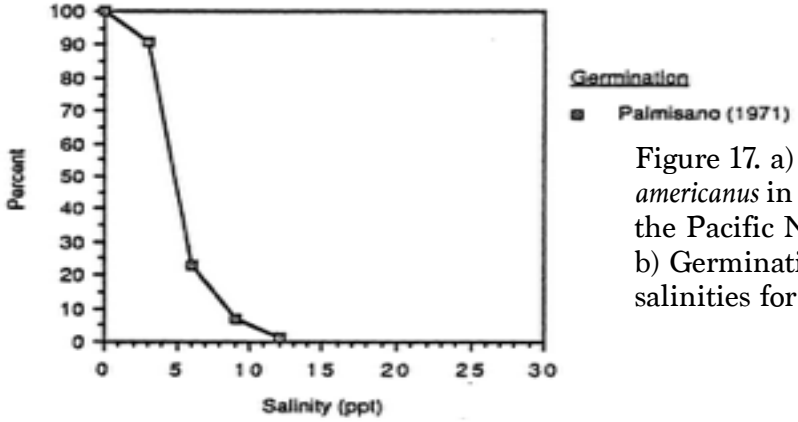


Figure 17. a) Salinity Range for *S. americanus* in various rivers around the Pacific Northwest
b) Germination success in varying salinities for *S. americanus*

Table 2. Salinity, Soil, and Elevation in Nisqually Delta

Site	Salinity (growing Season range) ppt	Soil	Elevation(m)
Nisqually Delta	0-10	silty-sandy	1.5-2

Here in the Puget Sound region, *S. pungens* is found in low elevation salt marsh and is able to tolerate higher salinities than other species. *S. pungens* is found in the Puget Sound in sandy,

moderate to highly saline, low elevation communities. This plant is able to tolerate a wide variety of conditions so can be found in many different wetland environments.

2.Cultural Significance

"Some people think that we had no written language. Our language was one of action. It was written on the baskets." -Johnny Moses, Tulip Storyteller and Culture Keeper (relayed by Melinda West, Personal Communication 2015).

Wray (2012) states, "sweetgrass from estuary tide flats and cattails are sometime woven into baskets of cedar bark or the basket may be made of just sweetgrass...as you gather the grass you clean, split, and store it in a dry place." Sweetgrass is used in basketry techniques of many aboriginal peoples around the world. In the Pacific Northwest, sweetgrasss is used for both the weft and the warp of the basket with different techniques being invoked depending on the style of basket being made.

There are many names used for sweetgrass. Some of the common names include American three-square, basketgrass, and three-corner grass. Traditional indigenous names for the sedge include: *toh-toh* "three corner grass", *tux-tux* "edged along the length" (onomonopic for the sound sweetgrass makes when pulling the shoots off when harvesting) (Wray 2012), and *ka'qsxw* (Kris Miller, Personal communication, 2014).

Wray (2002) further depicts the importance of sweetgrass for indigenous peoples in the Puget Sound region in her book Native People of the Olympic Peninsula: Who We Are and the challenges of harvest today:

> Until the 1930s Twana women from the Skokomish Reservation harvested sweetgrass (*Scirpus americanus)* from the estuary for making baskets and other items. Industrial and agricultural development in Western Washington estuaries has all but eliminated Sweetgrass, and only a few remnants of Skokomish sweetgrass were found outside of Nalley dikes by the 1970s.

she continues:

> The Quinault traditional homeland continues to be a focus of Quinault culture...Each year the Quinault people travel to various sites on and off the reservation to gather basketry materials, cedar bark, bear grass, cattail, sweetgrass, and beach grass, as the Quinault people have done for hundreds of years.

The Seasonal harvest rounds are an important part of the lives of the indigenous peoples in the Pacific Northwest.

Other culturally significant plants located in the Nisqually Delta include:
Tule (*Schoenoplectus acutus)*
Springbank clover (*Trifolium wormskioldii)*
Cattail (*Typha latifolia)*
Pickle weed (*Salicornia virginica)*
Gumweed (*Grindelia integrifolia)*
Pacific silverweed (P*otentilla ansarina var. pacifica)*
Wapato (*Sagittaria latifolia)*
Nettle *(Urtica dioica)*
Pacific crab apple *(Malas fusca)*

3. **Harvesting Guidelines** (Reese and Ziegler 1995)

Locale/appearance Look for sweetgrass on tidal flats, currently near Grays Harbor and Willapa Bay. It has a triangular stem tapering towards a brown flower cluster at the side near the top.
Part collected the stems
Time of year midsummer, depending on the weather (July)
Environmental concerns this grass has been over harvested in at least one area and is no longer available there. Please take this into consideration when gathering. Gathering permits are currently required in some areas.
Use twining, braiding, weaving, coiling (core and stitching) and cordage. Flower clusters (spikelets) are ornamental, and the sheath at the base of the stem is strong and supple, useful for cordage or twining.
Gathering at low tide, cut or pull the stems near the base. When you pull, avoid destroying the roots. Like most grasses, this one slips from its sheath with a satisfying pop. After early to midsummer the grass becomes more brittle and hard to pull and the tips are useless.
Drying dry sweetgrass before using it. Wash off the mud. Then spread the stems out in dappled sunlight or shade to dry and bleach out the green color.
Storing Bundle and hang the stems in a dry place, or stand them upright in a container. Do not expose the stems to dampness, as they mildew easily.
Preparing Place the desired quantity outside overnight in the rain or dew, or soak in warm water 15-20 min. Wrap the stems in damp towels and sit for 2 to 6 hours. (be sure to re-dry what you do not use.) The grass can be used whole or split to a smaller size. It does not take dye well but has a natural range of color in the tan-yellow-orange range with deep ruse to purplish bases.

Harvesting knowledge from Joyce McClould, Nisqually Elder and Cultural Program Coordinator (Personal Communication, 2015):
-Pull with hands one at a time to avoid pulling out/disturbing the roots (specifically *S. pungens)*
-Leave seedheads if possible (all plants)
-Only take what you need/can use

4. Botanical Classification

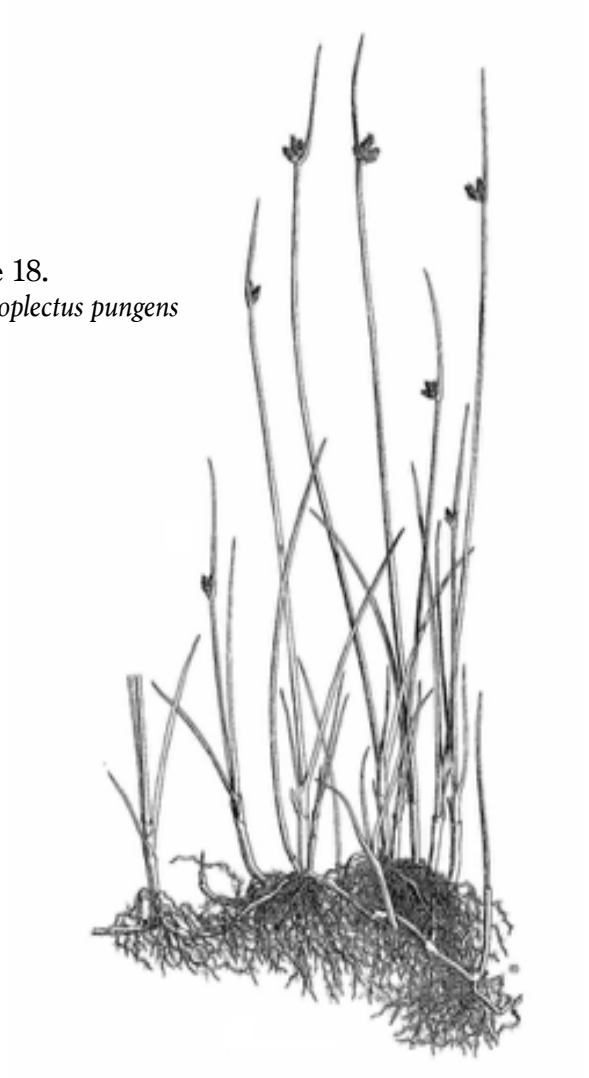


Figure 18.
Schoenoplectus pungens

Family: Cyperaceae (Sedge Family)

Grass-like herbaceous perennials with soft stems and reduced flowers, common in wet or moist areas.

Genus: Scheonoplectus (Bulrush)

Formally part of the *Scirpus* genus, recently moved to *Scheonoplectus* genus.

Species: pungens (means pointy)

Uppermost leaf with a well developed blade that is several times longer than its associated sheath and stems with flat to shallowly concave sides. This is compared to *S. americanus*,

where the uppermost leaf with a short blade is shorter than its associated sheath and stems with slightly concave sides. (Gobotany 2015).

Taken from Flora of North America vol.23:

S. pungens-

> Spikelets 1–5(–10); perianth bristles very stout to slender, unequal or equal, equaling achene to rudimentary; distal leaf blade several times longer than to rarely equaling sheath; achenes (2–)2.5–3.5 mm, plano- to unequally biconvex or obtusely trigonous; styles 2–3-fid (Flora of North America .

From what I have seen in the literature and documentation in Herbariums, in the Pacific Northwest the literature goes back and forth- much of the ethnobotanical documentation goes back and forth between *pungens* and *americanus.* Hybridization between *S. pungens* and *S. americanus* have been known to occur with the hybrids favoring *S. americanus* (Blum 2010). References to both species were used in the research for this project as well as the historical genus *Scirpus.*

5. Propagation

Propagation of *S. pungens* is usually done vegetatively. In studies that looked at transplanting establishment, *S. pungens* did not survive- Thomsen (2005), suggests that this could be due to the potentially narrow salinity tolerance of *S. pungens* when first establishing/initial colonization compared to survivorship after establishment (Figure 17a). Seed dispersal studies yielded no establishment (Figure 17b, Neff 2005).

6. Herbivory

Canada geese (*Branta canadensis*) are known to eat the below ground and aboveground mass of various wetland plants (Crandell 2001). Even low intensity of feeding by Snow Geese can reduce the productivity of *Scirpus* communities (Giroux 1987). Miller (1997) concludes that continued frequent and intense snow goose use combined with drought and lower water levels can produce denuded mudflats prone to soil erosion. The Canada goose as well as other geese species are a common site in the Puget Sound and specifically the Nisqually Delta (Figure 19 & 20). In 2001, Caren Crandell set up geese ex-

closures on a sight in the Duwamish River Delta to evaluate the effect geese have on planted stands of *Carex lyngbyei* and *Scirpus acutus.* Crandell found that plants protected with the exclosures were more productive and also had greater vegetative production, and 29 "volunteer" (unplanted) species came up with in the exclosures. Vegetation loss can be associated with several consecutive years of goose herbivory along with washout, high salinity, or prolonged flooding (Miller 1997).

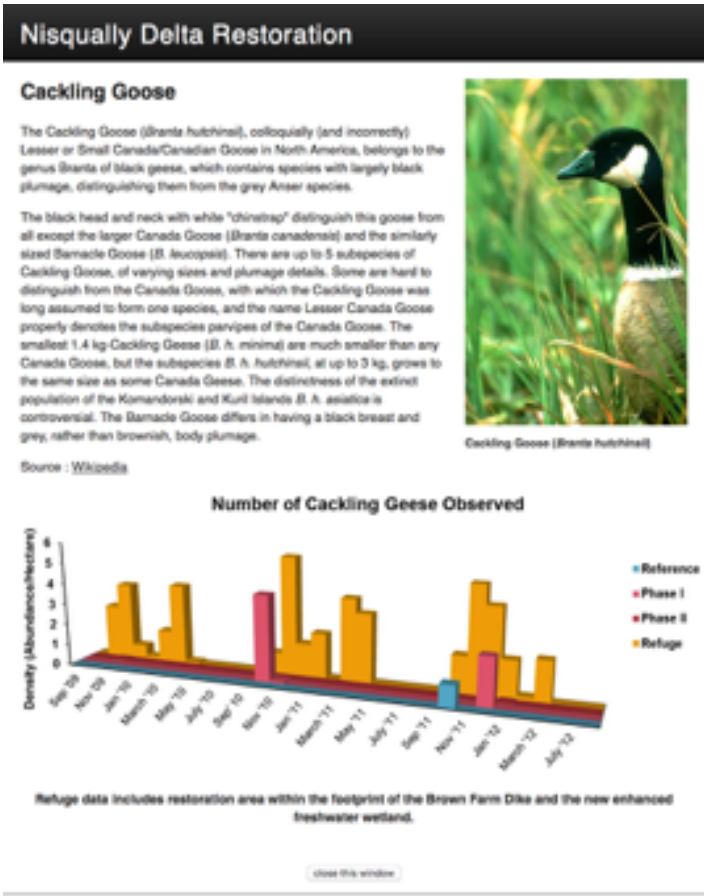


Figure 19. Crackling Geese in Nisqually Delta. Nisqually Wildlife Refuge.

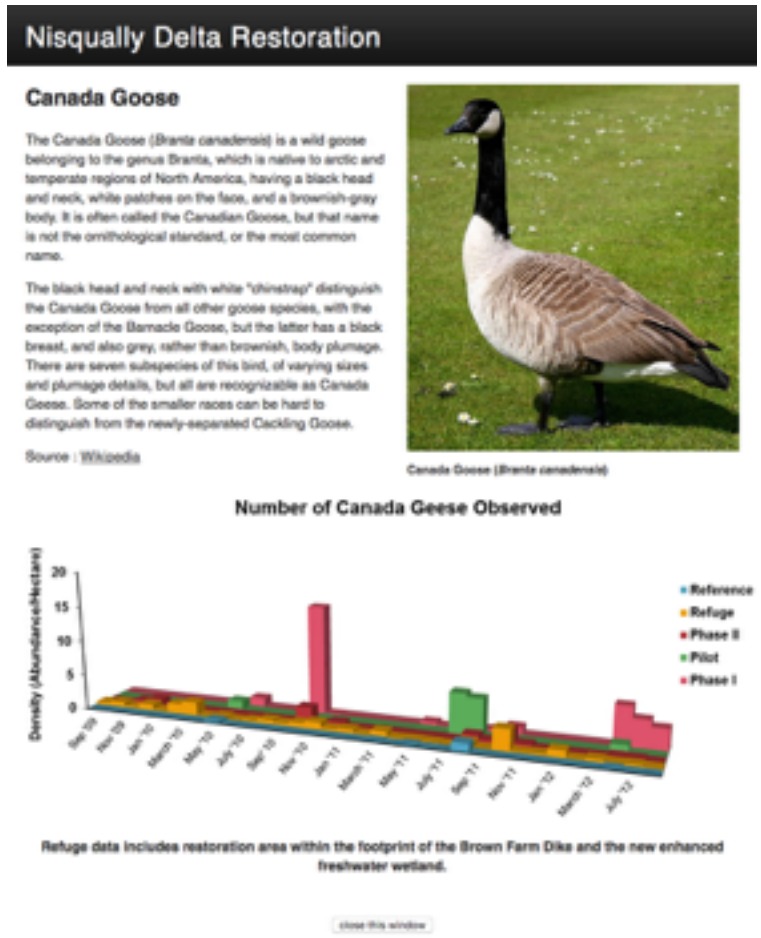


Figure 20. Canada Geese in Nisqually Delta. Nisqually Wildlife Refuge.

7. Horticultural Significance- Restoration

Estuary plant species are important in raising marsh elevation through stabilizing substrate with root growth, and trapping small debris. When the substrate is stabilized, new seedlings are less likely to be washed away and the higher elevation allows other plant species

to grow that are less tolerant of tidal influence (Jefferson 1975). Sweetgrass is a primary successional plant that can grow in the low elevation intertidal zone where most other plants cannot. This makes it a great plant to use in bank stabilization in wetland areas. Due to its rapidly spreading rhizomatous nature as well as aboveground parts adding organic matter to the system as they senesce each year, *S. pungens* is an ideal plant to use to decrease erosion or help to slow eroding areas.

Arreghini (2006) looked at the phytoremediation potential of *S. americanus.* Arreghini concluded that *S. americanus* is a stable species for phytoremediation of Zn contaminated wetlands with abundant nutrients and organic matter (OM). Another study showed that *S. americanus* has the ability to accumulate Pb, Cr, Mn, and Fe from its surroundings, with most of the heavy metals accumulating in the roots (Carranza-Alvarez 2008). Due to the similarity between the two species I imagine that *S. pungens* could have the same phytoremediation potential.

Emergent marsh pants perform a variety of habitat functions for fish and wildlife. For instance, juvenile salmon, live in in river tidal channels before migrating to the Pacific Ocean where vegetation provides crucial shelter for the growing fish. Waterfowl also use tidal salt-marsh habitat for feeding, reproduction, forage, and refuge (Crandell 2001).

8. A Look at Documented Locations of S. pungens

The Burke Museum Herbarium as well as online Consortium of Pacific Northwest Herbaria were consulted to analyze locations of collected *S. pungens* (figure 21). Most of the specimens on file came from the interior Pacific Northwest. Of these I mapped out the specimens

laying closest to the Puget Sound. My main focus was to see species distribution along the sound. Interestingly, Bowerman Basin/Grays Harbor -where most people go today to harvest

Figure 21. Locations of identified populations of *S. pungens*

sweetgrass-is not represented in the specimens collected. Specimens ranged from all over the sound with nothing consistent. Some of the older specimens that were collected are now developed areas with little to no native vegetation. There is documentation of two species collected in Tacoma and one in Seattle. Unfortunately today that area is no longer tidally inundated and is instead paved over with concrete due to urbanization (Figure 3). Where one might go look for sweetgrass today on the sound is not evident from the collected samples. This leads me to agree with Melinda West's notion that sweetgrass used to be found all along the Puget Sound (Personal communication 2015). Cecilia Carpenter, Nisqually historian, is also reported to have verified that the sweetgrass used to be found in thick stands on both sides of the Nisqually River mouth (Joyce McCloud, personal communication 2015).

Figure 22. East side of Nisqually River, persisting planted stands

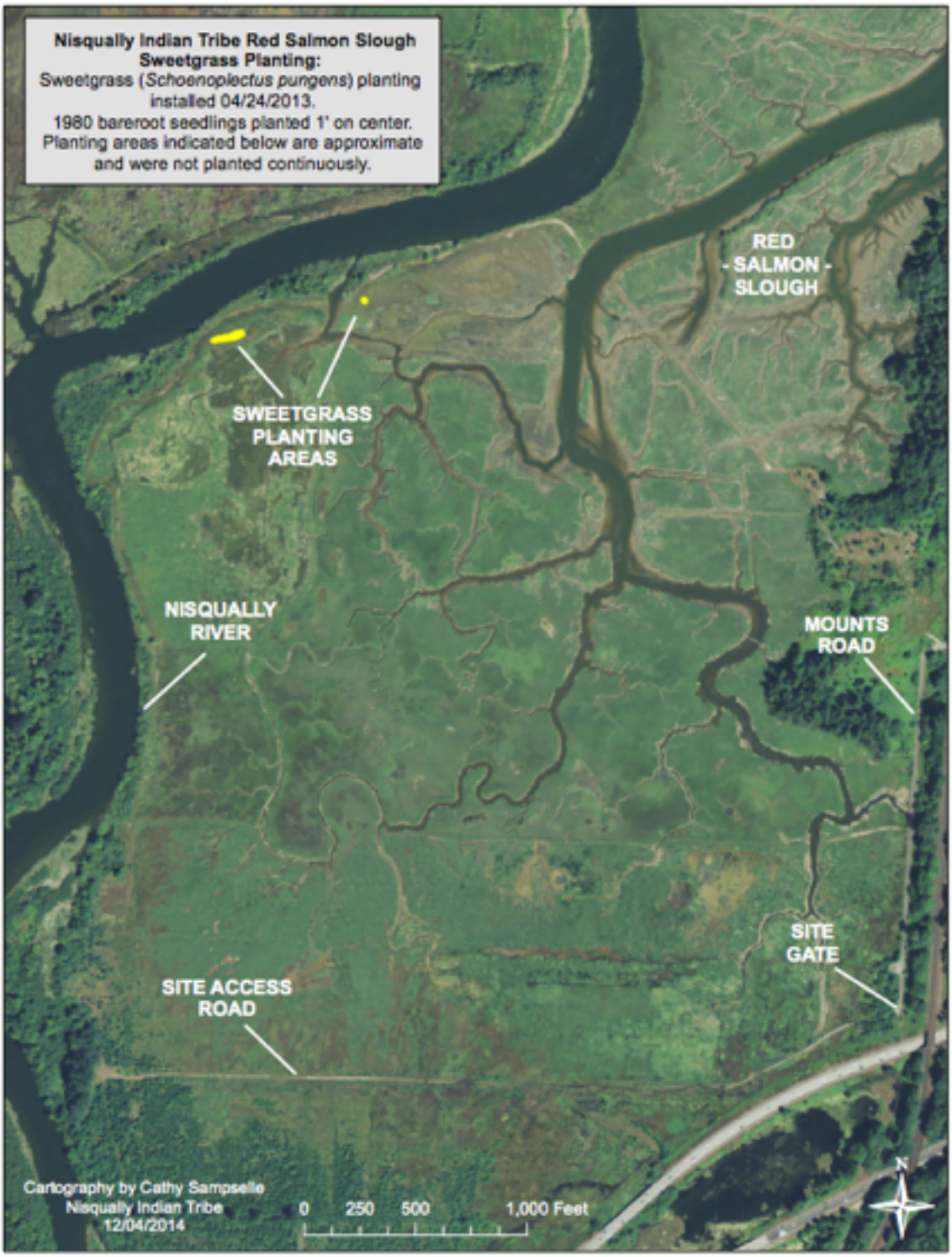


Figure 23. Stand 2- Planting location of *S. pungens* at Nisqually Wildlife Refuge provided by Jesse Barham

Figure 24. Stand 3-Planting location of *S. pungens* at Nisqually Wildlife Refuge provided by Jesse Barham

9. Restoration Sites

9.1 East Side- Nisqually Tribal Land

In 2013, the Nisqually Indian Tribe planted 1980 bare root plugs on the east side of the River. This was area where a dike had been removed in 2009, restoring natural tidal inundation to the section of the estuary (Figure 10 & 22). A small slough runs along the planted stands, distributing freshwater to the area. This area consists of mud flats, dominated by saltgrass (*Distichilis spicata)* and Saltmarsh bullrush (*Bolboschoenus maritimus).* The project was initiated by the Nisqually Cultural Center. Cultural center staff organized several discussions with the Cultural Committee and the Nisqually community at large regarding what plants the community was interested in having access to in 2009 and 2010. Sweetgrass was one of the plant desired by the community (both *Schoenoplectus pungens* and *Hierochloe odorata).*

Trial plantings were installed by the Nisqually Tribe's Natural Resource Department in 2013. The locations of the plantings were based off of the elevations of successful plantings in the Nisqually Wildlife Refuge (See below) and did not have existing vegetation. The 1980 bare-root plants were ordered from Fourth Corner Nursery, who originally collected vegetative cuttings of the rhizomes of *S. pungens* in the Skagit Delta. Planting was done with the potential for future harvest in mind depending on success and rate of establishment (Cathleen Sampselle 2015).

9.2 West Side- Nisqually Wildlife Refuge

In 2009, Jesse Barnham, biologist for the Nisqually Wildlife Refuge (NWR) planted 1000 bare-root plugs on 2 separate locations in the Nisqually Wildlife Refuge (Figures 23 & 24). Plantings were based off of other places *S. pungens* is found in the Puget Sound region through elevation and tidal/ freshwater influences and salinity (i.e. Grays Harbor and the Skagit River Delta). Experimentation with plantings of *S. pungens* in the NWR were initially based on the oral knowledge through Nisqually tribal

elders that it had occurred in the delta at one time as well as the fact that Nisqually basket makers were raveling to Grays Harbor to collect it (Jesse Barham personal comm. 2015).

Two sites were planted with *S. pungens*. Site 2 (figure 23) was located near the entrance of the Wildlife Refuge, in a slough that fills daily with tidal inundation. *Bolboschoenus maritimus* co-dominates here with *S. pungens*. Site 3 (figure 24) was located closer to the sound and the Nisqually River than site 3.

II. METHODS

Many different studies have taken place in the Nisqually Estuary, but this one is the first to date that looks at *S. pungens* and the restoration of culturally significant plants. I was able to find two studies that look at vegetation that took place post-dyke removal. Guthrie (2010) looked at success rates at restoration sites of woody vegetation within the Delta along the river bank. Belleveau (2012) focused on determining elevation and salinity field conditions for nine herbaceous species found in the salt marsh. Prior to dike removal and the restoration efforts of today, Berg (1984) looked at habitat change in the Delta since the 1800s. Multiple vegetation surveys have also been done (Mason et al 1974, Woo 2010) in the Nisqually Delta.

Studies concerning specifically S. *pungens* in the Pacific Northwest also were limited. Crandall (2014) and Ryan (2000) are the only two that I found that also look at the cultural significance of the plant. Many studies around North America have involved *S. pungens*. More studies and reference to *S. americanus* were discovered and based on the recent reorganization of *Scirpus/Schoenoplectus* genus (see above). In the studies that look at *S. americanus* it is important to consider that *S. pungens* may actually be the species referred to here.

A. Selection of planting sites in Nisqually Delta

The site selection of plantings of *S. pungens* were chosen by biologists from the Nisqually Wildlife Refuge and Nisqually Tribe Natural Resource Department (see I.C.9.1-9.2 above).

B. Data Collection

Initially the east side of the Nisqually Delta on land owned by the Nisqually Tribe was walked and evaluated in early Spring 2014. Plant community and salinity was evaluated at far

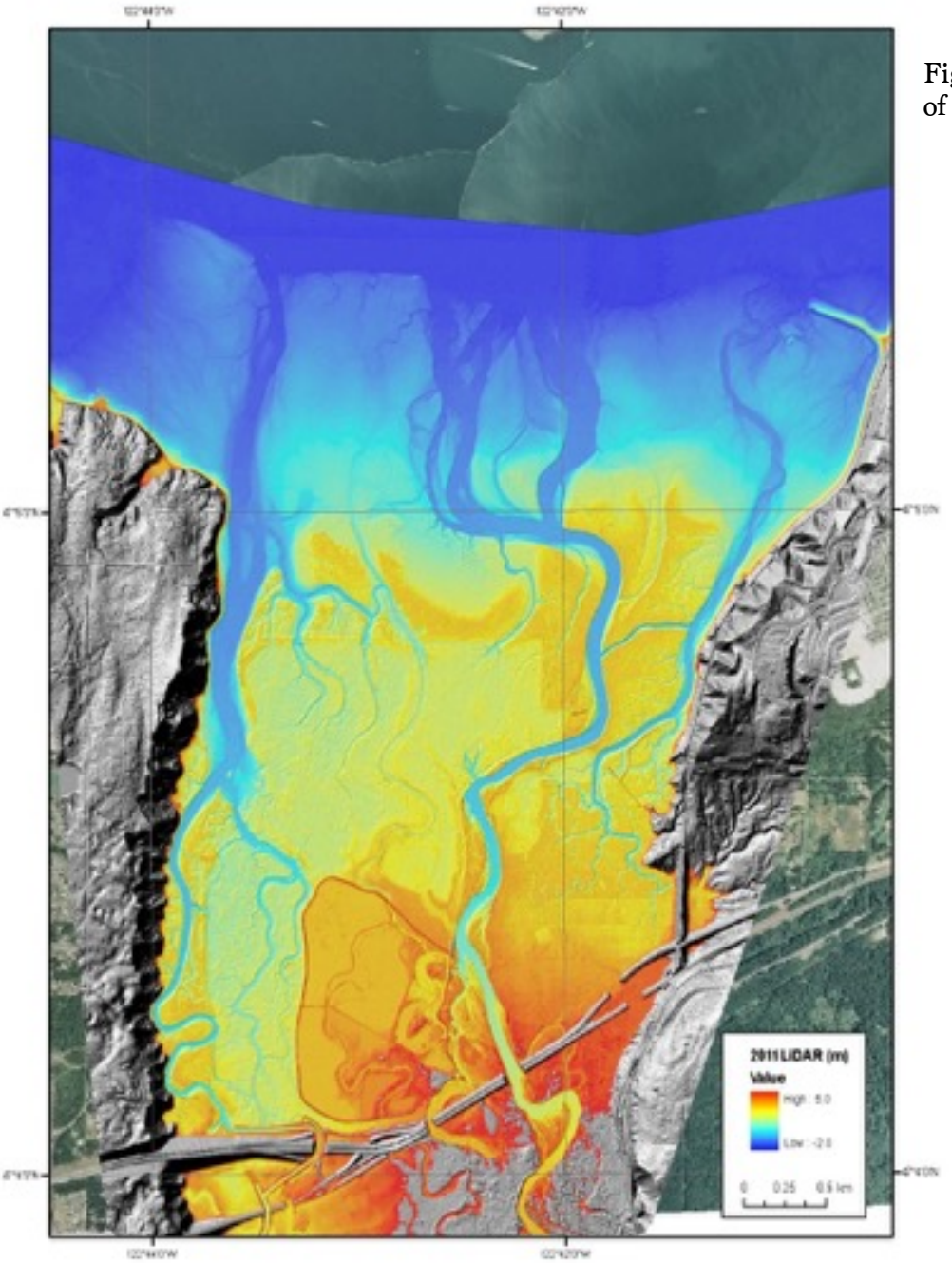


Figure 25. Lidar Map of Nisqually Delta

east access point to the delta. Access to this point is a trail maintained by Nisqually Indian Tribe that crosses the railroad In late spring 2014, planted stands of *S. pungens* were identified and mapped. These stands were continuously monitored throughout the 2014 growing season, senescence, and start of 2015 growing season.

1. Salinity

Salinity was taken each visit to the site. PVC pipes were used to extract groundwater through submerging them in the ground ~5 inches deep. Once water entered the pipe they were pulled out and the water collected into a waiting jar. Using a dropper, the water was placed onto a salinometer in order to determine the salinity of the site. PPT measurements were used. Salinities were taken each visit in order to compare salinities level changes throughout the seasonal yearly cycle.

2. Elevation

Elevation of sites were evaluated based on Lidar data taken by the USGS in 2011(Figure 25).

3. Soil

Soil samples were taken at each site and a basic soil texture test (Appendix II) was conducted while in the field. For the soil texture test, a small handful of soil was dug. The soil was already fairly wet due to the nature of an estuary (i.e. daily inundation) so no additional water was needed to help determine soil texture. Each soil sample was evaluated for distinguishing characteristics of each soil type (sand, silt, clay). USGS soil surveys of the area were also evaluated and compared to field data (Figure 27).

C. Vegetation Survey

Two transects, each 25 m long, were surveyed for plant composition near planted *S. pungens* site on Nisqually Tribal Land. On each transect, every 5 meters a circle with a 1m radius was drawn and the interior of the circle broken down into percentage (vegetation, bare ground,

Figure 26. Major Estuaries of the Puget Sound

organic material, etc). The shoreline of the delta was also traveled by kayak in search of *S. pungens* that was not easily accessible or visible on foot.

D. Measurement of Growth

Maximum height was measured using cloth tapes at one millimeter (mm) increments taken from the root crown to the tip of the main bract. Area of the documented stands were

measured using GPS and pacing (100ft.=19 paces), depending on availability. Measurements were taken at peak growth within the 2014 growing season.

E. Comparative Site Analysis

Other sites where *S. pungens* is known to grow were identified around the Puget Sound region (Figure 1). These sites were visited during peak growing season (late summer) in order to compare growing and site conditions to the planted stands within the Nisqually River Delta. Previous studies conducted in these estuaries were further analyzed (Ewing 1982, Crandall 2014, Ryan) and compared as well as on site evaluation with restoration biologists and technicians (Jason, Crandall, Bailey, Sampselle, Personal Communication 2014).

F. First Person Interviews

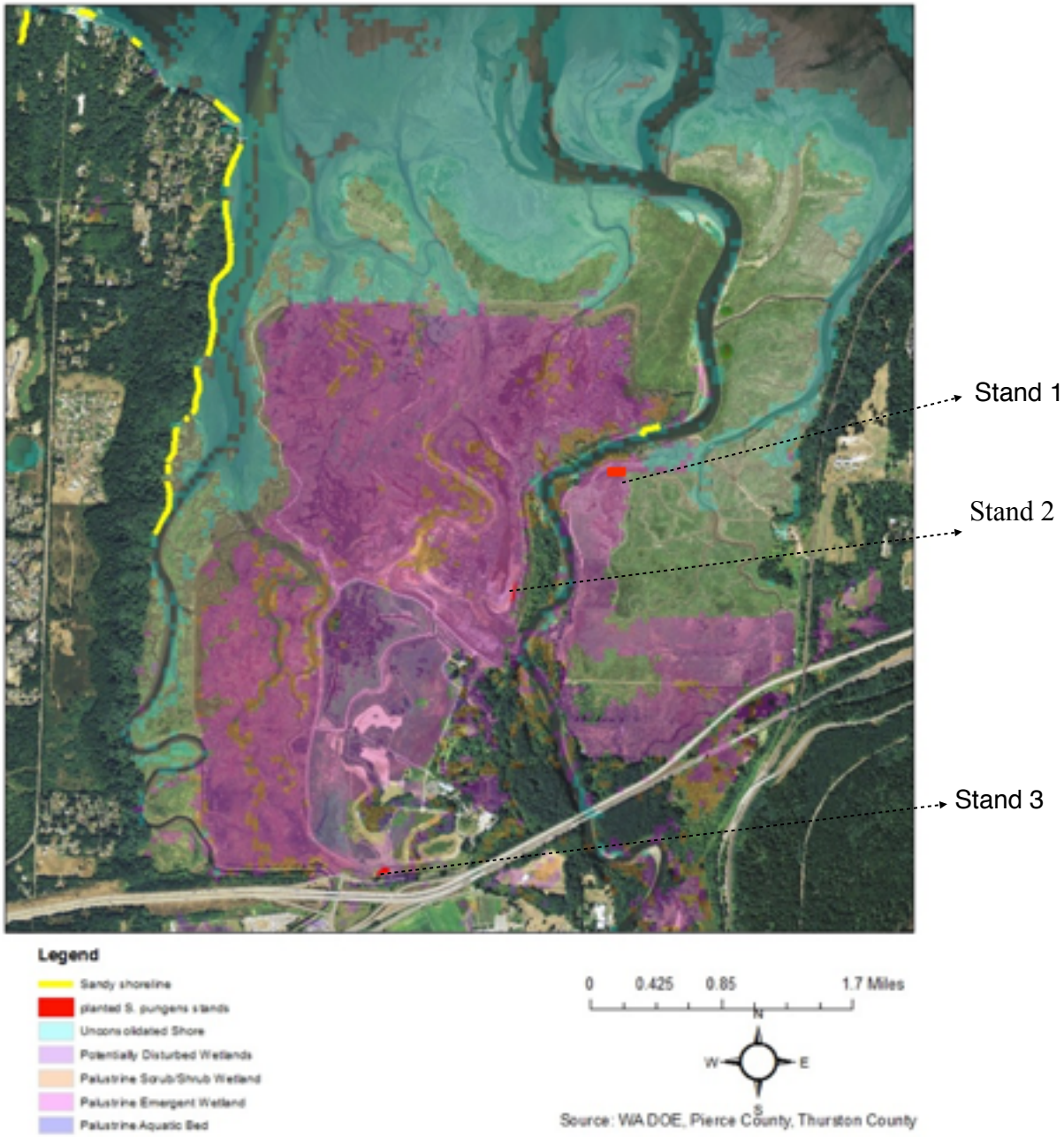
First person interviews were conducted with Native and Non-Native weavers in the Puget Sound region (Appendix III). Interviews were focused on interaction and perception of *S. pungens*, and the surrounding environment.

G. Historical Map Comparisons

The earliest maps of the Nisqually Delta were consulted and analyzed looking at shoreline changes. The earliest map of the area found was from the Wilkes Expedition dated 1848. Metsker Maps of both Thurston and Pierce County were traced and overlaid to compare shoreline and river meander changes (Figure 30).

III. RESULTS

Figure 27. Potential Sweetgrass Habitat in the Nisqually Delta



A. Environmental Conditions

1. Soil

Average ocean salinity is 35 ppt. The salinity in the Nisqually Delta varied from 0 ppt to 17 ppt. As to be expected due to lower freshwater inputs into the estuary due to lack of rain and dwindling snow melt, the higher salinity levels occurred mid to late summer.

2. Elevation

Based on USGS Lidar map (Figure 24) elevation in the Nisqually Delta ranges from 5 m to - 2 m. Elevation levels in the planting sites in the Nisqually Delta were at 1.5 m on the east side (tribal), and both sites on the west side of the river (NWR) at 2.5 m.

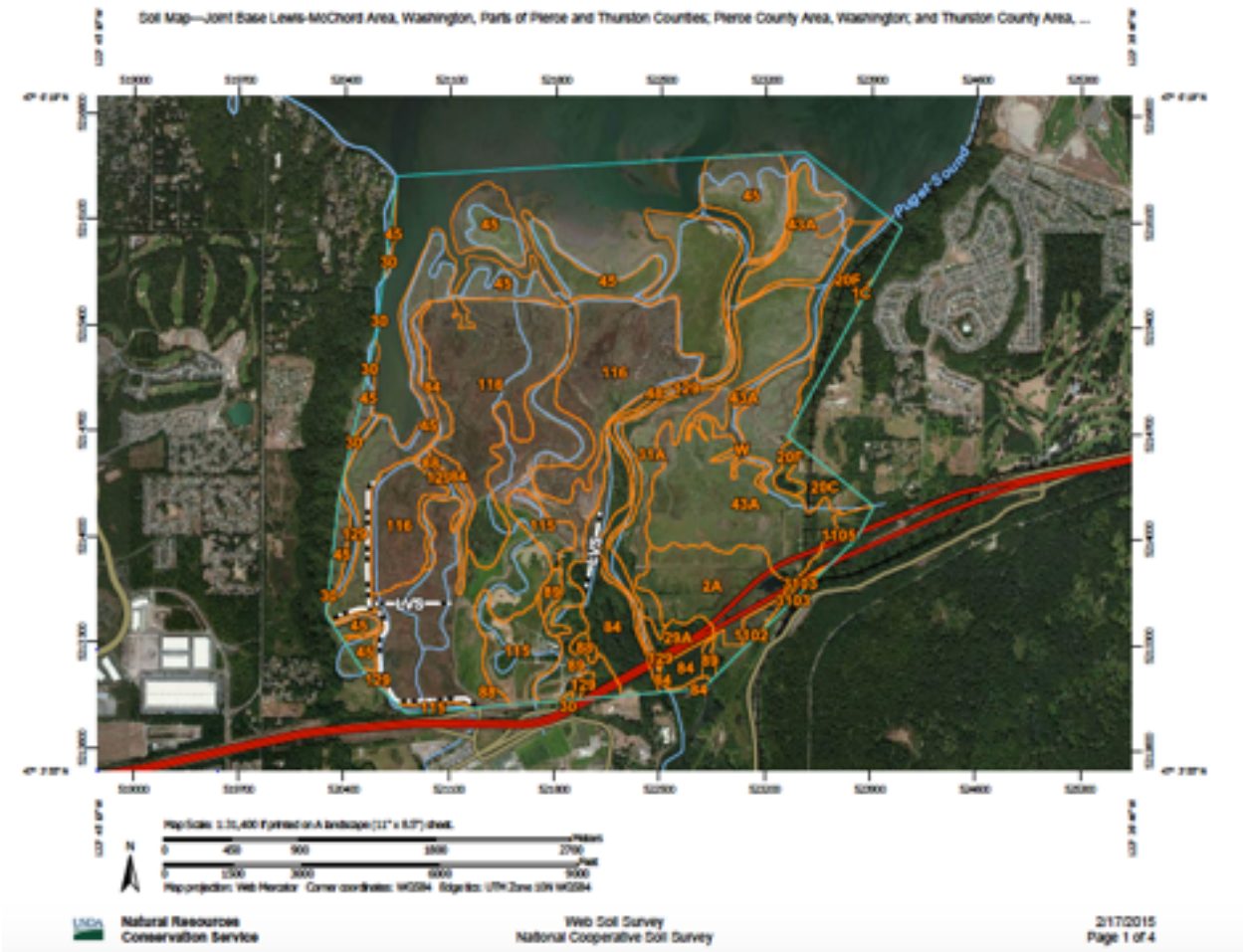


Figure 28. USGS Soil Survey. Nisqually Delta (Appendix IX)

3. Soil

Soil types in the Nisqually Delta vary. According to the USGS Soil Survey:

Site 1- Puyallup fine sandy loam- very deep, well drained soils formed in recent alluvium

Site 2 - Puget silt loam- consists of very deep, poorly drained soils that formed in recent alluvium on floodplains and low river terraces

Site 3- Sultan silt loam- consists of very deep, moderately well drained soils formed in recent alluvium on floodplains at elevations of near sea level to 120 feet

Manual soil texture analysis (Appendix III) at each site revealed sandy clay soil type.

B. Historical Map Comparisons/Herbarium/Burke Museum Collection

Figure 29. Top: Prairies in the 1800s constructed from land use and other historical records. Bottom: Shrinking of prairie area by the late 20th century. (Kruckeberg 1991)

The shoreline along the Nisqually River as well as along the sound changed very little. The largest changes observed were the natural meanders becoming lost (figure 30) due to channelization of the river. It is unknown if river channelization was from natural causes or man-made.

The distribution of *S. pungens* found in herbariums did not coincide with any sites looked at in this study (figure 21). The closest locations of specimens collected to the Nisqually Delta were from downtown Tacoma (late 1800s) and in Port Orchard (early 1900s).

A total of 10 out of 2907 "Northwest Coast" baskets in the Burke Collection are identified with "sweetgrass" being a material used in its construction (APPENDIX XI). The baskets I looked at were both the collection of baskets believed to have come from the Nisqually area as well as baskets with sweetgrass as an identified material of which the basket was made. None of the baskets thought to have come from the Nisqually area contained sweetgrass. The majority were made predominantly with cedar.

C. Interviews

Personal interviews with native and non-native weavers emphasized the direct tie of weavers to the materials used in their craft as well as ideas around the presence of *sweetgrass* throughout the Puget Sound region pre-colonization. The native weavers I talked to had been weaving and harvesting since childhood, developing a close tie to the land and ideas around land management and stewardship being installed in them from their elders at an early age. Non-native weavers whom I talked to did not start weaving until an older age, though they discussed ideas of land stewardship and a relationship as well, though this was not emphasized in the same way. All the non-native weavers I talked to grew sweetgrass on their property due to harvesting access/restrictions.

1. Growing Sweetgrass

Another way to ensure an easy access to a population of sweetgrass is to grow it oneself. This connects the weaver to the plant in a new way as it becomes a part of the home garden. The weaver can easily cultivate and watch their own stand of sweetgrass throughout the season. Based on interviews with Melinda West, Jo Hart, and other information from people who are growing sweetgrass at home, I have formulated the following planting protocol. The good news is that sweetgrass seems to grow and thrive in a wide variety of conditions.

Soil: Rich organic soil. Mulch and compost added in each year

Light: Full sun to part shade

Moisture: Varies depending on location and planting style (see below)

Maintenance: Weed throughout the season, water periodically. Site dependent

1.1 *Melinda West- Indianola, WA*

Figure 30. Melinda West (2015), submerged kiddie pool, creating wetland-like conditions

Figure 31. Melinda West (2015), pots planted with *S. pungens*, Indianola, WA.

Melinda West originally got the rhizomes from a nursery in Oshkosh, Wisconsin. She planted these rhizomes in a submerged kiddie pool in the soil to hold water and create a wetland-like environment (figure 30), as well as in pots (figure 31). One pot has drain holes and the other does not. Both pots seem to be doing well. Her plants are in both full sun and part-shade. The plants located in shade are reported to grow taller than the ones in the sun. Melinda is able to harvest enough to use for her own weaving projects.

1.2. *Jo Ann and George Hart- Seabeck, WA*

Jo Ann and George Hart have a designated garden of sweetgrass on their property. She originally planted a handful of rhizomes in her flower garden but after a few years they became so vigorous, they had the Skokomish tribal biologist remove all but a few starts for a new bed. She and her husband prepared a new bed that was in full sun and added a top dressing of organic garden mix and mulch. The native soil is acidic, mixed loam, and glacial till. It is watered approximately 1-2 times per week during the hottest part of summer. Jo Ann got her rhizome fragments when they were accidentally pulled up with harvesting when permits were al-

lowed in Bowman Basin many years ago. Jo and George are now able to harvest enough for basket making for their use and teaching classes.

Figure 32. Jo Hart (2015) Planted stand of *S. pungens*, Seebeck, WA.

D. Vegetation Survey

A total of 16 species were identified in the Nisqually Delta around throughout the growing season (Appendix XI). Plants identified at planted stands 1-3 included *Carex lyngbyei, Distichilis spicata, Cotula coronopifolia, Salicornia virginica, Triglochin maritimum, Bolboschoenus maritimus, Scheonoplectus acutus,* and *Typah latifolia.*

E. Stand Health

Stand 1 and 3 showed persistent communities of *S. pungens.* Stand 2 had no remaining *S. pungens* growing. Height of *S. pungens* averaged 1 meter during the peak of the growing season at stand 1 and 3. No *S. pungens* was found outside of the planted areas.

The NWR plantings were planted in 2011- this is their 4th year of growth. Based on the fact that 1000 plants were planted at a 1-foot spacing means that around ~1000 square feet of land was planted with S. pungens. If this is true and around half was planted at site 2 (which

experienced complete dieback), then around 500 square feet of land would have been originally planted at site 3. Currently at site 3 the plantings of *S. pungens* are interspersed with *S. maritimus* and *D. spicata*. *B. maritimus* is the predominant vegetation at site 2, where it is growing in dense stands.

Table 3. Transect Vegetation Cover (Appendix XI)

Site	Date	Time	Salinity	High tide	Low tide	0m	5 m	10m	15m	20m	25m
Transect 1	5/27/14	13:00	6 ppt	13' 6"	- 1' 6"	15%BG	20%-BG, 80% Veg-CALA, TRMA ,SCMA,POAN	100% Veg-TRMA, JUBA, SCMA, DISP	100 % Veg-TRMA, DISP , COCO	100% Veg-CRIN, POAN , TRMA , SCMA , DISP	50% VEG-TRMA , 50% dead plant mater-ial
Transect 2	5/27/14	13:00	14 ppt	13' 6"	- 1' 6"	10%BG,90 % Veg-TRMA ,COCO,DISP,SCMA	100% Veg-SCPU , DISP, SCMA ,COCO	100% Veg-SCPU, COCO, SCMA	25% dead plant ma-teri-al, 65% Veg-SCPU, COCO, DISP , 10% BG	75 % BG, 25% Veg-COCO, SAVI, DISP, SCMA	100% BG

Table 4. Vegetation identified around planted stands

Species	Stand Identified location
Carex lyngbyei	1,2,3
Distichilis spicata	1,2,3
Cotula coronopifolia	1
Salicornia virginica	1
Triglochin maritimum	1,2,3
Bolboschoenus maritimus	1,2,3
Scheonoplectus acutus	3
Typah latifolia	3

V. CONCLUSION/DISCUSSION

Despite anecdotal accounts, historical records, and scientific journal reviews that lead me to conclude that *S. pungens* used to occur in the Nisqually Delta, I was unable to find it growing in any other locations other than the planted stands. Factors contributing to the present day absence of *S. pungens* in the Nisqually Delta could be a lack of sedimentation being deposited caused by dams, or the diking of land suited to *S. pungens* prohibiting inundation and the salinity levels needed for this plant to compete with other species.

Due to the damming of the Nisqually River, sediment flowing off of Mount Rainier accumulates behind the dams instead of being transported down the river into the estuary and sound. This is problematic as the rich minerals coming from the volcanic mountain are not making their way into the delta, as well as limiting the accretion of shoreline.

Salinity strongly affects vegetation distribution in salt marshes. Within the Nisqually delta the salinity of the sites 1-3 did not vary, sitting around 0-15 ppt depending on the time of year. All three stands contain plants that are known to tolerate higher salinities. Stand 1 in particular had species known to tolerate higher salinity levels. I do not think this was a factor contributing to the decline of Stand 2 since plants seen at other sites where *S. pungens* persisted were also found. Other factors such as herbivory, which I was not given permission to measure, have potential for further study as the demise for stand 2.

A. Stand Health and Possibility of Harvest

Within the time constraint of this project is it difficult to determine if stands of *S. pungens* expanded since the time of planting. It was determined that stand 2 did not persist. Stand 1 and Stand 3 seem to be doing well based on the growth and vigor of aboveground shoots in the 2014 growing season.

Wether or not the stands are expanding at all sites is difficult to determine due to lack of data, since routine monitoring and documentation was not being done on the stands prior to this project. Cathleen Sampselle, Nisqually Indian Tribe Biologist, plans to go out this coming summer 2015 to monitor stand 1 on tribal land comparing areas to last summer 2014.

If the stand is proven to indeed be growing in area the possibility to harvest at site 1 in the near future exists as the stand is producing aboveground mass of harvestable size and quality. The main obstacle is once again access. The option of getting to the stand during high tide via canoe/boat is a good solution to the access problem of this site.

The Nisqually Wildlife Refuge, to my knowledge, has no plans to continuing monitoring the stands of sweetgrass. Though originally planted with the thought of future harvest by the Nisqually Tribe (Jesse Barham, personal communication 2015) that does not seem to be on the current agenda for the wildlife refuge. I believe this could change if Nisqually basket makers were to approach the Wildlife Refuge and establish harvesting protocol similar to what is currently in place at Gray's Harbor Wildlife Refuge. Access to this site is ideal as it is both roadside and an easy walk from the parking lot. Safety is also less of a concern at the site as it is in a much more visible location with minimal traversing of mud-flats.

While perhaps the plantings might not be located in the original locations where there used to be stands of *S. pungens,* I believe that *S. pungens* used to occur in the Nisqually Delta predike, and through these restoration efforts it will again.

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Appendix I: Estuary Classification

INTERTIDAL subsystem includes the substratum from extreme low water of spring tides to the upper limit of spray or influence of ocean-derived salts. Uses ELWS- Extreme low water of spring tides. ELWS is used instead of MLLW because of the desiccation experienced during the frequent tides falling below MLLW appears to limit the distribution of many species.
SUBTIDAL- habitat below ELWS

For Estuarine systems, we recognize four energy/enclosure categories:

Open: Shorelines exposed to moderate to long fetch and receiving some wind waves and currents, but still diluted by freshwater as defined under Estuarine.

Partially Enclosed: Bays or river mouths partially enclosed by headlands, bars, spits, or artificial obstructions reducing circulation. Minimal wave action or currents. Drift algae and sea grass often concentrate here.

Lagoon: Protected, largely enclose pond or embayment, flushed regularly or irregularly because tidal influence is partially blocked by a spit.

Channel/slough: Open or blind narrow inlets, constantly submerged and with tidal backup water at high tide. Subtidal channels are deeper areas carrying much of the water mass discharged from a river.

MODIFIERS
Tides
Backshore- areas above mean high water line of spring tides (MHWS) but still receiving matine influence, through spray or irregular flooding.
Eulittoral- Areas between MHWS and ELWS, regularly inundated and uncovered by the tides.
Depth
Shallow: 15 m or less below MLLW
Deep: deeper than 15 m below MLLW
Salinity
Hyperhaline: >40 ppt
Euhaline: 30-40 ppt
Mixohaline (brackish): .5-30 ppt
    Polyhaline: 18-30 ppt
    Mesohaline: 5-18 ppt
    Oligohaline: 0.5-5 ppt
p. 32
Estuarine Intertidal sand: partly enclosed, eulittorial, polyhaline (Marsh)

Common Habitat associated with deltas and along shorelines having some freshwater influence. Waves current, tides, or freshwater flows are sufficient to prevent siltation. Strata often have some peat or silt.
DIAGNOSTIC Species: *Distichlis spicata, Distichlis spicata-Salicornia virginica, Salicornia virginica*
Common associates: *Jaumea carnosa, Puccinellia spp., Triglochin maritimum, Glaux maritima, Spergularia spp, Palntago maritima, Stellaria humifusa*

p.33 Estuarine Intertidal Sand: PARTLY ENCLOSED EULITTORIAL, MESOHALINE (MARSH)
Bays and deltas with significant freshwater influence and high enough energy to prevent siltation. Salinities range from oligohaline to polyhaline.
These types provide great amounts of food and habitat for terrestrial and marine organisms as well as exporting large quantities of detritus to estuarine ecosystems. Animals using salt marshes range from deer and elk to voles, wolves, insects, snow geese and other birds.
Diagnostic Species: *Scirpus americanus, Carex lyngbyei*
Common associates: *Triglochin maritimum, Carex lyngbyei, Zannichellia palustrus*

p.34 ESTUARINE INTERTIDAL MIXED-FINES: PARTIALY ENCLOSED
These habitats occur in backwaters or on deltas away from large distributary channels. They consist of mixed sand and mud with small amounts of gravel or with some clay and peat. Productivity is high due to eelgrass, micro and macro algae, and salt marsh vegetation. Drift algae and seagrass may be abundant seasonally.
Diagnostic species: 4 marsh communities that occur in this habitat:
1)*Carex lyngbyei- Distichlis spicata*
2) Distichlis spicata- Salicornia virginica- Triglochin maritimum
3) Jaumea carnosa- Salicornia virginica- Triglochin maritimum
4) Salicornia virginica-Triglochin maritimum
These 4 communities occur from higher to lower in the low marsh zone with the fourth colonizing tide flats
Common associates: MARSH
These communities tend to be species rich for being low marsh. *Glaux maritima, Stellaria humifusa, Puccinellia spp., Spergularia spp. Carex lyngbyei, Triglochin concinnum, Plantago maritima,* and *Atriplex patula*

p. 37 Estuarine Intertidal Organic: Partly enclosed, backshore, polyhaline (Marsh)
This habitat is intermediate between true low and high marsh. Salinities as high as 28 ppt have been measures. it can occur as a band between high and low marsh, along the edges of tidal sloughs, or in slight depressions in the high marsh.
Diagnostic species: 1) *Deschampi caespitosa-Distichlis spicata* 2) *Deschampsis caespitosa- Distichlis spicata-Salicornia virginica.* The first community appears to occur at slightly lower salinities and higher elevations than does the second. Some incongruently occurring assemblages also fall into this intermediate habitat: *Potentila pacifica, Grindelia integrifolia, and Juncus gerardii*
Common Associates: *Deschampsia cauespitosa caespitosa-Distichilis spicata* can have no associates or any of the following: *Atriplex patula, Triglochin maritimum, Juncus balticus, Hordeum spp.*

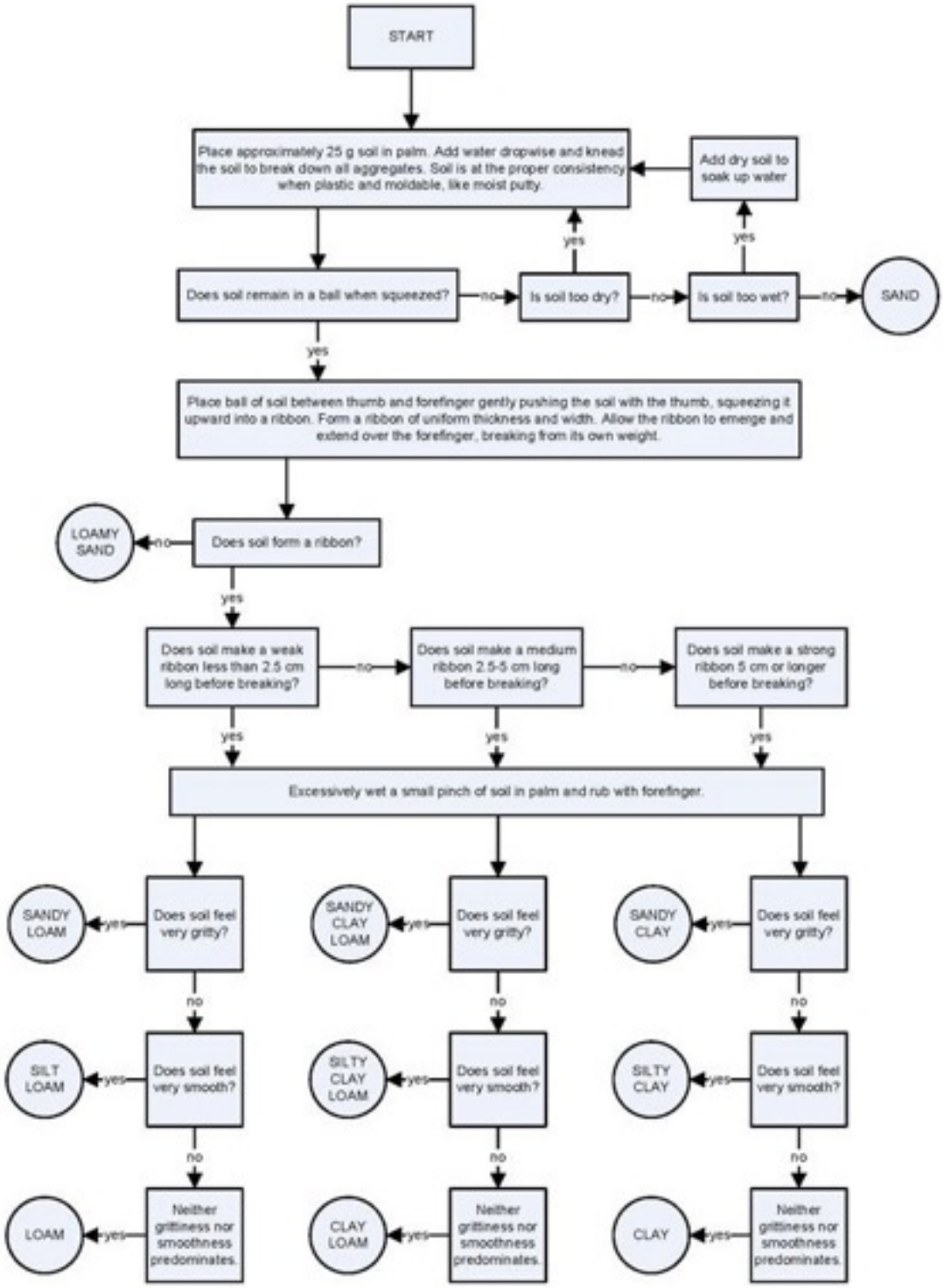
Deschampsia caespitosa-Distichlis spicata-Salicornia virginica has several associates: *Carex lyngbyei, Glaux maritima, Grindelia integrifolia, Jaumea carnosa, Triglochin maritimum, Juncus balticus, Juncus gerardii, Atriplec patula,* and *Potentilla pacifica*

Estuarine Intertidal Organic: Partly enclosed, backshore, Mesohaline (Marsh)
This habitat includes the high marsh and occurs on peat soils. Interstitial soil salinities can drop below 5 ppt.
Diagnostic Species: 4 native plant communities can occur at this habitat.

1)*Deschampsia caespitosa-Juncus balticus-Potentilla pacifica*
2)*Juncus balticus-Potentilla pacifica*
3)*Carex lyngbyei-Potentilla pacifica*
4)*Festuca rubra*

The fourth community is seldom found anymore. A fifth community is found in this habitat, but it is dominated by and exotic (non-native) plant species, *Agrostis alba.*
Common Associates: *Aster subspicatus, Triglochin maritimum, Hordeum spp.*

Appendix II: SOIL TEXTURE ANALYSIS



USGS. Modified from S.J. Thien. 1979. *A flow diagram for teaching texture by feel analysis.* Journal of Agronomic Education. 8:54-55

Appendix III- Interview Questions

Are you a weaver?
Who taught you how to weave?
Do you have a favorite material to work with?
Do you harvest sweetgrass?
If not, how do you get it?
Why do you not harvest it yourself? What obstacles stand in your way?
What is your first memory of sweetgrass?
What are some ways you were taught to identify this plant?
What are other names do you know sweetgrass by?
What are some other important plants to you that live in the estuary?
Do you have any stories or memories you would like to share?
Have you ever tried to grow sweetgrass or know anyone who has?
Do you ever notice other animals nearby when you are harvesting?

Do you harvest for yourself or for a friend/family member?
Are their any specific characteristics you look for when selecting sweetgrass to be used in weaving?
Where do you think sweetgrass grows best?

*Questions were adapted depending on background of person interviewed, but the above questions provided a framework to work in.

APPENDIX IV: Seasonal Bird Count at Nisqually Delta

Nisqually Delta Restoration Bird Abundance

The area of each circle represents the number of birds observed. A minimum area of 20 pixels has been applied for numbers from 1-19. Blue rectangles indicate highlighted species

Common Name	Sep '09	Oct '09	Nov '09	Dec '09	Jan '10	Feb '10	Mar '10	Apr '10	May '10	Jun '10	Jul '10	Aug '10	Sep '
Aleutian Cackling Goose		•	•										
American Bittern	•	•	•	•			•	•					
American Coot					•	•	•	•		•			
American Crow	•	•	•	•	•	•	•	•	•	•	•	•	•
American Golden Plover											•		
American Goldfinch	•	•	•						•	•	•	•	•
American Green-winged Teal		•	•	•	•	•	•	•	•	•			•
American Kestrel				•	•	•	•	•			•	•	•
American Pipit	•	•											
American Robin	•	•	•	•	•	•	•	•	•	•	•		•
American Wigeon	•	•	•	•	•	•	•	•	•				•
Anna's Hummingbird													•
Audubon's Yellow-rumped Warbler								•					
Baird's Sandpiper												•	
Bald Eagle	•	•	•	•	•	•	•	•	•	•	•	•	•
Band-tailed Pigeon										•	•		
Barn Swallow	•				•				•	•	•	•	•
Belted Kingfisher	•	•	•	•	•	•	•			•	•	•	•
Bewick's Wren	•	•	•	•		•	•	•	•			•	•
Black Brant													
Black Phoebe													
Black-bellied Plover													
Black-capped Chickadee	•	•	•	•	•	•		•		•	•	•	•
Black-headed Grosbeak										•			
Black-throated Gray Warbler											•	•	
Blue-winged Teal								•	•				
Bobolink													
Bonaparte's Gull													
Brewer's Blackbird								•		•			
Brown Creeper			•	•				•	•	•		•	•
Brown-headed Cowbird									•	•	•	•	
Bufflehead			•	•	•	•	•	•				•	
Bullock's Oriole									•		•		
Bushtit								•			•		
Cackling Goose		•	•	•	•	•	•	•					
California Gull			•					•				•	
Canada Goose	•	•	•	•	•	•	•	•	•	•	•	•	•
Caspian Tern	•								•	•	•	•	•
Cedar Waxwing	•	•	•						•	•	•	•	•
Chestnut-backed Chickadee													
Cinnamon Teal								•	•	•			
Cliff Swallow								•	•	•	•		
Common Goldeneye				•	•	•	•	•					
Common Merganser				•			•	•	•	•	•		
Common Raven							•					•	•
Common Snipe								•					
Common Yellowthroat	•							•	•	•	•	•	•
Cooper's Hawk	•	•	•	•								•	•
Dark-eyed Junco (Oregon race)		•		•		•							

Appendix V: Plant Propagation Protocol

Plant Propagation Protocol for *Schoenoplectus pungens* (Vahl) Palla
ESRM 412 – Native Plant Production
Protocol URL: https://courses.washington.edu/esrm412/protocols/*[USDASpeciesCode.pdf]*

Schoenoplectus pungens (Vahl) Palla, syn. Cyperus pungens (Vahl) Missbach & E.H.L.Krause, nom. ill.

TAXONOMY	
Plant Family	
Scientific Name	Cyperaceae
Common Name	Sedge
Species Scientific Name	
Scientific Name	*Schoenoplectus pungens* formerly known as *Scirpus americanus*
Varieties	*pungens*, *longispicatus* (Britt.)
Sub-species	
Cultivar	
Common Synonym(s)	
Common Name(s)	American Three-square, Sweetgrass, Basketry grass

Local habitat and abundance	Commonly associated with *Carex lambyii* (occurs at higher elevations than *S. pungens*) [3] It is usually found in standing water about 10 to 15 cm (4 to 6 in) deep, and will tolerate alkaline and saline conditions as well as freshwater. *S. pungens* can survive seasonal drought, when the water table is more than 1 m (3 ft) below the surface. It grows in fine silty clay loam to sandy loam soil [6]
Plant strategy type / successional stage	stress tolerator, both a late successional and initial community species[2]
Plant characteristics	Graminoid[1], long-lived rhizomatous perennial grass-like herb. The stems are sharply triangular with the sides being slightly concave to slightly convex. The flowering stems can be 10 to 180 cm (4 in to 6 ft) tall. The leaves are basal, v-shaped and 5 to 75 cm (2 to 30 in) long. The inflorescence is a tight terminal cluster of 1 to 5 orange to brown spikelets subtended by a green leaf-like bract. Fruits are small, brown, lenticular achenes surrounded by four to six barbed bristles. [6]
PROPAGATION DETAILS	
Ecotype	
Propagation Goal	Plants
Propagation Method	Seed
Product Type	container plug [6]
Stock Type	
Time to Grow	
Target Specifications	large enough to compete with a root structure to hold plants in place
Propagule Collection Instructions	Collect seed at the end of summer season (July-August) Seeds persist in seed head for a couple of months if not disturbed. Seeds may be collected by hand or with a power seed harvester. [6]
Propagule Processing/Propagule Characteristics	~216,000 seeds per pound [6]

Pre-Planting Propagule Treatments	Clean and process seeds removing chaff. This can be done mechanically by rubbing seed heads to remove outer protective sheath. A hammer mill can be used to knock the seeds from the stem. Cleaning seed can be done by hand or with a No. 7 screen top screen and a 1/20 bottom screen. Blow chaff away. [6] Seed germination is difficult. When collecting seeds make sure spikelets feel "full" and have developed. The germination rate may be enhanced by light scarification and wet pre-chilling the seeds in a mixture of water and sphagnum moss at 2C for 30 days.[6]
Growing Area Preparation / Annual Practices for Perennial Crops	After pre-chilling, place seeds in the soil surface in containers or flats and provide light, moisture and heat for germination. Press seed into soil surface very lightly and do not cover seed. Plants with desiccate if the soil dries out, and will fail to germinate. [6]
Establishment Phase Details	Germination should begin in a few weeks. maintain moisture. [6]
Length of Establishment Phase	2-3 weeks [6]
Active Growth Phase	early spring to mid summer
Length of Active Growth Phase	
Hardening Phase	
Length of Hardening Phase	
Harvesting, Storage and Shipping	
Length of Storage	
Guidelines for Outplanting / Performance on Typical Sites	

Species Code (as per USDA Plants database)	SCPU10
GENERAL INFORMATION	
Geographical range	Found throughout North America. It can also be found in South America, Europe, Australia and New Zealand [6] 
	 Distrubution in Washington State [5]
Ecological distribution	estuaries, freshwater and brackish marshes [2] *S. pungens* is found in flood plains, ditches, streams and marshy areas and along margins of ponds and lakes [1,6]
Climate and elevation range	low elevations [3,6]

Other Comments	When wild plants are collected for transplanting, no more than 1 ft^2 x 6 in deep should be removed from any 1 yd^2 area. The hole will fill back in within one growing season. Care should be taken not to collect plants from weedy areas as these weeds can be relocated to the transplant site. In addition, the hole left at the collection site may fill in with undesirable species. Planting plugs (either from the greenhouse or wild transplants) is the surest way to establish a new stand of this species. Plug spacing of 30 to 45 cm (12 to 18 in) will fill in within one growing season. Soil should be kept saturated. Case Study: The Skokomish Tribe uses a modified clam gun to gather wild transplants from Bowerman Basin, Washington. The clam gun consists of a piece of automotive tailpipe with a T-handle and a siphon hole drilled on the top (Dublanica pers. comm. 1999). The edges are sharpened and make a clean cut with the tube approximately 30 cm (1 ft) long and 8 cm (3 in) in diameter. Three to twelve tillers are recovered per plug extraction. Transplant success was highest in borrow pits within the diked complex at the Skokomish River where *Schoenoplectus* remnants were already growing. *S. pungens* is managed for ethnobotanic uses by reducing the density between plants to stimulate shoot production. Fire was used historically to manage *Schoenoplectus* dominated wetlands in some areas. Due to the loss of estuarine wetland habitat throughout the United States, it is rarely appropriate to harvest wild plants in those areas. Wild plant collecting should be restricted to salvage sites with appropriate approvals or permits. *S. pungens* populations are declining due to loss of habitat and commercial use.
INFORMATION SOURCES	
References	See Below
Other Sources Consulted	See Below
Protocol Author	Alexandra Harwell
Date Protocol Created or Updated	05/15/2014

References

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3. Ewing, Kern. Plant Growth and Productivity Along Complex Gradients in a Pacific Northwest Brackish Intertidal Marsh. *Estuaries*. Vol 9, No 1, p. 49-62. March 1986.
4. Poor, Allison, Chad Hershock, Kristin Rosella and Deborah E. Goldberg. Physiological Integration and Soil Heterogeneity Influence the Colonial Growth of *Schoenoplectus pungens*? *Plant Ecology*, Vol. 181, No. 1 (2005), pp.45-56.
5. USDA Plant Database. *Schoenoplectus pungens*. Natural Resources Conservation Service. http://plants.usda.gov/core/profile?symbol=scpu10
6. USDA. Plant Guide: Common Three Square. http://plants.usda.gov/plantguide/pdf/pg_scpu10.pdf

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8. Crandell, Caren. Is Sweetgrass (*Schoenolectus pungens*, Formerly *Scirpus americanus*) on the Decline? University of Washington. 2012. Poster http://depts.washington.edu/hortlib/student_research/2012/Crandell_SweetgrassDecline_2012.pdf
9. Native Plant Center. *Schoenoplectus pungens var. pungens*. http://www.nativeplantcenter.net/?q=plants/791
10. Robert W. Freckmann Herbarium. University of Wisconsin. http://wisplants.uwsp.edu/scripts/detail.asp?SpCode=SCHPUN

APPENDIX VI: Field Notes from Grays Harbor

Field Notes-Grays Harbor 7/19/14 @ 12:00
Site 1:
Cool, cloudy, geese present
low tide
salinity 1-15
large stand of S> pungens
pacific silverweed, carex lyngbyi
gravelly soil
lower salinity -> taller stands
S. pungens taller closer to road
smaller and yellower closer to water
daytime lows in sept. higher salinity, spring lower salinity

Salinity in the early growing season affects growth (what will grow)
Salinity affects plant growth
plant grows shorter and more sense with more sediment and age
young stands are taller
stands have expanded out (accretion)
High energy environment
c. lyngbyi- associated with fresh water
eel grass- Z. japoinica-non native
effect on sweetgrass?
weavers prefer tall and thin
12-25 cm root depth-rhizome mat
possible expansion west along shore
chioniouse creek -> large population of s. pungens north west of site 1

East of entry point
C. lymbei populations larger due to lower salinity, saltgrass, dischampsia, jamea

Sie 2- tressel site
some transects lost to erosion
further south east of site 1
higher elevation contributed to construction of airport
Depressions- remnants of old logs, find only sweetgrass growing, stronger and robust
Spartina native to east coast
Triglochlin present

Harvest: cutting v. pulling
physiological response
-pull a group at a time, go home to grade material

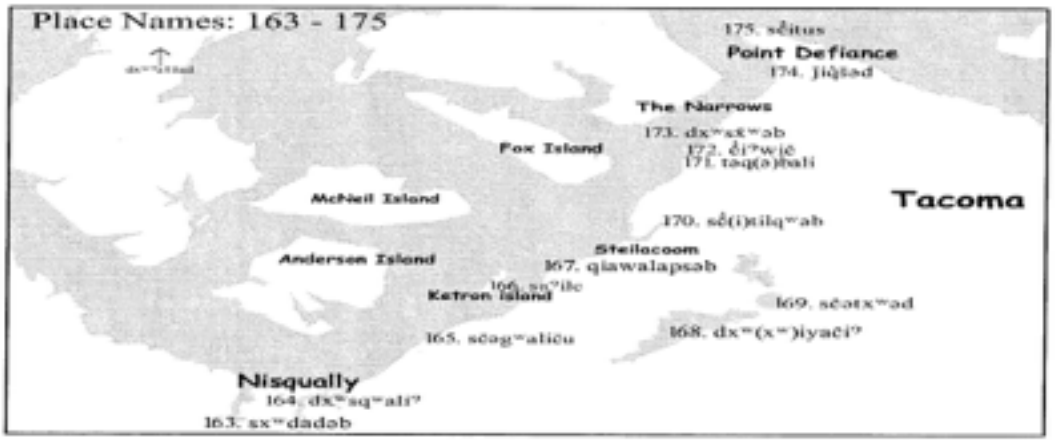
Higher elevation- more organic matter in substrate- fine driftwood, wrack settles
low ph, low salinity
S. maritimus clumps, shallow pans,
shaded area preferred for more supple SCPU
Hummocks present
Site 3- airport
original monoculture stands- now dischampsia and salicornia have come in,
used to be bare sand.

APPENDIX VII: Nisqually Place Names. (T.T. Waterman 1920)

NAMES OF PLACES ON THE SOUTHERN SHORE OF THE SOUND FROM JOHNSON POINT TO THE VICINITY OF TACOMA

[Map 9.11, place names 162 - 175]

Map 10.11



163 Sxuda'dap for McAllister Creek entering the Sound on the west side of Nisqually Flats. This means "place where they get a form of spirit power." The power referred to is the xuda'b, discussed by Haeberlin and later by myself, which enables a shaman to visit the underworld and recover lost souls.

164 ^{Tu}sqwE'le "late," for the old village site at the mouth of the Nisqually River. The run of salmon was said to be later in the Nisqually than in any other stream. The people there would be engaged in taking and curing salmon after they were gone from the other rivers. The present Anglicized name Nisqually represents this old term, somewhat distorted.

APPENDIX VIII: Timeline of events impacting Nisqually River , Post-contact

Nisqually People inhabit the land since time immemorial. Extensive knowledge and relationship with the area. Large and many village sites established along the Nisqually River.
1792- Vancouver aboard Discovery, first British expedition to explore Puget Sound. The closest they came to Nisqually Delta was camping overnight on the eastern shore of Anderson Island.
1824- Hudson Bay Company establishes Fort George on Columbia River and Fort Langley on the Fraser River- Nisqually Delta in between the two lines of trade.
1833- Archibald McDonald choses site near the mouth of the Nisqually for a fort and trading post.
1839-Puget's Sound Agricultural Company (PSAC). 13 families from England arrive at Nisqually, only one stays after the first year.
1841- Wilkes Expedition, first American Expedition to the area
1845- James McAlliser family settled in Nisqually area at the confluence of Medicine Creek.
1847- Two more american families settle- George Shazer family (west bank of the Nisqually River) and William Packwood (established a ferry across the Nisqually River).
1850- Donation Land Law- allowed every mile settle who had occupied and cultivated land for our consecutive years prior to December 1, 1850 to claim 320 acres of land, if married women could claim an equal amount in their own name. These tittles to the land could not be granted until Indians are persuaded to sign treaties relinquishing ownership of territory to the U.S.
1853- Washington Territory established- Isaac Stevens becomes governor.
1854- Medicine Creek Treaty
1854-1856- Treaty Wars (also known as the Indian Wars)
1958- Leschi Executed
1904- Brown Farm established- Four mile dike built around property to exclude tide.
1906- Fort Nisqually purchased for explosives manufacturing plant
1912- Northern Pacific Railway Company builds railway running through the estuary. Diversion Dam installed
1917- Land appropriated for the Fort Lewis Military Reservation, U.S. Army moves onto Nisqually Land
1924- Dike at Brown Farm built higher and reinforced. Indian Citizenship Act
1934- Indian Reorganization Act
1945- La Grande and Alder Dam built on Nisqually River
1971- Nisqually Delta designated as a Natural Landmark (excluding diked areas)
1974- National Wildlife Refuge established on west side of Nisqually River after purchase of the U.S. Government of the Brown Farm Property. Boldt Decision regarding Fishing Rights.
1996-Nisqually tribe purchases Braget farm, section of dike removed as pilot
2009- Large scale dike removal begins in the Nisqually Estuary, *S. pungens* planted in Nisqually Wildlife Refuge (West side of Nisqually River)
2010- Meander restored to Ohop Creek, a tributary of the Nisqually River
2011- Last of the remaining dike along Nisqually River Removed
2013- *S. pungens* planted on Nisqually Tribal lands (east side of Nisqually River)

APPENDIX IX. Treaty of Medicine Creek

TREATY WITH THE NISQUALLI, PUYALLUP, ETC., 1854.

Dec. 26, 1854. | 10 Stat., 1132. | Ratified Mar. 3, 1855. | Proclaimed Apr. 10, 1855.

Articles of agreement and convention made and concluded on the She-nah-nam, or Medicine Creek, in the Territory of Washington, this twenty-sixth day of December, in the year one thousand eight hundred and fifty-four, by Isaac I. Stevens, governor and superintendent of Indian affairs of the said Territory, on the part of the United States, and the undersigned chiefs, head-men, and delegates of the Nisqually, Puyallup, Steilacoom, Squawskin, S"Homamish, Stehchass, T" Peek-sin, Squi-aitl, and Sa-heh-wamish tribes and bands of Indians, occupying the lands lying round the head of Puget"s Sound and the adjacent inlets, who, for the purpose of this treaty, are to be regarded as one nation, on behalf of said tribes and bands, and duly authorized by them.

ARTICLE 1.

The said tribes and bands of Indians hereby cede, relinquish, and convey to the United States, all their right, title, and interest in and to the lands and country occupied by them, bounded and described as follows, to wit: Commencing at the point on the eastern side of Admiralty Inlet, known as Point Pully, about midway between Commencement and Elliott Bays; thence running in a southeasterly [*662] direction, following the divide between the waters of the Puyallup and Dwamish, or White Rivers, to the summit of the Cascade Mountains; thence southerly, along the summit of said range, to a point opposite the main source of the Skookum Chuck Creek; thence to and down said creek, to the coal mine; thence northwesterly, to the summit of the Black Hills; thence northerly, to the upper forks of the Satsop River; thence northeasterly, through the portage known as Wilkes"s Portage, to Point Southworth, on the western side of Admiralty Inlet; thence around the foot of Vashon"s Island, easterly and southeasterly, to the place of beginning.

ARTICLE 2.

There is, however, reserved for the present use and occupation of the said tribes and bands, the following tracts of land, viz: The small island called Klah-che-min, situated opposite the mouths of Hammersley"s and Totten"s Inlets, and separated from Hartstene Island by Peale"s Passage, containing about two sections of land by estimation; a square tract containing two sections, or twelve hundred and eighty acres, on Puget"s Sound, near the mouth of the She-nah-nam Creek, one mile west of the meridian line of the United States land survey, and a square tract containing two sections, or twelve hundred and eighty acres, lying on the south side of Commencement Bay; all which tracts shall be set apart, and, so far as necessary, surveyed and marked out for their exclusive use; nor shall any white man be permitted to reside upon the same without permission of the tribe and the superintendent or agent. And the said tribes and bands agree to remove to and settle upon the same within one year after the ratification of this treaty, or sooner if the means are furnished them. In the mean time, it shall be lawful for them to reside upon any ground not in the actual claim and occupation of citizens of the United States, and upon any ground claimed or occupied, if with the permission of the owner or claimant. If necessary for the public convenience, roads may be run through their reserves, and, on the other hand, the right of way with free access from the same to the nearest public highway is secured to them.

ARTICLE 3.

The right of taking fish, at all usual and accustomed grounds and stations, is further secured to said Indians in common with all citizens of the Territory, and of erecting temporary houses for the purpose of curing, together with the privilege of hunting, gathering roots and berries, and pasturing their horses on open and unclaimed lands: Provided, however, That they shall not take shellfish from any beds staked or cultivated by citizens, and that they shall alter all stallions not intended for breeding-horses, and shall keep up and confine the latter.

ARTICLE 4.

In consideration of the above session, the United States agree to pay to the said tribes and bands the sum of thirty-two thousand five hundred dollars, in the following manner, that is to say: For the first year after the ratification hereof, three thousand two hundred and fifty dollars; for the next two years, three thousand dollars each year; for the next three years, two thousand dollars each year; for the next four years fifteen hundred dollars each year; for the next five years twelve hundred dollars each year; and for the next five years one thousand dollars each year; all which said sums of money shall be applied to the use and benefit of the said Indians, under the direction of the President of the United States, who may from time to time determine, at his discretion, upon what beneficial objects to expend the same. And the superintendent of Indian affairs, or other proper officer, shall each year inform the President of the wishes of said Indians in respect

thereto.

ARTICLE 5.

To enable the said Indians to remove to and settle upon their aforesaid reservations, and to clear, fence, and break up a sufficient quantity of land for cultivation, the United States further agree [*663] to pay the sum of three thousand two hundred and fifty dollars, to be laid out and expended under the direction of the President, and in such manner as he shall approve.

ARTICLE 6.

The President may hereafter, when in his opinion the interests of the Territory may require, and the welfare of the said Indians be promoted, remove them from either or all of said reservations to such other suitable place or places within said Territory as he may deem fit, on remunerating them for their improvements and the expenses of their removal, or may consolidate them with other friendly tribes or bands. And he may further, at his discretion, cause the whole or any portion of the lands hereby reserved, or of such other land as may be selected in lieu thereof, to be surveyed into lots, and assign the same to such individuals or families as are willing to avail themselves of the privilege, and will locate on the same as a permanent home, on the same terms and subject to the same regulations as are provided in the sixth article of the treaty with the Omahas, so far as the same may be applicable. Any substantial improvements heretofore made by any Indian, and which he shall be compelled to abandon in consequence of this treaty, shall be valued under the direction of the President, and payment be made accordingly therefor.

ARTICLE 7.

The annuities of the aforesaid tribes and bands shall not be taken to pay the debts of individuals.

ARTICLE 8.

The aforesaid tribes and bands acknowledge their dependence on the Government of the United States, and promise to be friendly with all citizens thereof, and pledge themselves to commit no depredations on the property of such citizens. And should any one or more of them violate this pledge, and the fact be satisfactorily proved before the agent, the property taken shall be returned, or in default thereof, or if injured or destroyed, compensation may be made by the Government out of their annuities. Nor will they make war on any other tribe except in self-defence, but will submit all matters of difference between them and other Indians to the Government of the United States, or its agent, for decision, and abide thereby. And if any of the said Indians commit any depredations on any other Indians within the Territory, the same rule shall prevail as that prescribed in this article, in cases of depredations against citizens. And the said tribes agree not to shelter or conceal offenders against the laws of the United States, but to deliver them up to the authorities for trial.

ARTICLE 9.

The above tribes and bands are desirous to exclude from their reservations the use of ardent spirits, and to prevent their people from drinking the same; and therefore it is provided, that any Indian belonging to said tribes, who is guilty of bringing liquor into said reservations, or who drinks liquor, may have his or her proportion of the annuities withheld from him or her for such time as the President may determine.

ARTICLE 10.

The United States further agree to establish at the general agency for the district of Puget"s Sound, within one year from the ratification hereof, and to support, for a period of twenty years, an agricultural and industrial school, to be free to children of the said tribes and bands, in common with those of the other tribes of said district, and to provide the said school with a suitable instructor or instructors, and also to provide a smithy and carpenter"s shop, and furnish them with the necessary tools, and employ a blacksmith, carpenter, and farmer, for the term of twenty years, to instruct the Indians in their respective occupations. And the United States further agree to employ a physician to reside at the said central agency, who shall furnish medicine and advice to their sick, and shall vaccinate them; the expenses of the said school, shops, employéées, and medical attendance, to be defrayed by the United States, and not deducted from the annuities.

[*664]

ARTICLE 11.

The said tribes and bands agree to free all slaves now held by them, and not to purchase or acquire others hereafter.

ARTICLE 12.

The said tribes and bands finally agree not to trade at Vancouver"s Island, or elsewhere out of the dominions of the United States; nor shall foreign Indians be permitted to reside in their reservations without consent of the superintendent or agent.

ARTICLE 13.

This treaty shall be obligatory on the contracting parties as soon as the same shall be ratified by the President and Senate of the United States.

In testimony whereof, the said Isaac I. Stevens, governor and superintendent of Indian Affairs, and the undersigned chiefs, headmen, and delegates of the aforesaid tribes and bands, have hereunto set their hands and seals at the place and on the day and year hereinbefore written.

Isaac I. Stevens, [L. S.]
Governor and Superintendent Territory of Washington.

Qui-ee-metl, his x mark. [L. S.]
Sno-ho-dumset, his x mark. [L. S.]
Lesh-high, his x mark. [L. S.]
Slip-o-elm, his x mark. [L. S.]
Kwi-ats, his x mark. [L. S.]
Stee-high, his x mark. [L. S.]
Di-a-keh, his x mark. [L. S.]
Hi-ten, his x mark. [L. S.]
Squa-ta-hun, his x mark. [L. S.]
Kahk-tse-min, his x mark. [L. S.]
Sonan-o-yutl, his x mark. [L. S.]
Kl-tehp, his x mark. [L. S.]
Sahl-ko-min, his x mark. [L. S.]
T"bet-ste-heh-bit, his x mark. [L. S.]
Tcha-hoos-tan, his x mark. [L. S.]
Ke-cha-hat, his x mark. [L. S.]
Spee-peh, his x mark. [L. S.]
Swe-yah-tum, his x mark. [L. S.]
Cha-achsh, his x mark. [L. S.]
Pich-kehd, his x mark. [L. S.]
S"Klah-o-sum, his x mark. [L. S.]
Sah-le-tatl, his x mark. [L. S.]
See-lup, his x mark. [L. S.]
E-la-kah-ka, his x mark. [L. S.]
Slug-yeh, his x mark. [L. S.]
Hi-nuk, his x mark. [L. S.]
Ma-mo-nish, his x mark. [L. S.]
Cheels, his x mark. [L. S.]
Knutcanu, his x mark. [L. S.]
Bats-ta-kobe, his x mark. [L. S.]
Win-ne-ya, his x mark. [L. S.]
Klo-out, his x mark. [L. S.]
Se-uch-ka-nam, his x mark. [L. S.]
Ske-mah-han, his x mark. [L. S.]
Wuts-un-a-pum, his x mark. [L. S.]
Quuts-a-tadm, his x mark. [L. S.]
Quut-a-heh-mtsn, his x mark. [L. S.]
Yah-leh-chn, his x mark. [L. S.]
To-lahl-kut, his x mark. [L. S.]
Yul-lout, his x mark. [L. S.]
See-ahts-oot-soot, his x mark. [L. S.]
Ye-takho, his x mark. [L. S.]
We-po-it-ee, his x mark. [L. S.]
Kah-sld, his x mark. [L. S.]
La"h-hom-kan, his x mark. [L. S.]
Pah-how-at-ish, his x mark. [L. S.]
Swe-yehm, his x mark. [L. S.]
Sah-hwill, his x mark. [L. S.]
Se-kwaht, his x mark. [L. S.]
Kah-hum-klt, his x mark. [L. S.]
Yah-kwo-bah, his x mark. [L. S.]
Wut-sah-le-wun, his x mark. [L. S.]
Sah-ba-hat, his x mark. [L. S.]
Tel-e-kish, his x mark. [L. S.]

Swe-keh-nam, his x mark. [L. S.]
Sit-oo-ah, his x mark. [L. S.]
Ko-quel-a-cut, his x mark. [L. S.]
Jack, his x mark. [L. S.]
Keh-kise-bel-lo, his x mark. [L. S.]
Go-yeh-hn, his x mark. [L. S.]
Sah-putsh, his x mark. [L. S.]
William, his x mark. [L. S.]
Executed in the presence of us— —
M. T. Simmons, Indian agent.
James Doty, secretary of the commission.
C. H. Mason, secretary Washington Territory.
W. A. Slaughter, first lieutenant, Fourth Infantry.
James McAlister,
E. Giddings, jr.
George Shazer,
Henry D. Cock,
S. S. Ford, jr.,
John W. McAlister,
Clovington Cushman,
Peter Anderson,
Samuel Klady,
W. H. Pullen,
P. O. Hough,
E. R. Tyerall,
George Gibbs,
Benj. F. Shaw, interpreter,
Hazard Stevens.

APPENDIX X: USGS Soil Survey Legend

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Joint Base Lewis-McChord Area, Washington, Parts of Pierce and Thurston Counties
Survey Area Data: Version 4, Sep 30, 2014

Soil Survey Area: Pierce County Area, Washington
Survey Area Data: Version 9, Sep 16, 2014

Soil Survey Area: Thurston County Area, Washington
Survey Area Data: Version 6, Sep 30, 2014

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 9, 2010—Aug 20, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

APPENDIX XI: Vegetation

Site ID	Location (east/west of river)	Date	Time	weather	Salinity (ppt)	Soil	Elevation	High Tide	Low Tide	Plant/Species	Height	Notes
North entrance by first metal foot bridge	east	4/29/14	11:00		15 ppt			13' 9"	-1' 4"	DISP, SAVI		
North entrance ~150 ft out, 1st wood bridge	east	4/29/14	11		17 ppt			13' 9"	-1' 4"	CALY, GRIN		
near main channel foot bridge directly south of entrance	east	4/29/14	11:00		15			13' 9"	-1' 4"	DISP, GRIN		
near wooden post, main channel se of entrance	east	4/29/14	11:00		15			13' 9"	-1' 4"	SAVI		
walking out to s. pumpkins dikes	east	5/19/14	11		15			14' 4"	-1' 6"	SASPP, TRWO		
stand 1	east	5/19/14	11		12 ppt, 14 ppt			14' 4"	-1' 6"	SCMA, CALY, SCMI		
Grays Harbor	NA	7/15/14	12	cool, cloudy	0-15	gravelly		10'	4' 11"			
Skagit River	NA	8/15/14	11:25	overcast drizzle				14'	1' 5"	CALY, POAN, SCAC, SCPU		
Stand 1- across channel	east	8/19/14						12'	8"	SCMI, SCMA, TRMA	2' 10", 3'	Planted a foot apart
Stand 2	east	8/19/14						12'	8"	SAVI, SCMA	3'8"	
Stand 3- south of stand 2	east	8/19/14						12'	8"		3'	large stand with small tufts, mostly blue/green vegetation
Small tufts	east	8/19/14						12'	8"		4'	3 little sections off of main-tallest populations
Nisqually Tribal Land along the river, 47.086 Lat, 122.724 long	east	10/16/14						12' 6"	2' 11"	TYLA, SCMI, DISP, SCAC		361 m^2
Site 1	east	1/24/15	13:00		10 ppt, 7 ppt			7:52 , +19' 10"	2:00, 3'7"			King tide
NWR site near entrance, ~ 7 m away from gravel dike	west	2/2/15	10:30	cloudy, drizzly	4ppt, 3 ppt,	sandy clay		14' 1"	-0' 4"			
NWR site near entrance inbetween road and slough	west	2/2/15		cloudy, drizzly	0ppt, 5 ppt			14' 1"	-0' 4"			
NWR site near entrance, slough	west	2/2/15		cloudy, drizzly	0 ppt			14' 1"	-0' 4"			
NWR site close to sound	west	2/2/15	1:00	cloudy, drizzly	0-2 ppt			14' 1"	-0' 4"	TYLA, DISP, SOMA		
nisqually site 1	east	2/20/15	1:00	overcast, low tide	10, 8, 0			10' 4"	-1'			
Nisqually Site 1	east	4/8/15	3:00	sunny, low tide	10ppt			12' 4"	- 0' 2"	TRMA, SCPU	6'	

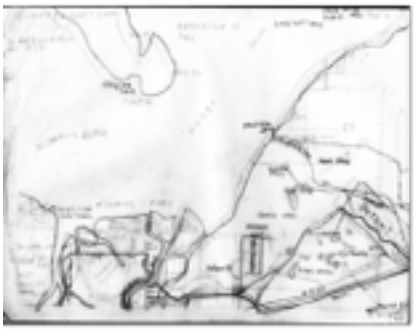
Code	Genus	species	common name	Lashootseed (Thompson)
BG	Bare ground			
VEG	herbaceous vegetation			
CALA	Carex	lyngbeyi	Lyngbyei's sedge	
POAN	Potentilla	anserina	pacific silver weed	s~'Iko'sab
TRMA	Triglochin	maritima	Seaside arrow grass	stu'?a'la
SCMA	Scirpus (Bolboschoenus)	maritima	Saltmarsh bullrush	
COCO	Cotula	coronopifolia	Brass buttons	
DISP	Distichilis	spicata	salt grass	
JUBA	Juncus	balticus	Baltic rush	sllewa' łkut
GRIN	Grindellia	integrifolia	gum weed	
SAVI	Salicornia	virginica	pickle weed	
SASPP	Salix	spp.	willow	
TRWO	Trifolium	wormskjoldii	clover	
SCMI	Scirps	microcarpus	small fruit bullrush	
SCAC	Schoenoplectus	acutus	tule	
OESA	Oenanthe	sarmentosa	water parsley	
SCPU	Schoenoplectus	pungens	sweetgrass	ka'qsxw
TYLA	Typha	latifolia	cattail	suweła'łqut
SALA	Sagittaria	latifolia	wapato	spi'aqo.' ?oc

APPENDIX XII: Sweetgrass (S. pungens) Baskets from Burke Museum Collection

Courtesy of the Burke Museum of Natural History and Culture, catalog number 2.5e1175, and 2.5e1618

Appendix XIII: Historical Maps

Metsker Maps 1924-1986



Wilkes Expedition 1846