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VEGETATION OF THE NISQUALLY DELTA

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ABSTRACT

A study was done of the basic vegetation communities of the Nisqually Delta Wildlife Refuge and bordering marshlands. The landscape was divided into five main areas: inner Delta, dike, McAllister Creek marsh, Front Delta and Nisqually River marsh. The inner delta is mainly comprised of grasslands or slough regions, the dike of shrubs or deciduous forest, the McAllister Creek marsh and Front Delta of salt water vegetation and the Nisqually River marsh of freshwater species.

INTRODUCTION

Comparatively little work has been done on salt marsh vegetation on the west coast. Our purpose was to identify and map major vegetation habitat types of the newly formed wildlife refuge as well as adjacent marshland. We hope our work will provide a foundation for further studies of salt marsh vegetation as well as its role as the basis of the food chain. We provided the Nisqually Delta Laboratory with a basic map for display and use by future environmental education programs.

LITERATURE REVIEW

Most previous work on salt-marsh vegetation has been done in the eastern United States and Europe (Chapman 1964 and Ranwell 1972). Many species in England seem to be similar to those found on eastern marshes of the United States; those of the west coast tend to be different. Salicornia (pickleweed) comprises a primary community, not only on the sandy western marshes, but also on the muddy flats of the southern and southeastern coasts. Several species, both perennial and annual, can be found throughout the world in marshes of temperate climates. One reason for its abundance is that its seeds can germinate in water that is far saltier than seawater. As a result of this adaptation, it can colonize even the tops of sandbanks, where evaporation has concentrated the salt content of the soil.

Spartina dominates the grasslands, S. townsendii being found on the southern, southeastern, and eastern coasts. It thrives in this environment because of its ability to excrete excess salt from its system through the stomata. On the sandier marshes to the west, it is replaced by either Puccinellia maritima (sea poa) or Festuca rubra (red fescue).

The marshes of the eastern United States have been described by John and Mildred Teal (1969). Salicornia and two species of Spartina dominate the salt marsh environments. S. alternifolia is the larger, growing to ten feet. It is a coarse grass that grows in dense stands and thrives in a rigorous, salty habitat. The other type, S. patens, is a small, finer grass that forms a carpet on the grasslands. Its stands grow no taller than two feet.

Marshes to the far north (Teal and Teal 1969), such as those found in Arctic Canada, are generally dominated by grasses, the principal species being Puccinellia phryganodes. No trees have adapted to life in these regions because the winter winds and icy tides would cut off newly established seedlings.

From Florida to the tropics (Teal and Teal 1969), the Spartina flats are replaced by mangrove swamps. Black mangrove (Avicennia nitida) and red mangrove (Rhizophora mangle) average about twenty feet tall, with a trunk of about four to eight inches in diameter, although further south they can grow to be as much as eighty feet tall. Mangroves dominate the area by crowding, and also by preventing light from reaching the shorter species.

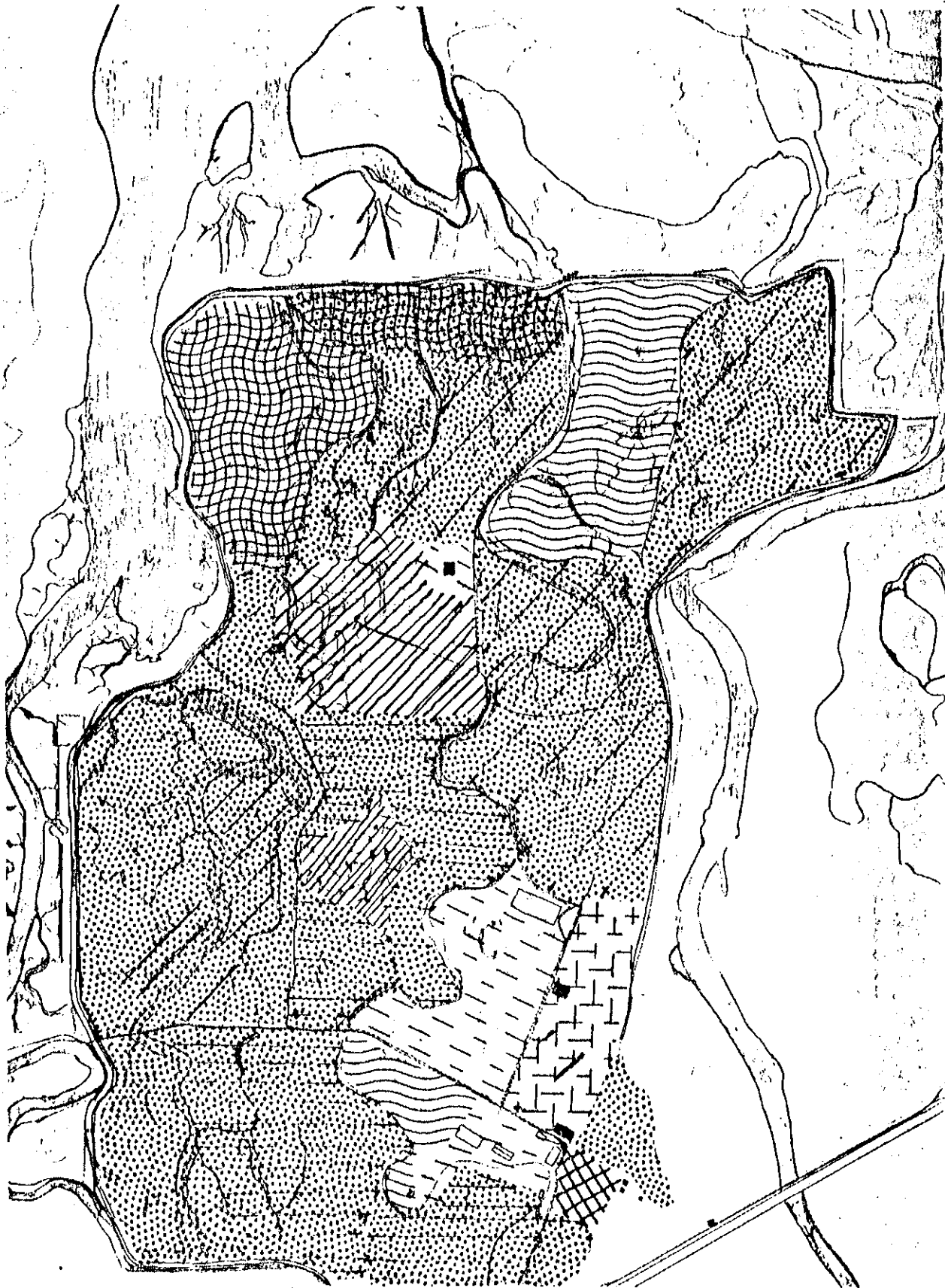
A great deal of research has been done at Bodega Head, California (Barbour et al. 1973). The salt marsh plants, such as Distichlis (salt grass) and Salicornia, are essentially the same as those found on the Nisqually Delta. About one third of the grassland plants are forms that have been introduced from Europe during the past two hundred years. Italian ryegrass and lupine are most dominant, with an abundance of herbs such as golden yarrow, seaside daisy, and buttercup. These plants differ from the characteristic species found in our study.

The most significant work on Delta vegetation was done by Helen Ulmschneider. In the summer of 1974 she collected and pressed samples of all plants found there, as well as writing a brief paper and compiling a comprehensive plant list (see Appendix C).

Figure 1. Major Roads and Buildings of Nisqually Delta



Figure 2. Vegetation of the Inner Delta



Legend for Figure 2.

Legend

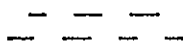


Dominant Species

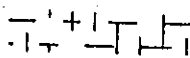
A. alba, A. repens
H. lanatus



L. corniculatus, R. repens



C. arvense, R. crispus,
A. repens, D. glomerata



Juncus sp., C. lyngbyei



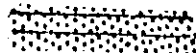
Domestic apple and pear
orchard (Pyrus spp.)



A. geniculatus, P. pra-
tense, A. alba



Juncus sp., H. lanatus



F. rubra, H. lanatus, A.
repens

T. latifolia, J. effusus,
C. lyngbyei



A. alba

Secondary Species

Juncus sp., L. corniculatus,
P. fusca

Trifolium sp., Juncus sp.

E. angustifolium, Trifolium sp.

A. repens, A. alba, R. repens

D. glomerata, C. arvense

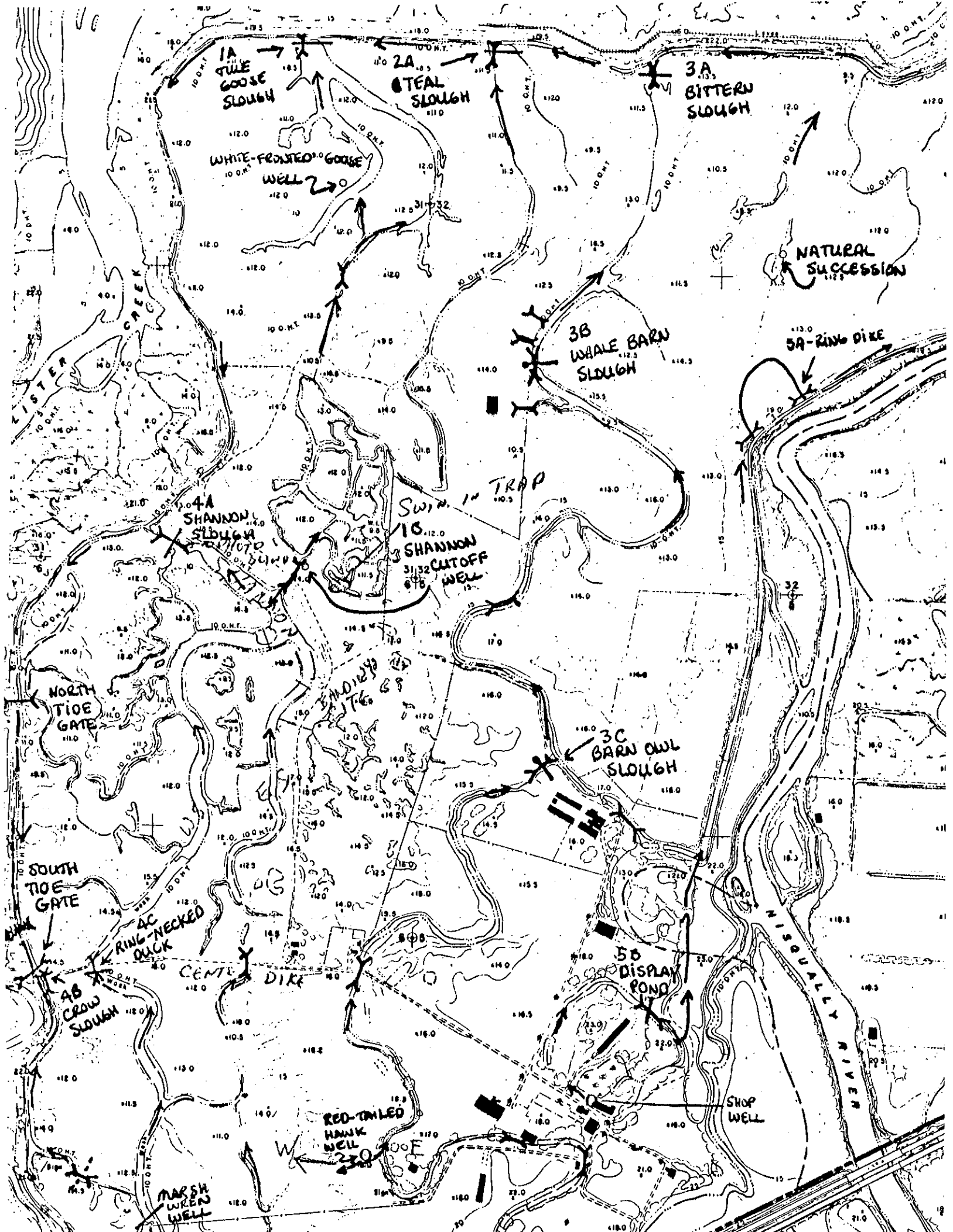
D. spicata, C. lyngbyei, J. effusus

R. repens

Juncus sp.

J. balticus, R. repens, S. mariti-
mus

A. repens



1A TULE GOOSE SLOUGH

2A TEAL SLOUGH

3A BITTERN SLOUGH

WHITE-FRONTED GOOSE WELL

3B WHALE BARN SLOUGH

NATURAL SUCCESSION

5A-RING DIKE

4A SHANNON SLOUGH

SWAMP TRAP

SHANNON CUTOFF WELL

3C BARN OWL SLOUGH

NORTH TIE GATE

SOUTH TIE GATE

5A RING DUCK

4B CROW SLOUGH

CENTRE DIKE

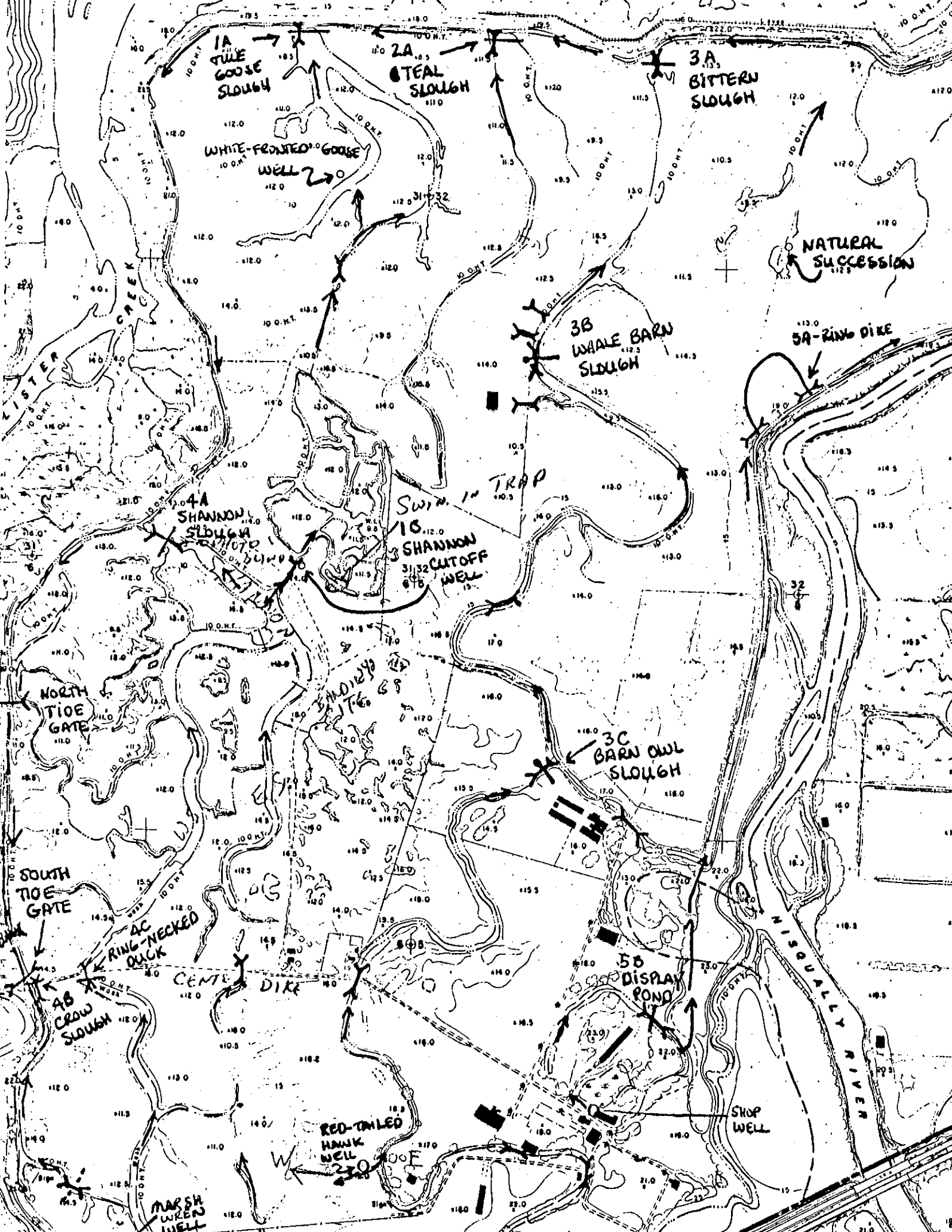
5B DISPLAY POND

RED-TAILED HAWK WELL

SHOP WELL

MARSH WREN WELL

NISKALLY RIVER



METHODS AND PROCEDURES

It is important to become familiar with the landscape to be studied in any project of this kind. We spent the first week in the field taking notes and observing the different plant species. We then needed to become familiar with them so we collected samples which were identified with the help of various floral keys (Gilkey and Dennis 1973; Hitchcock 1950; Hitchcock and Cronquist 1973; Hitchcock et al. 1969) and the Nisqually Delta Laboratory Herbarium.

Accurate notes regarding what kinds of vegetation were found, and careful estimates of quantities were essential to our project. We found that it was helpful to carry a small map of the Delta so that different vegetation communities could be easily marked. When interpreting our notes for the final maps, aerial photographs were found to be the best resource, as they enabled us to discern the size of the communities and their exact location.

Because we had been informed (Ulmschneider 1974) that grassland vegetation deteriorates rapidly in the fall, we first concentrated on that of the inner delta. We completed approximately one third of it as a group, then divided into two groups to complete the remainder, the dike and the outer delta. This was necessary because of the relatively short amount of time that we had to complete our study.

RESULTS AND DISCUSSION

For the purposes of this discussion, we have divided the Delta into five main areas: grasslands and sloughs, dike, McAllister Creek marsh, front Delta and Nisqually River marsh.

Grasslands and Sloughs

Formerly farmlands, most of the fields have been extensively cultivated. John Morehouse (1974) explains that at one time the McAllister Rod and Gun Club planted oats and wheat to attract ducks. In the summer of 1973, the land was heavily grazed by horses and cattle. This caused vegetation to be lower and less dense than usual. In addition, many fields were hayed in the summer of 1974. An obvious example of past cultivation is the apple and pear orchard (see Figure 2). Located near the entrance road, the now unmanaged trees still dominate the area. Ground cover beneath the trees consists of Dactylis glomerata, Agrostis alba and Ranunculus repens (in order of dominance). Also found were quantities of Cirsium arvense, Rubus procerus, Rumex sp., and Bidens amplissima.

Disturbed areas occur around barns, houses and along roads. Common to these areas were C. arvense, species of Trifolium, species of Plantago, Matricaria matricarioides (pineapple weed), Urtica lyallii (nettle), R. repens, Acer macrophyllum, Acer circinatum, Atriplex hastata, R. procerus and Alopecurus pratensis.

Grasslands of both high and low elevation, make up most of the inner delta. Although the level of the land varies only slightly, distinct vegetation changes are obvious. Species representative of the higher areas are

A. alba, Agropyron repens, D. glomerata and Festuca rubra. Secondary species include Aster eatonii, species of Trifolium, Phleum pratense, C. arvense, Bromus sitchensis, Bromus tectorum and Lotus corniculatus. Plants most typical of the lower areas are A. alba and Holcus lanatus. Among the secondary species are Lotus purshianus, C. arvense, R. repens and Achillea millefolium.

In many fields the land seems to fluctuate in elevation. A consociation of A. repens and A. alba, representatives of high and low areas respectively, is common. Between extreme high and low places species characteristic to each grow intermixed. It is not unusual to find clumps of Juncus growing in an apparently level field. The presence of Juncus seems to suggest that standing water is likely to occur in the event of rains. This was found to be the case in the pasture near the caretaker's house: what was noted as grazing land interspersed with Juncus in October has become a duck pond after only a month of rain.

The many sloughs meandering over the Delta's length provide contrast to the grasslands. Once flowing tidal channels, they now stand still, protected from tidal flow by a dike. The species are mainly freshwater, as indicated by the presence of Typhus latifolia (cattail) and Juncus effusus. However, the presence of Juncus balticus, Scirpus maritimus and Distichlis spicata (salt grass) indicate a fairly high salt concentration. It may be that it was left from salt marsh days, is carried in by the fog, or is present in the water table.

The plant communities of a slough vary considerably. The most abundant species are A. alba, Carex lyngbyei, J. effusus and T. latifolia, but no single one is dominant along the entire length. For example, a slough to the west of the orchard has no standing water and only a string of tall A. macrophyllum, Pyrus sp., Salix sp., Alnus rubra and Populus trichocarpa to mark its path. Where water stands, Sparganium simplex dominates the bed, with Eleocharis palustris, Phalaris arundinacea, J. effusus and Potentilla pacifica along its banks.

Dike

The dike is surrounded on both sides by water (see Figure 3). On the outside it is bounded by McAllister Creek, Puget Sound and the Nisqually River; on the inside by a slough that runs the length of the dike. Were it not for this barrier, it would be possible for high tides to reach as far as the freeway.

The vegetation of the dike can be divided into two main categories. The Nisqually side, with its apparently moister soil, is characterized by deciduous trees and plants that thrive in wooded areas. The McAllister and northern sides of the dike have a rockier soil and sparser vegetation. The plants found in these areas are generally shrubs or small trees.

Beginning at the southernmost part of the McAllister side of the dike, the soil is sandy and comparatively dry. The vegetation here is mainly shrubby, although a few willow trees are present. Lupinus bicolor (lupine), F. rubra (red fescue), C. arvense (Canada thistle), A. repens (quack grass), and species of Vicia (vetch) constitute the dominant vegetation. Further west, Cystisus scoparius (scotch broom) forms a prominent community, growing thickly on the

top and sides of the dike. The path turns sharply and begins to follow the general direction of McAllister Creek. Soon after the turn, C. scoparius thins out and is gradually replaced by a community of R. procerus (himalaya blackberry), P. fusca (crabapple), and Rosa pisocarpa (rose), with Symphoricarpos albus (snowberry), Pyrus communis (pear), and Rubus laciniatus (evergreen blackberry) playing a secondary role. The R. procerus grows profusely on the sides of the path and would block it completely if it had not been mowed. Close to the turn is a stand of Berberis aquifolium (Oregon grape) about eighty feet long; this is the only place it was found on the Delta. Also in this area are several tall P. trichocarpa (cottonwood trees). Mowed A. alba is the dominant ground cover.

The vegetation changes abruptly shortly before the washout, a barren area toward the north end of the dike. Trees give way to scattered, shrubby P. fusca and a little C. scoparius. R. procerus continues to dominate, with R. pisocarpa and S. albus secondary. A. alba remains the predominant ground cover. In this sparsely populated area, there are several small Pseudotsuga menziesii (Douglas fir); they are among the few conifers found on the Delta. Slightly north is where the dike washed out in the winter of 1973. It was repaired with coarse sand and gravel on a layer of large stones; no pioneer species have yet appeared.

The north dike has much the same vegetation as the west, but with more, taller P. fusca. They line the dike and dominate the vegetation, with R. procerus, R. laciniatus, R. pisocarpa, S. albus and A. alba making up the remainder of the community. On the sides, plants such as L. purshianus (lotus), Plantago lanceolata (plantain), A. millefolium (yarrow), Vicia sp. (vetch), Senecio jacobaea (tansy ragwort), C. arvense and A. eatonii (aster) are found.

As the dike turns sharply to the south, the vegetation changes abruptly to deciduous trees. The soil becomes moister and A. macrophyllum (big leaf maple) and A. rubra (red alder) dominate, with P. trichocarpa, Fraxinus latifolia (Oregon ash), and varieties of Salix in lesser quantities. The secondary shrub level includes R. parviflorus, R. spectabilis, R. procerus, R. laciniatus, R. ursinus, S. albus and R. pisocarpa. The lowest layer of vegetation is dominated by R. repens (creeping buttercup), a low stoloniferous form of A. alba, Polystichum munitum (sword fern), Athyrium felix-femina (lady fern) and species of Vicia. Carex (sedge) grows in the water on the sides of the dike. This vegetation pattern remains unvaried for the rest of the east dike.

McAllister Creek Marsh

McAllister Creek runs along the western side of the wildlife refuge (see Figure 4). The area is characterized by having channels coursing around and through the marshland. In places there are three to four foot dikes that enclose or protect areas along the creek from the regular flooding of the tides. The dikes described here are not to be confused with the main dike, which encloses the inner delta.

In the extreme southern area Carex lyngbyei grows in dense wide mats along and extending into the water. Higher on the banks is found mainly Deschampsia caespitosa, with some A. repens. Above this area, Atriplex patula, A. eatonii, A. millefolium, Pyrus sp. and C. arvense are found. At the highest levels are A. alba, Holcus lanatus and D. glomerata.

Moving north, Distichlis spicata replaces C. lyngbyei along the creek's edges and extends up to a small dike. On the sides of the dike Grindelia integrifolia, Salicornia virginica and A. patula become part of the D. spicata community. A. repens grows on the top of the dike. The area enclosed by this dike is dominated by A. repens and D. spicata with A. millefolium, S. virginica, A. patula and P. communis (pear) as secondary species.

Slightly farther north there is another dike which has the same vegetation as the previous one adjacent to and on its banks. The major difference is that D. glomerata with P. lanceolata, and Pyrus sp. dominates the top rather than A. repens.

This dike protects a low area of predominantly D. spicata. S. virginica, Triglochin maritimus, Jaumea carnosa and Carex lyngbyei are secondary here. Slightly higher, Hordeum jubatum and D. caespitosa are mixed in, with G. integrifolia located mainly along the edges.

The salinity of the creek increases as it flows toward Puget Sound. We believe that this causes a change in the vegetation: C. lyngbyei disappears. The vegetation becomes fairly uniform, with D. spicata being by far the most prevalent; G. integrifolia, S. virginica, J. carnosa, T. maritimus and P. maritima are secondary.

Roughly parallel to this area and the main dike runs a low (three to four foot) ridge. F. rubra, J. balticus and A. eatonii are on the top and D. spicata and A. patula are on the sides of this ridge. Water sometimes gets trapped behind this ridge and creates areas with only D. spicata, S. virginica and G. integrifolia. There are also higher sandy areas where B. tectorum, Rumex sp., C. scoparius, Ulex europaeus and moss grow.

Continuing north, there is an area of clay soil along the banks with scattered patches of vegetation. D. spicata, S. virginica and A. patula are found along the water's edge. Higher, Hordeum brachyantheum, D. caespitosa, C. lyngbyei and G. integrifolia are present. Above this are A. alba and Holcus lanatus.

There is nothing growing on the banks where the washout occurred.

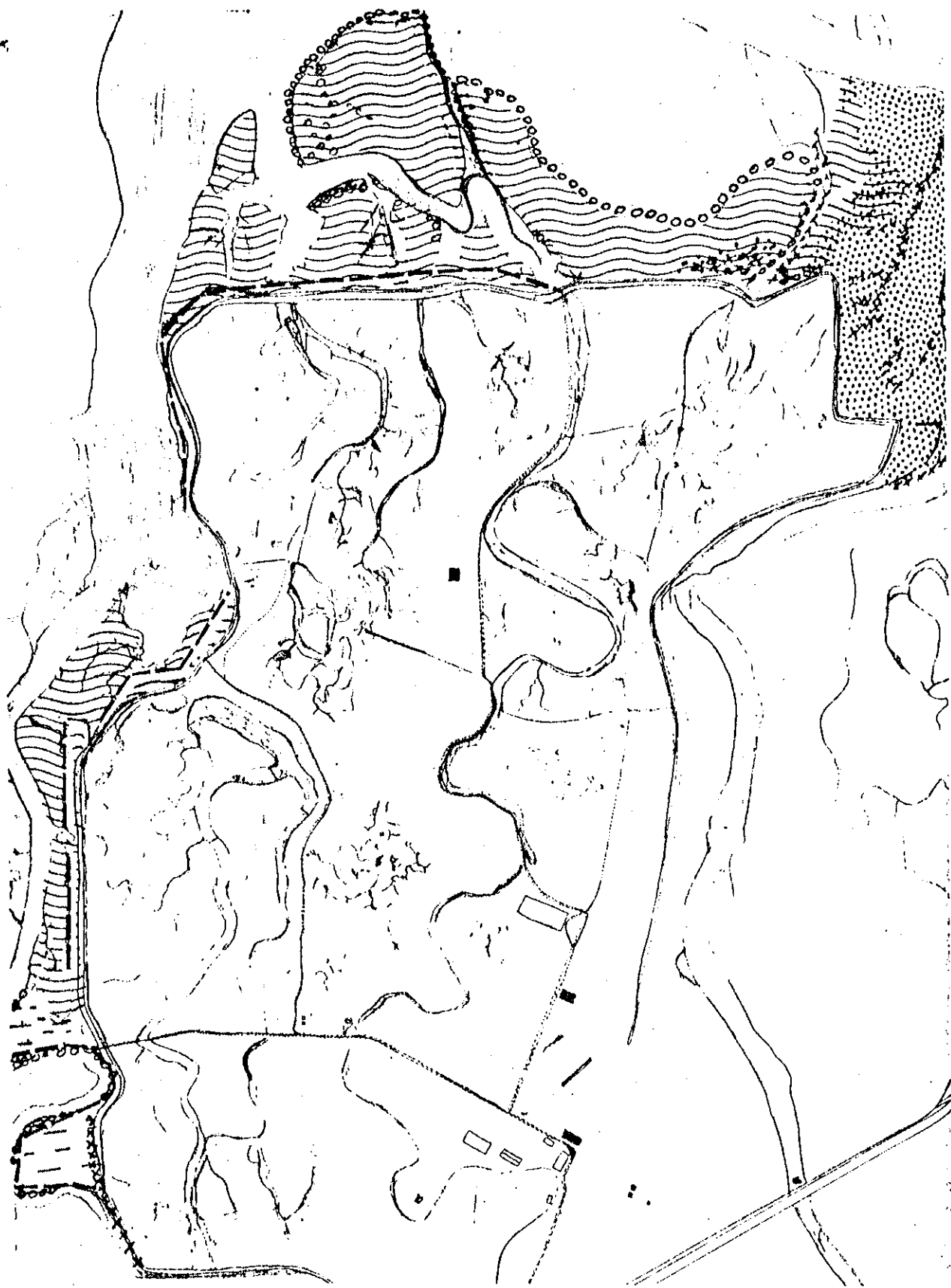
Closer to Puget Sound there is a high bar of sand with Festuca rubra and A. rubra dominating. Vicia sp., C. scoparius, Juncus balticus and A. millefolium are secondary species with one four foot Abies grandes.

Around the northwest corner, the low dike vegetation becomes mainly F. rubra, with A. repens, H. lanatus, D. spicata and J. balticus being secondary community members. The areas lower than this dike are composed of S. virginica, D. spicata, J. carnosa and A. patula.

Front Delta

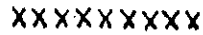
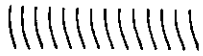
This marshland is located between McAllister Creek and the Nisqually River, and reaches out into Puget Sound (see Figure 4). On the outermost reaches, only D. spicata is able to exist. It forms a twenty foot band, enclosing other vegetation found on the mudflats.

Figure 4. Vegetation of the Outer Delta



Legend for Figure 4.

Legend



Dominant Species

A. macrophyllum, A. rubra, P. trochocarpa, F. latifolia, Salix sp.

C. scoparius.

Dike washout area. No vegetation.

P. fusca, R. pisocarpa, R. procerus, A. alba (stoloniferous form)

R. pisocarpa, R. procerus, A. alba, P. fusca

L. bicolor, F. rubra, C. arvense, A. repens

Secondary Species

Vicia sp., Salix sp.

S. albus, R. laciniatus
P. communis

S. albus, R. laciniatus

Vicia sp., Salix sp.

Somewhat higher, salt grass remains dominant. Other species form an important part of the community, specifically T. maritimus, S. virginica, J. carnosa, and C. lyngbyei. This area is very uniform in makeup, with species quite evenly distributed. The only exception is J. balticus, a secondary species which grows in circular patches. Other lesser species include G. integrifolia, which is prominent along slough edges, and P. maritima, which is interspersed throughout.

This community continues to the foredike, where erratic vegetation patterns occur. There is a four foot ridge running along the outer edge of the foredike, characterized by Agropyron sp., Puccinellia sp., D. spicata, H. brachyantheum, and B. tectorum. D. caespitosa grows on the north side, and A. patula on the south. Scattered along the ridge are areas of J. balticus, P. fusca, A. millefolium and A. eatonii.

Tides frequently flood low areas behind the ridge. They are characterized by D. spicata, S. virginica, J. carnosa, and G. integrifolia. Less prevalent are P. maritima, J. balticus and H. jubatum. The higher areas here have loose and sandy soil supporting growths of moss and Aira sp.

Nisqually River Marsh

The Nisqually River flows along the eastern side of the wildlife refuge and has a much greater flow of fresh water than McAllister Creek (see Figure 4). Because of this the tides affect the flora less, and the vegetation is predominately that of a freshwater marsh.

This area has the highest marshland of the outer delta. There are many steep-banked sloughs without vegetation on the sides. The sloughs and banks of the river are dominated by C. lyngbyei. In areas where the current is strong, the Carex is flattened down or even sheared off. Along the upper banks grows Heracleum lanatum, Vicia sp. and clumps of Phalaris arundinacea.

The northeast corner of the marsh is made up exclusively of C. lyngbyei. Inward, as the land rises, are found D. caespitosa, T. maritimum, and Potentilla pacifica.

Still higher the surface becomes more level and the vegetation more uniform. D. caespitosa and A. eatonii are the most dominant species. Secondary are Galium sp., A. alba, C. lyngbyei, and T. maritimum. In these higher areas are slight depressions with G. integrifolia, D. spicata, P. maritima, C. lyngbyei, D. caespitosa and J. balticus. Further south along the river there are thickets of alder trees, Rosa sp., Spirea douglasii and H. lanatum.

The southernmost area was very damp. It differed from other areas by the presence of more Galium sp. and contained thicket areas including A. rubra and P. fusca.

Present near the edge of the dike were Salix sp., Rosa sp., T. latifolia, Oenanthe sarmentosa and A. alba.

CONCLUSION

The Delta was divided into five basic areas, each having its own characteristic vegetation. The inner delta was comprised of sloughs and grasslands; the dike of drier, bushy vegetation and deciduous trees; the McAllister Creek marsh and Front Delta of saltwater vegetation; the Nisqually River marsh of freshwater species. It should, however, be kept in mind that many species are found in more than one area.

Tidal movement, soil salinity, changes in elevation, and the presence of the dike all play a part in determining the location of plant species. It is important that our results be checked in the spring and summer to assure that they are valid for all times of the year. Soil and water samples would be of value to further understand the formation of plant communities. A study of the interrelationships of plants and animals would also be of interest.

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APPENDIX A

Climate Information¹

The growing season this year has been the longest in five years. The number of days between the last spring freeze and the first fall freeze was 175 (the average being 166 days). The last frost of spring was April 14; the first fall frost was October 6.

Temperature (degrees Fahrenheit)

<u>1974</u>	<u>Average: 0</u>
April 46.6	-1.6
May 51.8	-2.2
June 59.6	+0.7
July 62.4	-1.2
August 64.7	+1.9
September 63.2	+4.6
October 49.5	-1.1

As of the 22nd, November has been slightly warmer than usual, and the nights have been milder.

Rainfall (in inches)

<u>1974</u>	<u>Average: 0</u>
April 4.77	+1.63
May 2.65	+0.77
June 1.57	0.0
July 2.29	+1.59
August 0.07	-1.10
September 0.50	-1.62
October 1.38	-3.50

As of the 22nd, November's rainfall has been slightly above average.

1. Davis, Jack. U.S. Weather Bureau, Olympia, Washington (personal communication).

APPENDIX B. DOMINANT SPECIES

Acer macrophyllum (Big-leaf maple) -- Native species. Deciduous tree, to 50 feet tall, 3 feet diameter. Dominant along the eastern dike. In the fall its leaves turn beautiful hues of green, yellow, and orange. Fallen leaves add a rich supply of detritus to the ground.

Agropyron repens (Quack grass) -- Native species to scattered areas of the West Coast, but the delta stand is believed to be introduced. An important member of delta, dike, and salt marsh (salt marsh species may be A. canium), it is of much value for forage and as a soil binder. According to Gilkey (1957), the ability of A. repens to store nutrients in the rootstock allows it to crowd other plants out. Coupled with root tips strong enough to pass through other roots in crowded soil, and a high germination ratio of seeds, it provides stability to the grassland.

Agrostis alba (Redtop) -- Introduced species. Most abundant grass on the delta. Found in two forms: as an erect sod-forming grass 2-4 feet tall in mid-high fields, and, as a low growing, stoloniferous grass encompassing every community from edges of sloughs to high grasslands. Generally A. alba is considered an important element in permanent pastures, meadows, and lawns.

Alnus rubra (Red alder) -- Native species. Deciduous tree, to 50 feet tall. A large amount of A. rubra is found along Nisqually River; some is found on higher marsh areas of McAllister Creek. The greatest stands occur on the Eastern dike in mixture with A. macrophyllum, Populus trichocarpa and Pyrus fusca. Growing extremely well in this area, leaves are commonly 6 inches long and 4 inches wide.

Aster eatonii (Common aster) -- Perennial species, to 3 feet tall. Still blooming in October, A. eatonii densely populates a few moist areas of the Western inner delta. It is an integral member of the Nisqually River marshland, growing densely through the Deschampsia caespitosa grassland.

Carex lyngbyei (Sedge) -- Native species. Perennial. C. lyngbyei is a dominant member of inner delta sloughs and the less saline areas of salt marsh. Inland it forms dense bands along Typhus latifolia sloughs, or it may be the main slough species of an area. River and slough banks of the Nisqually River marsh, and those south-most of the McAllister Creek marsh, are densely matted in belts to 20 feet wide with C. lyngbyei. Single plants are uniformly scattered throughout the salt marsh.

Cirsium arvense (Canada thistle) -- Introduced species. Perennial. Dense stands are found on the inner delta, mainly in areas of high grassland. This is an undesirable species; its presence indicates disturbance of the more desirable grasses, probably by prolonged overgrazing (Weaver 1954). The branching root system is able to spread quickly over large areas from a single point of infestation.

Cystisus scoparius (Scotch broom) -- Introduced species. Perennial shrub, to 8 feet tall. A scattered few of these species are found on disturbed areas near the McAllister Creek marsh. A dominant stand has colonized a large portion of the Southern dike. Generally considered a nuisance

for crowding out native vegetation along roads, on the dike it appears to be the only species with ability to thrive in the rocky and exposed habitat.

Deschampsia caespitosa (Tufted hair grass) -- Native species. Either perennial or annual; ours appears to be a perennial stand. Dominant in the more freshwater areas of the salt marsh, especially along the Nisqually River. Its bunching forms a dense, hummocky land, with panicked seed heads rising to 6 feet. Before dike construction, D. caespitosa may have been dominant in the inner grasslands.

Distichlis spicata (Saltgrass) -- Native species. Most dominant and uniformly spaced member of the salt marsh, D. spicata is able to exist farthest out on the mudflats as well as into the high marsh. Unlike Salicornia virginica, who stores excess salt within, D. spicata has adapted to the salty environment with a process of excreting excess salt through pores in its leaves (Barbour et al. 1973). Experiments have found D. spicata (as well as other salt marsh species) to grow best in low salinity, and in less saturated soil than that in which they occur. The conclusion was that salt marsh species live in a physiologically suboptimal habitat, and succeed because they alone can cope with the environmental difficulties.

Festuca rubra (Red fescue) -- Native species. Perennial. Dominant as a bunch grass to 4 feet tall in areas of the Southern delta, and further north near the single barn. In contrast to this environment, F. rubra also dominates high areas of the salt marsh, especially along the small dikes.

Grindelia integrifolia (Gum-weed) -- Native species. Perennial herb, to 2 feet tall. With the exception of Triglochin maritimum, this is the tallest member of the salt marsh community regularly flooded by tides. It mainly occurs in even belts along slough edges.

Holcus lanatus (Velvet grass) -- Introduced from Europe. Perennial. Found in moist depressions and along slough banks throughout the inner delta; it usually grows by low A. alba. A desirable species, H. lanatus is occasionally cultivated as meadow grass.

Juncus balticus (Baltic rush) -- Native. Perennial. Found scattered through inner delta, often with J. effusus, but gains the most prominence on the salt marsh. Here forms circular patches, although the greater percentage appears as single plants scattered throughout.

Juncus effusus (Common rush) -- Native. Perennial. Dominates enormous patches throughout the inner delta, also found scattered through the lowest grasslands. Appears to do best in seasonally wet lands. The soil beneath J. effusus was moist but firm October to mid-November. With the coming of rain, these areas were the first to flood. Juncus sp. are considered by Weaver (1954) to be favorable members of the grassland for their long-liveness and stability.

Lotus corniculatus (Bird's-foot trefoil) -- Introduced from Europe. Prefers moist places; found near the ground to two feet tall on a large percentage of grassland. Commonly cultivated with grasses for its high nutrient content and nitrogen fixing ability, L. corniculatus is a good forage species.

yellow



Populus trichocarpa (Black cottonwood) -- Native species. Deciduous tree, largest hardwood indigenous to the West. Growing well over 60 feet tall, with 3-4 foot diameters, these trees grow mainly on the Eastern portion of the delta: along barnyard-roads and along the dike.

Pyrus fusca (Oregon crabapple) -- Native species. Deciduous tree. This is the most common tree of the delta. Found sparsely in high salt marsh areas, it gains dominance on the dike. Even more abundant is its inner delta population. Ranging from 1-15 feet tall, nearly every field has been invaded by these trees. Dense stands occur sporadically throughout the inner delta. The greatest stand is found in the northeast corner. Fence-rows commonly have a few along their length; many support an unbroken string. North of the single barn all remains of a fence are gone, but the old boundary is thoroughly marked by this proliferant tree.

Ranunculus repens (Creeping buttercup) -- Introduced from Europe. Perennial. Dominant along the Eastern dike in the prevailing moist and shady habitat. Found also throughout the inner delta in moist lowlands, and along the edges of sloughs. This escapee is considered undesirable. It crowds out natural grasses, and is poisonous to livestock.

Rosa nutkana, R. pisocarpa (Wild rose) -- Native species. Perennial shrubs. Found on inner delta, dike, and less saline areas of salt marsh. Often forms thickets along edges of sloughs, or in moist depressions. In the fall this shrub is striking, with bright red fruits ladening its branches.

Rubus laciniatus (Evergreen blackberry), R. procerus (Himalayan blackberry) -- Introduced species. Evergreen and deciduous shrubs, respectively. Thicket forming species to 10 feet tall, Rubus sp. are important to the barnyard vegetation, to inner delta slough banks, and especially to the dike. By mid-summer the Eastern dike became impassable, as Rubus sp. overgrew the path. (The dike path has since been mowed.) Rubus sp. invade disturbed areas, and generally are considered nuisances.

Salicornia virginica (Pickleweed) -- Native species. Rhizomatous perennial. Found in most salt marsh areas with D. spicata. Pure covering by S. virginica occurs on the front marsh foredike. It appears these areas are flooded only at highest tides. Water may be trapped and evaporated, leaving an extremely high salt concentration. Teal (1969), has explained S. virginica will germinate in water saltier than seawater, allowing it to colonize areas as noted above.

Symphoricarpos albus (Snowberry) -- Native species. Deciduous shrub to 6 feet tall. Usually grows adjacent to Rosa sp. on inner delta moist depressions, slough edges, and on the dike. Although found in both shady and sunny environments, it is most abundant as understory on the Eastern dike.

Triglochin maritimum (Arrowgrass) -- Native species. Perennial herb. Never found in clumps, or in extreme density, but a fairly constant salt marsh member, especially in the front delta. Its form interestingly appears as a 3-sided, branchless twig, sticking straight up for 3 feet.

Typhus latifolia (Cattail) -- Native species. Perennial. The most abundant slough member of the inner delta, T. latifolia forms dense stands to 8 feet tall. These stands sometimes follow the slough's path for long distances, but just as common are smaller communities.

APPENDIX C

Plant List of the Nisqually Delta

- Abies grandis (Dougl.) Lindl. (Grand fir)
- Acer circinatum Pursh (Vine maple) -- Native. Found in field.
- Acer macrophyllum Pursh (Large-leaved maple) -- Native. Found on dike and in field.
- Achillea millefolium L. (Yarrow, Milfoil) -- Found on salt marsh, dike, and in field.
- Agropyron caninum (Scribn. & Smith) C.L. Hitchcock -- Found on foredike and in field.
- Agropyron repens (L.) Beav. (Quackgrass) -- Perennial. Native and Mediterranean. Found on salt marsh, dike, and in field.
- Agrostis alba L. (Redtop, Creeping bentgrass) -- Perennial. Introduced. Found on salt marsh, dike, and in field.
- Aira caryophyllaea L. (Silvery hairgrass) -- Found on dike and in field.
- Aira praecox L. (Little hairgrass) -- Europe. Found on foredike, dike, and in field.
- Alisma plantago-aquatica L. (Water plantain) -- Found in field.
- Alnus rubra Nutt. (Red alder) -- Found on salt marsh, dike, and in field.
- Alopecurus geniculatus L. (Bent foxtail) -- Perennial. Found in field.
- Alopecurus pratensis L. (Meadow foxtail-grass) -- Europe. Found in field.
- Anaphalis margaritacea (L.) B & H (Pearly everlasting) -- Native. Perennial. Found on dike and in field.
- Angelica genuflexa Nutt. -- Found on salt marsh.
- Angelica lucida L. (Sea watch) -- Native. Found on salt marsh.
- Anthemis cotula L. (Dog fennel, Mayweed) -- Europe. Annual. Found in field.
- Arctium minus Schk. (Smaller burdock) -- Europe. Biennial. Found on dike and in field.
- Aster eatonii (Gray) Howell (Michaelmas daisy, Common aster) -- Perennial. Found on salt marsh, dike, and in field.
- Athyrium felix-femina (L.) Roth (Lady fern) -- Found on dike.

- Atriplex patula L. (Beach salt-bush) -- Native. Annual. Found on foredike, salt marsh, and in field, along with some A. patula var. hastata.
- Azolla mexicana Presl. (Water fern) -- Found in field.
- Berberis aquifolium Pursh (Oregon grape) -- Native. Found in one place on dike.
- Bidens amplissima Greene, Pitt. (Beggar tick) -- Annual. Found in field.
- Brassica rapa L. (Wild rutabaga) -- Winter annual or biennial. Europe. Found in field.
- Bromus mollis L. (Soft chess, Soft brome) -- Annual. Europe. Found on dike and in field.
- Bromus pacificus Shear. (Pacific brome)
- Bromus sitchensis Trin. -- Perennial. Europe. Found on dike and in field.
- Bromus tectorum L. (Cheatgrass, Brome) -- Europe. Annual. Found on salt marsh, dike, and in field.
- Callitriche stagnalis Scop. -- Chiefly European. Found in field.
- Capsella bursa-pastoris (L.) Moench (Shepherd's purse) -- Europe. Annual. Found in field.
- Carex lyngbyei Hornem. (Sedge) -- Native. Perennial. Found on salt marsh, dike, and in field.
- Carex obnupta L.H. Bailey (Slough sedge) -- Native. Perennial. Found on dike.
- Cerastium vulgatum L. -- Europe. Perennial. Found on dike and foredike.
- Cirsium arvense Scop. (Canada thistle) -- Eurasia. Perennial. Found on dike and in fields.
- Cirsium vulgare (Savi.) Ten. (Bull thistle) -- Europe. Found on dike and in fields.
- Clematis vitalba L. -- Not native. Found in field.
- Conium maculatum L. (Poison hemlock) -- Europe. Biennial. Found in fields.
- Cotula coronopifolia L. (Brass buttons) -- Perennial. Succulent. Found on dike and in field.
- Crepis capillaris (L.) Wallr. (Smooth hawksbeard) -- Europe. Annual or biennial. Found on dike and in field.
- Cuscuta salina Engelm. -- Found on salt marsh.
- Cytisus scoparius (L.) Link. (Scotch broom) -- Europe. Perennial shrub. Found on salt marsh and dike.

- Dactylis glomerata L. (Orchard grass) -- Europe. Perennial. Found on salt marsh, dike, and in field.
- * Deschampsia caespitosa (L.) Beauv. (Tufted hairgrass) -- Native. Perennial or annual. Found on salt marsh.
- Distichlis spicata (L.) Greene (Saltgrass) -- Native. Perennial. Found on salt marsh and in field.
- Eleocharis palustris (L.) R. & S. (Spike rush) -- Native. Perennial. Found in sloughs.
- Epilobium angustifolium L. (Fire-weed) -- Perennial. Native; also native in Eurasia. Found on dike and in field.
- Epilobium watsonii Barbey in Brew. & Wats. -- Found in sloughs and on dike.
- Equisetum telmateia Ehrh. -- Found on dike and in field.
- Festuca myuros L. (Rat-tail fescue) -- Annual. Europe. Found on dike.
- Festuca rubra L. (Red fescue) -- Perennial. Native. Found on salt marsh, dike, and in field.
- Fraxinus latifolia Benth. (Ash) -- Found on dike.
- Galium parisiense L. (Bedstraw) -- Annual. Europe. Found in field.
- Galium triflorum Michx. (Bedstraw) -- Perennial. Found on dike and in field.
- Geum macrophyllum Willd. -- Perennial. Found on dike.
- Glaux maritima L. (Sea milkwort) -- Native. Perennial. Found on salt marsh.
- Gnaphalium uliginosum L. -- Annual or biennial. Found on dike and in field.
- Grindelia integrifolia DC (Gumweed) -- Native. Perennial. Found on salt marsh.
- Heracleum lanatum Michx. Perennial. Found on salt marsh and dike.
- Holcus lanatus L. (Velvet grass) -- Europe. Perennial. Found on salt marsh, dike, and in field.
- Hordeum brachyantherum Nevski (Meadow barley) -- Native. Perennial. Found on salt marsh, dike, and in field.
- Hordeum jubatum L. (Foxtail barley) -- Native. Perennial. Found on salt marsh.
- Hydrocotyle ranunculoides L. (Water pennywort) -- Found in field.
- Hypericum perforatum L. (St. John's wort) -- Perennial. Europe. Found on dike.
- Hypochoeris radicata L. (False dandelion) -- Europe. Found on dike and in field.
- Impatiens noli-tangere L. (Touch-me-not) -- Annual. Found on dike and in field.

- Jaumea carnosa (Less.) Gray -- Native. Perennial. Found on salt marsh.
- Juncus balticus Willd. -- Perennial. Native. Found on salt marsh, dike, and in field.
- Juncus bufonius L. (Toad rush) -- Native. Annual. Found on dike and in field.
- Juncus effusus L. -- Native. Perennial. Found in slough areas in field.
- Lactuca biennis (Moench.) Fern. (Tall lettuce) -- Biennial. Found in field.
- Lapsana communis L. -- Introduced. Annual. Found on dike.
- Lathyrus polyphyllus Nutt. -- Native. Perennial. Found in sandy areas on dike.
- Lemna minor L. (Small duckweed) -- Found in field.
- Lepidium virginicum L. -- Annual or biennial. Found on foredike and dike.
- Lilaeopsis occidentalis C. & R. -- Perennial. Found on salt marsh.
- Lolium multiflorum Lam. (Italian ryegrass) -- Europe. Found in moist places on dike and in field.
- Lolium perenne L. (Perennial ryegrass) -- Europe, North Africa, Asia. Perennial. Found in moist places on dike and in field.
- Lotus corniculatus L. (Bird's-foot trefoil) -- Introduced. Perennial. Found on salt marsh, dike, and in field.
- Lotus purshianus (Benth.) C. & C. -- Found on dike and in field.
- Lupinus bicolor Lindl. -- Annual. Found on dike.
- Matricaria matricarioides (Less.) Porter (Rayless dog fennel, Pineapple weed) -- Western America. Annual. Found on dike and in field.
- Medicago hispida Gaertn. (Bur clover) -- Found on dike and in field.
- Mimulus guttatus D.C. (Common monkey flower) -- Found on dike.
- Montia perfoliata (Donn.) Howell (Miner's lettuce) -- Native. Annual. Found on dike.
- Montia sibirica (L.) Howell (Candy flower) -- Annual. Found on dike.
- Myosotis scorpioides L. (Forget-me-not) -- Europe. Apparently perennial. Found on dike and in field.
- Navarretia squarrosa (Esch.) H.&A. (Skunkweed) -- Annual. Native. Found in field.
- Nitrophila occidentalis (Moq.) Wats. Bot. King Exp. -- Perennial. Found on salt marsh and foredike.

Oenanthe sarmentosa Presl. (Water celery) -- Perennial. Native. Found on salt marsh, dike, and in field.

Osmaronia cerasiformia (T. & G.) Greene -- Found on dike.

Oleander -- Found in field.

Parentucellia viscosa L. (Eyebright) -- Annual. Mediterranean. Found on dike and in field.

Phalaris arundinacea L. (Reed canary grass) -- Perennial. Native. Found on salt marsh, dike, and in field.

Phleum pratense L. (Timothy) -- Perennial. Europe. Found in field.

Plantago lanceolata L. (Black plantain) -- Eurasia. Perennial. Found on dike and in field.

Plantago major L. (Broad-leaved plantain) -- Europe. Perennial. Found on dike.

Plantago maritima L. -- Perennial. Found on salt marsh.

Poa pratensis L. (Kentucky bluegrass) -- Europe and Asia. Perennial. Found on dike and in field.

Polygonum aviculare L. (Knot-weed) -- Annual. Native and Eurasia. Found on foredike, dike, and in field.

Polygonum convolvulus L. (Climbing bindweed) -- Europe. Annual. Found in field.

Polygonum persicaria L. (Lady's thumb) -- Europe. Annual. Found on dike and in field.

Polystichum munitum (Kaulf.) Presl. (Sword-fern) -- Native. Found on dike.

Populus trichocarpa Torr. & Gray. (Cottonwood) -- Native. Found on dike and in field.

Potentilla pacifica How. (Silver-weed) -- Perennial. Native. Found on salt marsh and in field.

Prunella vulgaris L. (Heal-all) -- Europe. Perennial. Found on dike.

Pseudotsaga menziesii (Mirbl.) Franco (Douglas-fir) -- Found on dike and in field.

Pteridium aquilinum (L.) Kuhn (Western bracken fern) -- Found in field.

Puccinellia nuttalliana (Schult.) Hitchc. -- Perennial. Found on salt marsh and dike.

Puccinellia pauciflora (Presl.) Munz. -- Found on dike.

Pyrus fusca Raf. (Oregon crabapple) -- Native. Found on salt marsh, dike, and in field.

- Ranunculus repens L. (Creeping buttercup) -- Europe. Perennial. Found on dike and in field.
- Raphanus sativus L. (Radish) -- Found on dike and in field.
- Rhamnus purshiana DC (Cascara) -- Native. Found on dike.
- Rorippa islandica (Oed.) Barb. (Marsh cress) -- Annual or biennial. Found in field.
- Rosa pisocarpa Gray (Wild rose) -- Native. Perennial shrub. Found on dike and in field.
- Rosa nutkana Presl. (Common wild rose)
- Rubus laciniatus Willd. (Evergreen blackberry) -- Europe, naturalized on Pacific coast. Found on dike and in field.
- Rubus parviflorus Nutt. (Thimbleberry) -- Found on dike and in field.
- Rubus procerus Muell. (Himalaya blackberry) -- Europe. Found on dike and in field.
- Rubus spectabilis Pursh (Salmon-berry) -- Native. Found on dike.
- Rubus ursinus Cham. & Schlecht. (Trailing wild blackberry) -- Native. Perennial. Found on dike.
- Rumex acetosella L. (Red Sorrel) -- Perennial. Eurasia. Found on dike and in field.
- Rumex crispus L. (Curly dock) -- Europe. Perennial. Found in field.
- Rumex maritimus L. (Golden dock) -- Europe. Annual or biennial. Found in field.
- Rumex obtusifolius L. (Bitter dock) -- Perennial. Found on dike and in field.
- Rumex occidentalis Wats. (Western dock) -- Perennial. Found in field.
- Salicornia virginica L. (Pickleweed) -- Perennial. Found on salt marsh and on inside of north dike.
- Salix sp. (Willow) -- Found on dike and in field.
- Sambucus callicarpa Greene (Red elderberry) -- Found on dike.
- Scirpus maritimus L. (Bulrush) -- Perennial. Found in field.
- Scirpus microcarpus Presl. Rel. (Bulrush) -- Perennial. Found in field.
- Scirpus validus Vahl (Tule) -- Perennial. Found in field.
- Senecio jacobea L. (Tansy ragwort) -- Europe. Biennial or short-lived perennial. Found on dike and in field.

Senecio sylvaticus L. -- Europe. Annual. Found on dike and in field.

Sisymbrium officinale (L.) Scop. -- Europe. Annual. Found on dike and in field.

Solanum dulcamara L. (Bittersweet) -- Eurasia. Perennial. Found in field.

Sonchus arvensis L. (Sow-thistle) -- Europe. Perennial. Found on salt marsh.

Sonchus asper (L.) Hill (Sow-thistle) -- Annual or biennial. Found on foredike.

Sparganium simplex Huds. (Bur reed) -- Perennial. Found in field.

Spergula arvensis L. -- Europe. Annual. Found on dike and in field.

Spergularia canadensis (Pers.) G. Don. -- Annual. Found on salt marsh.

Spergularia marine (L.) Griseb. -- Europe. Annual. Found on salt marsh.

Spergularia rubra (L.) J. & C. Presl. -- Europe. Annual. Found on dike and in field.

Spiranthes romanzoffiana C. & S. -- Found in shady areas on foredike.

Spirea douglasii Hook. -- Found on dike and in field.

Stachys cooleyae Heller (Giant hedge nettle) -- Perennial. Found on dike.

Stellaria humifusa Rottb. -- Probably perennial. Found on salt marsh.

Stellaria longipes Goldie, Edinb. -- Perennial. Found in field.

Stellaria media (L.) Cyrill. -- Eurasia. Annual (surviving winter if mild weather). Found on dike and in field.

Symphoricarpos albus (L.) Blake (Snowberry) -- Found on dike and in field.

Trifolium hybridum L. -- Perennial. Europe. Found in field.

Trifolium pratense L. (Purple clover) -- Europe. Short-lived perennial. Found on dike and in field.

Trifolium repens L. (White clover) -- Introduced. Perennial. Found on salt marsh.

Trifolium wormskjoldii Lehm. (Marsh clover) -- Perennial. Found on salt marsh.

Triglochin maritimum L. (Arrow grass) -- Found on salt marsh.

Typhus latifolia L. (Cattail) -- Found in sloughs in field.

Urtica lyallii (Wats.) C.L. Hitch (Stinging nettle) -- Found on dike and in field in moist, shady areas.

Veronica americana Schwern. -- Perennial. Found on dike.

Vicia sativa L. (Cultivated vetch) -- Europe. Perennial. Found on dike and in field.

Vicia sativa var. angustifolia L. Amoen. (Narrow-leaved vetch) -- Perennial.
Found on dike and in field.

Vicia villosa Roth (Hairy vetch) -- Annual or biennial. Europe. Found on dike
and in field.

Ulex europaeus L. (Gorse) -- Europe. Serious pest; found on salt marsh and
along McAllister Creek.