Appendix C: Characteristics and Habitat Area of Historical Wetlands

ABSTRACT

Our GIS mapping includes 3.69 x 10^8 m^2 (36,900 hectares) of wetland area in the river valleys and estuaries of the Nooksack, Skagit, Stillaguamish, and Snohomish rivers. This area is roughly equally split between our "estuarine," "riverine-tidal," and "palustrine" mapping categories. To describe each wetland we draw on a number of sources, but most heavily on the General Land Office (GLO) field notes and maps, because they include direct field observation. We used our composite wetland descriptions to estimate the extent of summer and winter inundation in each wetland; we use "inundation" to mean covered by water to a depth greater than one foot. Because estimates of historical inundated area are sensitive to the quality and comprehensiveness of historical data and the assumptions with which the data are used, for each wetland and seasonal inundation estimate we indicate the primary sources and logic we used to estimate historical inundation. The inundation estimates assign a priority to historical field observation, and make conservative assumptions for those wetlands lacking direct (historical) observation. There is generally more information available for larger wetlands than for smaller wetlands., meaning that smaller wetlands are more likely to have conservative estimates (small amount of inundated area or no inundated area) than large areas. That more information is available for larger wetlands also means that inundation area estimates aggregated for each watershed, being heavily influenced by the larger wetlands, are relatively robust, whereas area estimates for individual smaller wetlands are less so. The resulting estimates indicate that 12 x 10^7 m^2 (12,000 hectares) were inundated in winter, 4 x 10^7 m^2 (3,900 hectares) was inundated in summer, 13 x 10^7 m^2 (13,600 hectares) were inundated tidally by

saltwater or brackish water and 3 x 10^7 m^2 (2,900 hectares) was inundated tidally by freshwater. Almost one-half of this inundated area was on the volcanigenic Skagit delta, and most of the remaining was in one of the three "Pleistocene valleys"—the lower Nooksack, Snohomish and Snoqualmie river valleys.

INTRODUCTION

This appendix consists of wetland descriptions that we synthesized from a number of sources. The descriptions include our estimates of the extent in summer, winter, and regular tidal inundation. Appendix A details the methods we used to map wetlands. Wetlands described in this report are given alphanumeric codes that reference the GIS coverage for each river basins. The codes include a three-character basin identifier (NKS = Nooksack; SKG = Skagit; STL = Stillaguamish; SNH = Snohomish; SNQ = Snoqualmie; SKY = Skykomish), which is followed by an underscore, then for some basins a second three-character sub-basin identifier, followed by the township and range (all townships are N and ranges are E of the Willamette Meridian), and a number given to wetlands within each township (e.g. "SKG_DLT330301"). The numeric identifier is unique; the basin identifier is added to aid the user in locating the wetlands and in sorting and querying data tables.

Approach and Assumptions for Estimating Inundated Area

For the purpose of this analysis, we consider a wetland to be "inundated" in winter or summer if a substantial amount of the wetland area is described in original source materials as (or can be inferred to have been) inundated by a foot or more of water. We developed rules for estimating inundated areas that we intend to be conservative. For example, if an area is described as "swamp" or "marsh" in GLO field notes, but the notes do not record any water depths, or observations of indicators of seasonal inundation, and we lack other direct evidence, we assume the wetland was not inundated. In other words, we generally take the absence of explicit information that indicates inundation to mean the area was not inundated. Many wetlands for which we have estimated no inundated area were certainly inundated in

some (small or possibly large) part, but at this time we lack a supportable rationale for estimating these areas.

The information available to describe the wetted area varies widely among wetlands in comprehensiveness and detail. However, in general, the larger a wetland, the more likely the information we used allows us to synthesize a more comprehensive and detailed description compared to smaller wetlands. This fact means we can have relatively high confidence in the aggregate inundated area estimates for watersheds, because the larger wetlands tend to represent most of the cumulative area. On the other hand, estimates for individual, smaller wetlands commonly draw from less information, and have a lower certainty associated with our characterization. It is also almost certain that our GIS mapping misses a large number of small and very small wetlands, owing to the nature of the available source materials; while this is not likely to affect the aggregate quantitative estimates, it may shade a user's view of historical aquatic habitat characteristics at the reach- or small sub-watershed scale.

The descriptions in this chapter, and the resulting estimates of inundated area we made from the descriptions, are to some extent limited by the time constraint under which we worked to develop this information for use in planning process. For example, there are doubtless additional sources of information that would refine our understanding of some individual wetlands. However since most of these sources would likely shed an increment of light on an individual wetland or a few nearby wetlands, it was not time effective within our time constraints. It is also likely that with further analysis we could develop more accurate or more sophisticated assumptions with which to analyze the data we already have for entire classes of wetlands. The intent here is to provide the data we have at this time, the assumptions with which we analyzed it, and the resulting habitat estimates, for immediate use. We provide the data and assumptions so the user can use the inundated area estimates advisedly, but also to invite users to interact with our description and analysis and to let us know of additional data sources, or local knowledge, or any other information that will allow us to refine these estimates in the future.

The assumptions we used to quantify historical inundated area for individual wetlands are given in Table C-1. The "A" rules represent a higher level of evidence that rely on field observations that allow at least a semi-quantitative estimate of inundation for a given season. The "B" rules represent lower levels of evidence and rely more on inference. The resulting estimates of inundated area are given in Table C-2. Nearly one-half of the winter-inundated area was in the Skagit study area, and most of the remaining in the Nooksack, Snohomish, and Snoqualmie (Table C-3). This variation points to the strong role played by geomorphic context, specifically that most winter inundated area is in "Pleistocene valleys" or on the lahar-created Skagit delta. Most of the summer inundated area was in the Skagit, Nooksack, and Snohomish study areas; in addition to the landform-dominance pointed to by the winter-inundated areas, the distribution of summer-inundated areas points additionally to the importance of tidal influence on freshwater summer rearing habitats. More analysis and discussion can be found in the main report.

NOOKSACK RIVER

Estuarine Wetlands

Estuarine wetlands were much more extensive in the Lummi River side compared to the Nooksack River side of the delta (see Figure 2). Possibly this difference reflects the Lummi River having been, in the mid 1800s, and presumably for some time prior to that, the dominant channel, and had thus had a greater sediment load, and prograded more low-elevation surfaces on which estuarine marshes could develop. It could also reflect contrasting sedimentation patterns resulting from differences in current and wind conditions between the Lummi and Nooksack bays.

We delineated the boundary between scrub-shrub and emergent estuarine marsh using GLO field descriptions and the presence or absence of bearing trees (see Appendix A for explanation of the bearing tree record and how we used it). There were no bearing trees near to four of the 10 survey points within the area mapped as scrub-shrub wetland, and the trees that were present averaged 20 m distance from the

survey point (Figure C-3).

NKS_LUM380101 Lummi Delta Estuarine Emergent (316 hectares) and *NKS_LUM380102 Lummi Delta Estuarine Scrub-Shrub* (224 hectares). The GLO surveyed the area in August 1859, then again in October 1873. The second survey included lines along 1/16-section boundaries (see Appendix A for explanation). The following lines are within the area we mapped as estuarine emergent wetland: Running south between S. 14 and S. 15 (T38NR1E) on August 22, 1859: "Through an open grass flat" and the line description of "Land level grass flat, good soil, but subject to overflow at extreme high tides;" then on October 2, 1873 "Land low tide prairie, subject to overflow of 3 ft." [Descriptive text quoted from the GLO notes in this Appendix are from the narrative written while the surveyors ran a line, and from the line summaries they wrote later for the entire line; see Appendix A.] Surveying west between S. 11 and S. 14, T38NR1E, on August 22, 1859, "Land level, low and wet, and with the exception of the last 20 chains, covered with willow and crabapple. Soil good but subject to overflow at extreme high tides." Between S. 10 and S. 15, T38NR1E, on August 22, 1859: "Overflowed at extreme high tides. It produces good grass. Timber a few dead willows" and on October 3, 1873 "Land low tide prairie, subject to heavy overflow." Through the south ½ of S. 10, T38NR1E, on October 8, 1873, surveyors noted "Wet tide prairie subject to overflow of 2 to 3½ feet" and through the center of the same section on the same day, "…low tide prairie subject to overflow of 18 in. to 3 ft." Lines entirely within the area mapped as estuarine scrub-shrub include between S. 2 and S. 11, (T38NR1E), on October 4, 1873: "…tide prairie. Subject to overflow of 18 in. to 2 ft," and between S. 11 and S. 12 (T38NR1E), "Low and swampy…willow and crabapple" on August 22, 1859. (In this appendix, for simplicity we use the surveyor's common names for trees and other vegetation; see Appendix A for equivalent scientific names for commonly identified trees.) Between S. 3 and S. 10, T38NR1E, the line description is "Land except West 15 chs. Tide prairie with scattering crab apple" on October 8, 1873. Surveying east through the north ½ of S. 12, T38NR1E, the notes read "Land low bottom subject to overflow. Scattering spruce and cedar timber. Undergrowth Willow and Hemlock" on September 22, 1873, and through the north ½ of S.

11, T38NR1E, "…subject to light overflow…" on October 4, 1873. Survey lines that cross through the boundary we have mapped between emergent and scrub-shrub vegetation include between S. 10 and S. 11, T38NR1E, "Subject to overflow of 18 in to 2 ft" on October 3, 1873, and through the center of S. 11, T38NR1E, "…tide prairie subject to overflow of 12 in. to 18 in." (October 4, 1873), and through the north ½ of section 10, T38NR1E, "Tide prairie subject to light overflow" on October 9, 1873.

NKS_SDY380104 Sandy Point Estuarine Emergent (49 hectares). We map Sandy Point, the prominent point of land to the west of the Lummi delta, as primarily estuarine wetland with grassland (presumably largely sand dunes) fringing the southern and western margin, based on U. S. Coast & Geodetic Survey (USC&GS) T-1871, surveyed in 1888, and GLO mapping. Their notes (from August 24, 1859) indicate for the line between S. 8 and S. 9, T38NR1E, running south, "At 8.39 chains leave swamp and enter grass flat…Thence across mud flat" and the line description includes, " Land level, soil 3rd rate. Prairie of good grass but unsuited to agriculture." The entry made identically for the lines between S. 9 and S. 16, between S. 8 and S. 17, and between S. 10 and S. 17: "Level prairie, soil gravelly and 3rd rate. Good grass cover."

NKS_DLT380201 Nooksack Delta Estuarine Emergent Wetland (29 hectares). The USC&GS mapped a small amount of saltmarsh in the Nooksack River delta. The GLO survey along only one line crosses the area. Running north between S. 7 and S. 8, T38NR2E, the notes indicate "At 6 chains leave tide prairie [underlining added] and enter willow brush" on July 7, 1859.

Immediately upstream of the mapped emergent wetland we map a 103 ha map unit of "scrub shrub floodplain," which we have not mapped as wetland. The USC&GS sheet T-1798 shows the area as forested. The symbol used on the chart in that era signified "Woods of any kind (or leaved Trees)" and is distinct from the symbols used to describe coniferous forests elsewhere on the sheet. The GLO field notes include descriptions of several lines crossing the area. Travelling north between S. 7 and S. 8, T38NR2E, the notes indicate [as they leave the area we map as estuarine wetland] "At 6 chains leave tide prairie and

enter willow brush" and "at 23 chains enter rushes with little water" and at 28.5 chains the south bank of the Nooksack River. The line description is "Land level and subject to overflow (but to no great depth). No timber. Covered with willow, grass, rushes, and crabapple" in July 7, 1859; this line description includes the area north of the river, which we map as wetland. On the same day, surveying east between S. 7 and S. 18, T38NR2E, the notes indicate "At 10.5 chains enter hardhack and willow." Notes from 1873 for the same line indicate at 20 chains "enter willow bottom" on October 21, 1873. Notes from the same year from a line surveyed through east through the center of S. 18, indicate "[at 27 chains] enter willow bottom" and "[at 38.5 chains] the beach." The 1938 aerial photographs have no meaningful information (e.g. relict tidal channels) because of the extent of deltaic progradation between the 1870s and 1938. While it is possible that the area was an estuarine or scrub-shrub wetland by today's criteria, in keeping with the USC&GS chart and the written descriptions by the GLO, we have mapped the area as simply scrub-shrub. Finally, USC&GS sheet T-1798 (surveyed 1887) shows a "Lummi village" in the NE ¼ of the NW ¼ of S. 18 (T38NR2E), which also supports the interpretation that the area was not a wetland.

We mapped the tideflats in Figure 2 in the Lummi and Nooksack estuaries as the area between the estuarine marsh and the MLLW line depicted on Coast Survey charts. We do not at this time have other confirming sources.

Riverine-Tidal Wetlands

The Lummi-Nooksack estuary had extensive riverine-tidal wetlands (see Figure 2). We distinguished these wetlands using several criteria. The USC&GS charts use symbols that distinguish freshwater marsh and saltmarsh. Distinguishing patterns on the U. S. Geological Survey (USGS) 15' Blaine 1907 topographic sheet also show the difference between saltmarsh and freshwater marsh. We then used the GLO field notes and high-resolution DEM to refine boundaries shown on the other two map sources. The GLO bearing tree record indicates that trees were small and very widely spaced. Six of 39 survey points

lacked nearby bearing trees (Figure C-3). Of those with trees, the average distance from them to the survey point was 39 m. More than one-half of bearing trees (38 of 68) were willow, which averaged 13 cm in diameter. Crabapple (16 of 68) and alder (10 of 68) were the other common bearing trees (Figure C-1). Detailed descriptions of riverine-tidal wetlands from GLO notes follow.

NKS_LUM380103 (314 hectares) *and NKS_LUM390201Riverine-Tidal Scrub-Shrub Wetland, Lummi Delta Side* (185 hectares). The GLO notes include the description of a line through the S ½ of S. 2, T38NR1E, on October 6, 1873 "Land level bottom subject to overflow of 2 to 4 ft [underlining added]. Timber spruce and alder. Undergrowth Willow and Rose bush," through the center of S. 2 on the next day "Land level bottom except West 10 chs. Subject to overflow of 1 to 3 ft. [underlining added] and covered with Willow thicket," and on the same day surveying east through the north ½ of S. 2, "[at 23.5 chains] Enter bottom," then "[at 37 chains] Open marsh brs. [bears] N. E. and S. W.," and "[at 44.5 chains] Enter Crab Apple thicket." The latter's line description includes "Spruce and Alder…with heavy undergrowth of Willow, Crabapple, and Rose bushes." Travelling north between S. 1 and S. 2, T38NR1E, the notes at 20 chains read "Enter swamp bearing NE and W," and the line description is "Land level bottom. All subject to overflow from 2 to 5 ft [underlining added]. Timber spruce, Alder, and Willow. Undergrowth Willow" on September 23, 1873. The line through the S. ½ of S. 1, T38NR1E, is described as "West of river. Swamp covered with Willow & Tule. Subject to overflow of 3 to 5 ft [underlining added]." on September 25, 1873; through the center of S. 1, as "West side of river wet swamp covered with Willow & Tule…Timber, Spruce, Cedar and Alder. Undergrowth Willow Hardhack & Raspberry" on September 24, and through the N ½ of the section on September 25 "West of river. Swamp covered with Willow and Tule. Subject to overflow of 3 to 5 ft [underlining added]." On the north boundary of S. 1, T38NR1E, surveying west, the terrain at the start was described as "In swamp covered with dense growth of flag Willow and Hardhack. Water in pools [underlining added] …" and the line is described as "Land, marsh covered with Willow, Hardhack and Tule. …subject to overflow of 2 to 5 ft [underlining added]." on September 10, 1873. The line between S. 35 and S. 36, T39NR1E indicates at 36.5 chains "Leave marsh

& enter dry ground and dead timber."

NKS_DLT380202 Riverine-Tidal Scrub-Shrub Wetland, Nooksack Delta Side (718 ha). The GLO notes indicate, between S5 and S. 6, T38NR2E, "[moving southward, at 18.5 chains] Open marsh bears West and S. E." and the line is described as "…subject to overflow from 2 to 4 ft [underlining added]" on October 16, 1873; on July 19, 1859, the line [traveling northward] was described as "…high water overflowed the 1st 65 chains " [underlining added]. Surveying northward between S. 4 and S. 5, T38NR2E, the notes indicate "[at 5.5 chains] leave bush and enter open swamp N. E. and S. W." and "[at 27.2 chains] enter timber E & W,' then ending at 53.4 chains, at the "…edges of an impassable swamp…water from 2 to 4 feet deep [underlining added] and covered with hard hack and willow bush" on July 19, 1859. Between S. 5 and S. 8, the line is described on July 19, 1859 as "…subject to overflow to the depth of a foot except along the stream where it is higher [underlining added] …The whole will make good meadow land. Timber, Willow, Crabapple & alder in small clumps." The northern 48.47 chains between S. 7 and S. 8, T38NR2E, is described as "…marsh with scattering willow and crabapple" on October 17, 1873. Within S. 7, a line through the center was "…covered with Willow and Crabapple" (October 22, 1873), through the N ½ was "…marsh covered with scattering clumps of Willow and Crabapple" (October 23, 1873); through the south ½ of S. 6 it was "…Marsh covered with clumps of Willow and Hardhack. Subject to overflow of 2 to 3 ft [underlining added]." (October 23, 1873), through the center of the section there was "Marsh covered with scattering Willow and Hemlock."

The field notes from summer 1859 suggest that at least part of this Nooksack-side wetland was inundated in summer. The Bellingham Bay side may have been wetter in summer than the Lummi side. This speculation is based in part on topography—the Bellingham Bay side wetland would probably have been lower in elevation than that of the terrain downstream, fronting Bellingham Bay which would have hindered drainage—and based on the rendering of wetlands on the delta on the Blaine 1907 USGS topographic map. The Blaine Quadrangle depicts about 60% of the area we map as riverine-tidal wetland

in the Bellingham Bay with a wetland symbol. That none of the Lummi Bay side riverine-tidal wetland was depicted as wetland may reflect the effects of early diking (the Blaine 1906 quadrangle does not show diking, but but does show roads along the Lummi River), or it may reflect drier conditions. The GLO notes indicate that both marshes are subject to inundation by 2-5 feet of water in the winter, which is comparable to the current relief in the marsh area. On the basis of these observations, we assume that about one-third of the NKS_DLT380202 wetland was inundated in summer, none of the NKS_LUM380103 and NKS_LUM390201 were summer-inundated, and that both were largely (three-quarters) inundated in winter.

Palustrine Wetlands on the Greater Nooksack Delta

We mapped three smaller wetlands on the greater Nooksack delta area.

NKS_SDY380105 (21 hectares). The surveyors on August 23, 1859 described this area north of Sandy Point, surveying westward between S. 4 and S. 9, T38NR1E as "willow-hardhack swamp" from 61 chains to the corner. Westward between S. 5 and S. 8, the surveyors began in "dense swamp" which they characterized in the line description as "dry in summer and wet in winter [underlining added]. Hardhack-crabapple swamp." About one-fourth of the area was mapped as wetland on the Blaine 1906 quadrangle, and we have taken this as an estimate of winter inundation.

NKS_DLT390203 Tennant Lake area wetland (34 hectares). This area is identified as a "swamp" between S. 32 and S. 33, T39NR2E on October 6, 1871. On the 1938 aerials, taken in summer, conservatively one-fourth of the marsh appears inundated; we have taken this as an estimate of summer inundation. We have assumed a winter inundation based on the more-detailed information available for similar wetlands in the nearby lower mainstem wetlands (see below).

NKS_LUM390202 (50 hectares). The GLO surveyors traveling northward between S. 29 and S. 30, T39NR2E noted "[at 68 chains] Enter Hard Hack swamp" and "[at 80 chains] Corner cannot be

established [on account of water] for sections 19, 20, 29, and 30" on October 13, 1871. Mid-October could either represent late dry season conditions, or winter conditions. Conservatively we have assumed the observations to represent winter conditions.

Palustrine Wetlands along the Nooksack River Mainstem

Topographic depressions on the floodplain of the lower Nooksack were sites of extensive freshwater wetlands (see Figure 2). The GLO field surveyors commonly described these marshes as "hardhack swamp," "willow swamp," and "beaver swamp" and noted standing water (see descriptions below). The eight entries below for the lower mainstem represent a total mapped wetland area of 1,880 hectares. We mapped all but one 6-hectare wetland (NKS390207) primarily from GLO field notes (summarized below) and plat maps. We refined wetland boundaries shown on GLO plat maps using SSURGO (USDA-NRCS Soil Survey Geographic Database) digital hydric soils mapping, which generally corresponded well with the GLO wetland mapping, and a high-resolution DEM (see Appendix A).

NKS_LMA400201 (773 hectares). This wetland winds through the west and north side of the river valley between RM 8 and RM 17. The GLO notes are from three different years and times of year. Moving in an upstream direction on October 10, 1871, the notes indicate: traveling east between S. 9 and S. 16, T39NR2E "[at 20 chains] Hard Hack and toolie swamp" and "[at 44 chains] Enter willow and alder bottom subject to overflow to the depth of 2 to four feet in time of freshets of the river [underlining added]." East between S. 4 and S. 9, T39NR2E, "[at 27.5 chains] Leave burn and enter Alder & spruce bottom," then "[at 42 chains] Enter Hard Hack marsh," and "[at 62 chains] Leave marsh and enter willow bottom;" the line description indicates "Land in bottom subject to overflow 2 to 4 feet in winter [underlining added]" from October 10, 1871. Northward between S. 3 and S. 4, T39NR2E, the surveyors noted "[at 24 chains] Enter crabapple and willow bottom which is subject to overflow in time of freshets to the depth of 4 to 6 feet [underlining added]," and "[at 33.5 chains] The land becomes higher and is not subject to overflow," then "[at 41 chains] Enter bottom again subject to overflow [underlining added]"

and "[at 60.7 chains] A lake with swamp beyond being impassable [underlining added]" on October 6, 1871.

On March 10, 1873, travelling north between S. 34 and S. 35 (T40NR2E), at 45 chains they noted "Willow swamp bears E & W water 2 feet deep [underlining added]," and they encountered a "lagoon" between 64.79 chains and 74.59 chains. Running east between S. 26 and S. 35, T40NR2E, they noted at 10 chains "a swamp water 18 in. deep [underlining added]" on March 10, 1873. On March 5, 1873 they note, "the corner to sections 25, 26, 35 & 36 [of T40NR2E] which it is impossible to establish on account of water [underlining added]…subject to overflow of 2 to 8 feet [underlining added] …Timber Willow, Alder & Spruce. Undergrowth Vine Maple & hardhack."

Travelling east on the north boundary of T39NR2E, the surveyors on August 6, 1859 ran "2 miles & 75 chains, intersect impassable swamp with water from 2 to 4 feet deep [underlining added] and a dense growth of Hemlock, Tasslewood Willow & Crabapple. The swamp bears N. W. and S. E." This description would apply to the easternmost 5 chains of the boundary between S. 33, T40NR2E and S. 4, T39NR2E. The next day, on August 7, 1859, they traveled west along the same line, and recorded "[at 7 chains] Leave belt of timber 150 lks wide N. W. and S. E. & enter swamp of hard hack & willow" then "[at 11.5 chains] leave swamp water from 1 to 3 feet deep [underlining added] & enter skunk cabbage swamp" and "[at 19.25 chains] Leave swamp S. E. & N. W." The same day (August 7), traveling east along the line between S. 34, T40NR2E and S. 3, T39NR2E, they noted in their line description "Land level and unfit for settlement or cultivation being overflowed by the water of the Nootsahk River [underlining added]. Timber Alder, with Hardhack undergrowth." Travelling south between S. 33 and S. 34, T40NR2E, at 40.5 chains they noted "Swamp covered with hardhack and willow. Water 2 to 3 feet deep rendering it impassible [underlining added]."

The eight surveyed lines given above represent three years and times of year. In March 1873, both of two lines were inundated; in August 1859, two of three were inundated; in October 1871, none mentioned

inundation at the time of survey. The lines surveyed in October 1871 are in the southern (downstream) part of the wetland map unit. This may reflect that this portion of the wetland is less wet in summer than the central part of the wetland, or it may on the other hand reflect the failure of the surveyors in 1873 to note water depths. That none of the notes from 1873 on the delta include water depths, while the 1859 notes for the same era do, supports the latter interpretation. A conservative estimate of the inundated area in summer is the amount in which the surveyors described standing water (in March 1873 and August 1859), which is in about one-half of the map unit, as indexed by proportion of linear surveyed distance. The surveyors mention typical winter inundation depths of between 2 and 8 feet throughout the wetland. We estimate that most (about three-quarters) of the wetland is winter inundated, and about one half is summer-inundated. We have applied these same proportions to several similar, smaller wetlands in the lower mainstem that follow below, totaling 225 hectares (*NKS_LMA390204*, *NKS_LMA390205, NKS_LMA390206, NKS_LMA390207,* and *NKS_LMA400202)*.

NKS_LMA390204 (74 hectares). Travelling east between S. 16 and S. 21 (T39NR2E), on October 9, 1871, the GLO surveyors noted "Enter swamp," and "[at 55 chains] Leave swamp and enter burn." The line notes indicate "Land on west side [of the Nooksack River] subject to overflow in time of freshet to the depth of 2 to 4 feet [underlining added]." Travelling south between S. 20 and S. 21, the notes indicate "[at 39 chains] Enter crabapple and willow swamp" and "[at 53 chains] Leave swamp and enter alder and vine maple bottom" on October 9, 1871.

NKS_LMA390205 (45 hectares). Travelling north between S. 9 and S. 10, T39NR2E, it is noted "[at 30 chains] Enter swamp covered with Hard hack flags & grass" and "[at 37.7 chains] A lake it being impassable [underlining added] " on October 5, 1871; the lake mentioned is shown on the plat map and appears in our GIS mapping.

NKS_LMA390206 (6 hectares). We mapped this small wetland using SSURGO hydric soils data and topography.

NKS_LMA390207 (68 hectares). Surveying north between S. 3 and S. 2, T39NR2E, the GLO notes indicate at 71 chains "Enter Hard Hack swamp" and then at the end of the line "The corner to sections 2, 3, 34, and 35 cannot be established [due to water; underlining added]" on October 4, 1871. Travelling west between S.2 (T29NR2E) and S. 35 (T40NR2E), on August 5, 1859, the surveyors noted "[at 40 chains] …swamp overflowed in winter…Enter marsh overflowed in winter to a depth of 6 feet [underlining added] with a dense growth of hardhack & alders."

NKS_LMA400202 (32 hectares). Surveying northward between S. 30 and S. 29, T40NR2E, the surveyors noted "[at 17 chains] Enter open marsh" until 42.5 chains on March 27, 1873.

NKS_LMA400301 (711 hectares). The wetland is elongate in an east-west direction, on the south valley side. Moving west to east, the GLO notes indicate: traveling north between S. 31 and S. 32, T40NR3E, "[at 50 chains] enter swamp water 2 feet deep [underlining added]" on December 4, 1872. Between S. 29 and S. 32, T40NR3E, on December 4, 1872, at the beginning of the line "enter swamp," and at 40 chains " Enter willow and hard hack swamp." At the end of the line, the notes indicate "The corner to Sections 29, 30, 31, & 32. Land swamp covered with willow and hardhack. Water 2 to 3 feet deep [underlining added]. Soil 1st rate." Between S. 32 and S. 33, T40NR3E, traveling north, at 60 chains "Enter burnt bottom bears E & W," and at 70 chains "Enter beaver swamp [underlining added] bears E & NW." The line description (which could include land south of the wetland) indicates "Timber Fir Cedar and Alder. Undergrowth Crabapple and Willow." Between S. 33 and S. 34, T40NR3E, moving north, at 50 chains "enter beaver swamp [underlining added], bears E & W," and at 75 chains "Leave swamp enter burn" on November 25, 1872. Between S. 34 and S. 27, T40NR3E, at 5 chains "enter willow bottom"; the line description reads: "Land level. Soil 1st rate. Timber Alder Willow and Crabapple" on November 26, 1872. Between S. 34 and S. 35, T40NR3E, at 50 chains the notes indicate "Enter spruce swamp," and the line description is "Land level. Soil 1st rate. Timber Fir Cedar and Spruce. Undergrowth Hard Hack and Willow."

The lines described as inundated by water are in the downvalley part of this wetland. On the basis of these line descriptions, we assume that less of this wetland was inundated than the wetlands described above, which are also farther downvalley than is this wetland. Consistent with this interpretation is that the topographic depression in the upper part of this wetland is not as deep as in the lower part of the wetland or the wetlands farther downvalley, suggesting the observations in the GLO notes may accurately describe inundated conditions. We assume that in winter about one-half of the area is inundated. Because the wetland is commonly described as beaver swamp, we also assume that a part (one-quarter) of the marsh is inundated in summer.

NKS_LMA400302 (171 hectares). The GLO survey traveled north between S. 21 and S. 22 (T40NR3E) and noted "[at 35 chains] enter swamp bears E & W. Water from 1 to 2 feet deep [underlining added]" on November 27, 1872. The line description indicates "Land subject to overflow from 2 to 6 feet deep [underlining added]. Soil 1st rate. Timber balm alder and maple. Undergrowth Hard Hack and Maple;" the line description includes land in the 35 chains south of the "swamp." Travelling east between S. 15 and S. 22 (T40NR3E), the notes begin "Enter swamp water from 2 to 6 feet deep [underlining added]" and continue "[at 65 chains] enter spruce and Hemlock bottom. Water from 1 to 2 feet deep [underlining added]." A small corner of the wetland crossed by the line between S. 15 and S. 16 is termed "swamp." Crossing a small section of the wetland between S. 22 and S. 23, traveling north, the notes read "[at 30 chains] enter Alder Swamp bears E and W" and "[at 47.5 chains] Leave overflowed land [underlining added]." On the basis of the extent of inundated land described along these survey lines we assume that most (about three-qaurters) of the wetland was winter inundated.

The bearing tree records that fell within areas mapped as scrub-shrub palustrine wetlands, when grouped together, include about one-half (11 of 23) that lacked any trees near the survey point. At the remaining points, the average tree diameter was only 20 cm, and alder accounted for 42% of trees, the remainder being willow (14%), crabapple, spruce, birch, cedar (11% each), and hemlock (6%). The

bearing trees were relatively closely spaced (average distance from survey point of 5.1 m; Figure C-3), and their overall distribution suggests that the small trees were patchy and closely spaced within patches (Figure C-2).

NKS_UMA390401 (10 hectares). The GLO surveyors mention the area as "swamp" between 46 chains and 60 chains, northward between S. 19 and S. 20, T39NR4E. No evidence of a wetland is visible in the 1938 photographs, when part of the area is under cultivation and part has been logged.

Palustrine Wetlands in the South Fork

The lower South Fork valley, which has a lower gradient than the forks elsewhere, included an extensive system of wetlands, small channels and ponds in the Black Slough area (see Figure 2).

NKS_SFK380501 (604 hectares). The few bearing trees that fall within the wetland complex (Figure C-2) suggest it was dominantly a spruce-alder swamp. Descriptions in the GLO notes indicate it had "…dense timber and thick undergrowth" and was "swamp covered with skunk cabbage and very dense thickets of spruce and crabapple."Travelling north between S. 29 and S. 30 (T38NR5E), the surveyors noted "[at 33 chains distance] Enter swamp covered with skunk cabbage and very dense thickets of spruce and crabapple" on May 9, 1885; the line description reads "Timber alder, cedar, spruce & maple very dense. Undergrowth same with skunk cabbage, vine maple and crabapple very thick." Surveying west between S. 20 and S. 29, T38NR5E, the field notes read "[at 13.8 chains] Enter swamp bears SE & NW" and the line description is "Timber Alder, Cedar and spruce, very dense. Undergrowth [illegible] with vine maple and crabapple very thick" on May 9, 1885. Between S. 17 and S. 20, moving west, at 28.5 chains the notes indicate "Enter swamp bears N. W. and S. E." and the line description is "Timber Alder and spruce very dense. Undergrowth same, with vine maple and crabapple very thick" on May 11, 1885. Surveying north between S. 19 and S. 20, the notes begin "Along edge of swamp, through dense timber and thick undergrowth," and then "[at 67 chains] Leave swamp bears E & W," and the line description is "Land low and swampy…Timber alder, cedar, spruce, and maple, very dense. Undergrowth vine maple, skunk

cabbage, and crabapple very thick" on May 10, 1885. Running east between S. 19 and S. 30, "[at 70 chains] Enter swamp bears N & S" on May 10, 1885. West between S. 29 and S. 32, on May 7, 1885, the line is described as "Land low. Soil A.1. Timber Alder, cedar, maple and spruce very dense. Undergrowth same, with vine maple and crabapple very thick." For a minimum estimate of the amount inundated in winter, we have taken the area mapped as wetland on the Wickersham 1918 and Van Zandt 1918 15' USGS topographic quadrangles (which were mapped after most of the wetland area had been converted to agriculture), or 30 hectares (about five percent of the total wetland map unit).

NKS_SFK380502 (18 hectares). This wetland was not crossed by the GLO survey, and was mapped because it is a forested wetland on recent Deming USGS quadrangle. For a minimum estimate of the amount inundated in winter, we have taken the area mapped as wetland on the Van Zandt 1918 15' USGS topographic quadrangles (which was mapped after most of the wetland area had been converted to agriculture), or 9 hectares (about one half of the total wetland map unit).

SKAGIT-SAMISH RIVER

Estuarine Wetlands

Throughout the Skagit-Samish delta, estuarine wetlands had already been diked by the time of USC&GS charting (see Table A-5). We relied primarily on the GLO field notes and presence and spacing of GLO witness trees to map estuarine emergent and estuarine scrub-shrub areas. In the scrub-shrub map unit, at 18 of 38 survey points there were no trees close enough to serve as a bearing tree (Figure C-6). Where there were trees close enough to serve as bearing trees, the average distance to them in the estuarine scrub-shrub wetland was 29.6 m, considerably more than in adjacent riverine-tidal wetlands (13.9 m in riverine-tidal scrub-shrub wetland) or floodplain forest (Figure C-6). The bearing tree records suggest that spruce and juniper would have been conspicuous; spruce accounted for 17 of 40 (43%) of bearing trees, and was much larger in diameter than other trees, averaging 48 cm and accounting for 63% of basal area

(Figure C-4). Juniper was the only other large-diameter tree, second to spruce, averaging 30 cm; the visual dominance (and dominance by biomass and basal area) of spruce and juniper was probably similar to the estuarine scrub-shrub wetlands in the present-day Snohomish River estuary (Figure C-9). The remaining bearing trees were small diameter alder, crabapple and willow.

Individual wetland map units are: Fir Island *SKG_DLT330303* ESW (1,096 hectares) and *SKG_DLT330302* EEW (1,236 hectares); East of Fir Island *SKG_DLT320302* ESW (121 hectares) and *SKG_DLT320301* EEW (143 hectares); North Side of North Fork *SKG_DLT330301* ESW (545 hectares) and *SKG_DLT330309 EEW* (86 hectares); Sullivan Slough and South Swinomish Slough *SKG_PDL340306 ESW* (887 hectares) and *SKG_PDL330306 EEW* (139 hectares); Padilla Bay and North Swinomish Slough *SKG_PDL340305* ESW (484 hectares) and *SKG_PDL340304* EEW (1,916 hectares); Samish Bay *SKG_SAM350303* ESW (622 hectares) and *SKG_SM350302* EEW (1,265 hectares).

Riverine-Tidal Scrub-Shrub Wetlands

General criterion we used for mapping riverine-tidal wetlands include: networks of tidal sloughs evident on 1937 aerials, elevation a few decimeters above the estuarine wetlands, and common descriptions in the GLO field notes. Vast tracts to the north and south of Fir Island—the Beaver Marsh area on the Skagit Flats, and an extensive wetland in the Cedardale area, east of the South Fork—were dominated by hardhack and willow brush in dense thickets or in a patchwork with open marsh, and subject to seasonal or year-round inundation. We mapped these areas as scrub-shrub wetlands, and describe them below. These descriptions are followed by the forested riverine-tidal wetlands, which were generally slightly higher in elevation and had a tree cover.

The bearing tree records give a general description of the tree cover in the riverine-tidal scrub-shrub wetlands. Thirteen of 34 survey points lacked any bearing trees (Figure C-6). Where trees were present, they were on average 13.8 m distant from the survey point. Willow (31%), alder (22%) and spruce (16%) were the most common bearing trees (Figure C-4). Birch, cedar, crabapple, and pine accounted for

between 4% and 8% each. The occasional conifer was larger in diameter on average (54 cm) than the more abundant hardwoods (averaging 21 cm). Detailed descriptions of individual scrub-shrub wetland map units follows.

"Beaver Marsh" was a complex of marshes in the Skagit Flats. For this analysis, we use "Main" Beaver Marsh to refer to the southern portion of the marsh, which is distinct morphologically and hydrologically from the north part, which is described separately.

Beaver Marsh SKG_PDL340301, drains north (634 hectares) *and SKG_DLT330308, drains south* (805 hectares). The GLO field descriptions of Beaver Marsh are strikingly uniform. The line notes for the survey north between S. 3 and S. 4, T33NR3E, read "[at 2 chains] leave willows and enter alder and scattering spruce timber. Water standing at the surface of the ground" and "[at 6 chains] Leave timber enter thick willow, 10 to 12 feet high" then "[at 25 chains] Hard hack brush with scattering clumps of willows and crabapple" on October 17, 1866. Going east between S. 33, T34NR3E and S. 4, T33NR3E, "[at 29 chains] Enter swamp, brs. NW & SE unfit for cultivation. Subject to inundation during the winter and most of the year from 1 to 3 feet deep [underlining added]" then "[at 43.1 chains] A beaver house 4 feet high brs. N. 60 lks dist" on October 6, 1866. Northward between S. 33 and S. 34, T34NR3E, on August 19, 1872, "Through beaver marsh covered with hardhack & willow," and north between S. 34 & S. 35, on October 4, 1866, T34NR3E "Through marsh covered with flags, hardhack & willow" for 45 chains. Travelling west between S. 28 and S. 33, T34NR3E on August 20, 1872 "Through marsh covered with dense thickets of willow and hardhack," and northward between S. 27 and S. 28 on the next day, the nearly same description, "Through marsh covered with willows, hardhack, tules & flags." Eastward between S. S7 and S. 34 on August 21, 1872: "Through marsh covered with willows and hardhack thickets" for the first 39.5 chains, and eastward between S. 22 and S. 27, T34NR3E, on the next day: "Through hardhack, willows, flags & tules."

The present-day elevation is entirely below 1.5 m. The marsh was at least in part created by tidal backwater; GLO field notes imply that the "tide bottom" inter-fingers with the western portion of the marsh, and the relict channels evident on 1937 photos show the area was fed and drained to the north and south by a network of tidal creeks. The northward and southward draining portions of the marsh, which are given separate identifying codes and areas, were delineated using the relict tidal channels mapped from 1937 aerial photos. The area was also fed by freshwater from flood-filled distributary creeks (distributaries of the Skagit River) flowing in several relict mainstem river channels in the "upper Beaver Marsh" area.

The similarity of descriptions—of willow and hardhack brush, with some crabapple, beaver ponds, and cattails (flags)—is not surprising, considering that the present-day surface of this area appears to the eye as almost perfectly level. There is only one entry that indicates the marsh is inundated from 1 to 3 feet throughout most of the year, but this description is probably generalizable throughout the area, given that 1 to 3 feet is more relief than characterizes the entire marsh, at most 2 ft, according to the DEM. We have assumed that most (75%) of the area was inundated in winter and half (50%) in summer.

Riverine-Tidal Portion of "Upper" Beaver Marsh SKG_PDL340302 (363 hectares). For this analysis, we refer to "Upper Beaver Marsh" as the complex of marshes that feed "Main" Beaver Marsh, and that drain directly to Padilla Bay and the Swinomish Slough. The "Upper" Beaver Marsh, in turn, can be subdivided into a tidal-freshwater section (described here) and a freshwater section (SKG_PDL340303), described in the next section of the report.

Upper Beaver Marsh, overall, is characterized by ridge-and-swale topography resulting from relict channels. On topographic maps and aerial photos, the channels appear large enough to have been relict from the Skagit River. This inference is consistent with an Army Engineer's description of the area based on an 1872 field examination:

"While making an examination of the low lands lying between the Skagit and Samish, in 1872, I

> saw indications that the former at one time flowed into Padilla Bay, 12 miles north of the present mouth of Steamboat Slough; the old channel being easily traced, traversed by numerous beaver dams, doubtless the principle cause of the diversion of the river into its present course" (U. S. War Department, 1881).

The GLO field notes for this tidal portion of the marsh include descriptions along several survey lines, and reflect the interfingering of different environments mapped in the area. Surveying northward between S. 20 and S. 21, T34NR3E, "[at 7.9 chains] The former channel of a river, now overgrown with Tules, and brushes, running west" then "[at 16.5 chains] Leave the large timber and enter swamp and water" and "[at 40 chains] The water was 2 ½ feet deep and appeared to be deeper farther northward, we therefore considered it unfit for cultivation and impracticable now to survey it [underlining added]" on November 2, 1866. Northward between S. 19 and S. 20, the notes indicate "[at 21 chains] Enter a narrow strip of timber and briers" and "[at 29 chains] A deep slough 70 lks wide runs SW" and "[at 33.5 chains] Enter a swamp covered with grass and scattering clumps of rosebriers" and "[at 38 chins] Enter timber" and "[at 41 chains] Enter marsh again, covered with tules," then "[at 46 chains] Higher ground and scattering trees," "[at 50chains] Leave the timber, and enter marsh," "[at 68 chains] A stream 20 lks wide runs W. in a strip of timber," and "[at 70 chains] Leave the timber and enter tule swamp." Surveying west between S. 17 and S. 20 on August 30, 1872, the marsh was described as "Through marsh Covered With Hard Hack Willow and scattering firs. Standing water from 6 in to two feet deep [underlining added]." The marsh ended at 65.75 chains where there was "open tide flats. Covered with grass." The line description included "…subject to an annual overflow of from 3 to 5 feet [underlining added]. Timber Willow Spruce and alder. Undergrowth, Hard Hack, Willow, and Rank Grass." Surveying north between S. 16 and S. 17 passed in and out of marsh: "[at 26.4 chains] Slough 130 lks wide brs. S. 50 N.," then "[at 33.5 chains] Leave Marsh Enter timber" and "[at 39 chains] Leave timber enter marsh," "[at 52.5 chains] At this point Marsh bears S. 50 W. N. 50 E.," and "[at 64.5 chains] Leave Marsh Enter Spruce and Cedar Timber;" the line description included "…subject to overflow of from one to four feet [underlining added]. Timber Fir

Cedar Spruce, Alder Maple Willow and Crabapple. Undergrowth Willow Hard Hack, Flags and Grass." In light of these descriptions and the wetland's position as the downstream extension of the upper Beaver Marsh and lower Beaver Marsh, and to be subject to tidal backwater effects, we assume that the area is inundated as often as upper Beaver Marsh (see later description for SKG_PDL340303).

SKG330401 Riverine-Tidal Scrub-Shrub Wetlands East of the South Fork Skagit (1,019 hectares). We mapped this area as riverine-tidal because of the networks of tidal channels evident on the 1937 aerial photographs, the elevation, and the similarity in vegetation to the main Beaver Marsh wetland. The GLO field notes from 1872 indicate a mosaic of willow-hardhack brush and open marsh. Traveling eastward between S. 8 and S. 17, T33NR4E, on October 19, the transect begins "In swampy land covered with hard hack & willow." The line description includes "Timber, scattering spruce & Alder." East between S. 17 and S. 20, the surveyors again began "In marsh covered with hardhack & willow" for 35 chains on October 18. North between S. 17 and S. 18 the surveyors traveled "In marsh covered with hardhack & willow," and north between 19 & 20 they surveyors began "In open marsh" until 63.75 chains when they indicated they "Enter brush." Similarly, westward between S. 19 and S. 20, they began "In open marsh" and then at 20 chains "Enter brush;" between S. 19 and S. 30 they also began "In open marsh" and at 20 chains "Enter willow brush." Northward between S. 29 and S. 30, the surveyors at 57.3 chains "Enter open marsh;" eastward between S. 20 and S. 29, they began in open marsh and at 24 chains "Enter brush" until they entered timber at 25 chains. Westward between S. 30 and S. 31, the surveyors alternated between brushy and timbered swamp; at 19.4 chains "Enter open marsh" then at 29.5 chains "Spruce and alder Timber [mapped as riverine-tidal forested wetland; see below]" and at 39.75 chains again "Hardhack swamp." We have assumed inundation characteristics similar to the main Beaver Marsh area.

Riverine-Tidal Forested Wetlands

We mapped forested riverine-tidal wetlands on Fir Island, in patches associated with the scrub-shrub wetland east of the South Fork, and on the Samish River delta. The GLO bearing tree records, while

fewer in number for these areas, show differences from the scrub-shrub areas. These wetlands were overwhelmingly alder and spruce swamps; 37 of 67 bearing trees (55%) were alders, and 10 of 67 (15%) were spruce. The other 30% of trees included 4 cedar, 3 crabapple, 3 birch, and one each fir and vine maple. Trees were also larger than in the scrub-shrub wetland, averaging 33 cm compared to 22 cm, and more closely spaced, 8.1 m compared to 12.5 m. Bearing trees were present at all survey points. Individual wetland areas are described below.

Fir Island Riverine-Tidal Forested Wetland SKG_DLT330304 (614 hectares*) and SKG_DLT 330307* (131 hectares). The renderings on GLO plat maps and descriptions in field notes are incomplete, but document what we have generalized as two riverine-tidal wetland areas. The larger of the two wetland map units include these field observations from the GLO survey: eastward between S. 12 and S. 13, T33NR3E, the notes indicate "[at 49 chains distance] Leave the swamp and enter alder timber." The line description is "Land west of 49 chs., <u>too wet for cultivation. Subject to inundation by freshets and high tides 1 to 2 ft</u>. [underlining added]" on September 28, 1886. This observation is important because it pertains to the upstream portion of the wetland, and thus implies that the more bay-ward parts of the wetland are similar or wetter; the field notes lack description in these lower areas. The smaller of the two wetland units (SKG330307) is to the west, and is more poorly documented, and it has been mapped as simply "riverine-tidal," because there is insufficient information to characterize the vegetation. The notes include, northward between S. 10 and S. 11, "[at 7 chains] Leave the timber and enter willow & hardhack & willow swale" and "[at 25 chains] Enter alder and spruce timber." Eastward between S. 11 and S. 14, on October 9, 1866, the notes indicate "[at 1.5 chains] Enter swale land or swamp" then "[at 7 chains] Leave the swamp and enter spruce timber" and "[at 68 chains] Leave spruce timber and enter swale or swamp [into wetland SKG330304]." The DEM shows that the current elevation of the smaller wetland (SKG330307) is slightly higher in elevation than that of the larger wetland SKG330304 (1.1-1.4 m compared to 0.8-1.4, respectively). The smaller wetland also does not appear to have been penetrated as deeply by tidal channels. These observations, combined with the GLO field descriptions of the smaller

wetland as "swale land or swamp" and "willow & hardhack and willow swale" compared to the larger wetland as "swamp," is taken as suggesting that the smaller wetland was probably not as frequently inundated as the larger one. In both cases we assume that winter inundation was periodic (rather than lasting most of the season), and therefore are not tabulating either area as winter inundated.

Forested Riverine-Tidal Wetlands East of the South Fork Skagit SKG_DLT330402 (three areas totaling 441 hectares). The GLO notes include the line between S. 5 and S. 8, T33NR4E "[at 40 chains] Enter alder and crabapple swamp," with the line described as "Land level, swamp…Timber. Alder spruce & crabapple. Undergrowth. Hardhack & willow." Between S. 6 and S. 7 on October 22, 1872 was characterized "Land level swamp…Timber cedar, spruce, & alder. Undergrowth, willow & hard hack." Surveying north between S. 8 and S. 9 on October 19, 1872 "[at 1.5 chains] Crabapple swamp bears E & W;" the line is described as "Land level. Soil rich bottom swampy. Timber spruce, cedar & alder. Undergrowth, hard hack, willow and vine maple." The inundation pattern of these areas is assumed to be similar to the Fir Island forested riverine-tidal map units described above.

SKG_SAM350301 Samish Bay Area Riverine-Tidal Forested Wetland (867 hectares). Unlike the other, previously described riverine-tidal wetlands, this area is *not* shown as wetland on the GLO plat maps. The 1937 photographs do however show tidal channels, although there are few of them (and there was probably considerably less channel habitat than in the other areas we have mapped as riverine-tidal). The GLO field notes describe the area as "alder bottom" with abundant willow, crabapple hardhack and rosebushes. Additionally, the present-day elevations of the area are comparable to those in the tidally-influenced areas mapped on the Skagit Flats, Fir Island, and east of Fir Island. The GLO field survey was in October 1870, which could have been at the end of the dry season, and could have caused the surveyors to underestimate the extent of inundation. For the purpose of estimating aquatic habitats, this area is assumed to have been inundated less frequently and to a lesser depth, and to have less channel habitat than other riverine-tidal forested areas, and we have assumed there was no winter or summer inundation.

The GLO field notes include the following. The line between S. 9 and S. 16, T35NR3E, is described as "Soil rich bottom subject to overflow but not to an extent to render it unfit for cultivation [underlining added]. Timber Fir Cedar Spruce, Alder & Cottonwood. Undergrowth Salmonberry Willow Vine Maple" on October 27, 1870. Between S. 3 and S. 4 was described on October 24, 1870, as "Timber…Alder & Crabapple. Undergrowth Vine Maple Willow & Salmonberry. Between S. 3 and S. 10 as "Timber Alder, Spruce, Cedar, Hemlock and Crabapple. Undergrowth willow and [illegible word]." Surveying south between S. 9 and S. 10, "[at 18 chains] Alder bottom" and the line is described as "Timber cedar, spruce, fir & alder. Undergrowth willow Hard hack Salmonberry and Nettles" on October 22, 1870. Between S. 7 and S. 18 id described on November 2, 1870, as "Soil rich…alder bottom. Timber small alder and crabapple. Undergrowth Hardhack and Rosebush." Surveying north between S. 17 and S. 18, the notes indicate "[at 32.5 chains] alder bottom" and the line is described as "Land level soil rich bottom. Timber on south half mile Cedar Spruce & Alder. Undergrowth Crabapple, Rosebush and Salmonberry." Between S. 8 and S. 17 is described as "Soil rich bottom. Timber alder Spruce and Cedar. Undergrowth Willow Crabapple and Vine Maple; between S. 8 and S. 9 as "Timber fir, Cedar, Spruce and Alder. Undergrowth Vine Maple, Crabapple, Rosebush & Gooseberry" on October 27, 1870. The line between S. 7 and S. 8 which includes "alder bottom" is described as "Rich bottom land. Timber scattering Spruce and Cedar. Undergrowth Crabapple and Willow" on November 3, 1870.

Palustrine Scrub-Shrub Wetlands on the Skagit-Samish Delta

Bearing tree records within the palustrine scrub-shrub wetland map units indicate that willow, alder, and spruce were the most common trees (32%, 21%, and 17%, respectively; Figure C-5), with lesser birch and cedar (both 8%), crabapple (6%) and pine (4%). The average distance to bearing trees was more than twice that in the forested palustrine wetlands—13.3 m compared to 5.7 m (Figure C-6).

Palustrine Section of "Upper" Beaver Marsh SKG_PDL340303 (894 hectares). We interpret the historical marshes in the "Upper Beaver Marsh" to be have formed in low spots created by relict

mainstem channels (see earlier quote from Army Engineers). The marshes create a mosaic that sprawls through a third of the township, a pattern that reflects the topographic template, and is created overall by the frequent flooding the area reportedly received. For example, the "general description" for T34NR3E in 1872 includes this about the Upper Beaver Marsh area:

> "The central and eastern portion is low bottom land generally heavily timbered, but interspersed with extensive marshes. All of which are liable to an annual overflow of from three to seven feet [underlining added]."

At the time of this description, the area would have yet to be diked; the description indicates the township was still sparsely settled, with "some thirty settlers in the Township, the most of which being located on tide flats, the balance over near the Skagit River." The description for T34NR3E states that:

> "…a large portion of it is subject to inundation by the Skagit River overflowing its banks. The banks of the river are generally higher than the surrounding country and yet above the large drift it appears to be subject to frequent inundations from one to 3 feet."

The line notes consistently (see below) report evidence of water marks on trees as high as 8 feet above the ground. At one point, the notes specify an "annual overflow of from four to six feet [underlining added]."

The area was surveyed in August, making possible a minimum estimate of summer inundation, by tallying the cumulative length surveyed in which the surveyors mention standing water. It is a minimum estimate, because the notes may not have mentioned water in all cases where it was present. In tallying up the distance along 15 section lines (24 km), about 9.5 km was described as wetland (8.9 km) or lake or "lagoon" (0.7 km). We found 3.5 km that were described as having standing water (in each case, either 0.5-2 ft or 2 ft) or where the line was offset to avoid water; combined with the 0.7 km of lake or "lagoon" (presumably beaver ponds) accounts for 44% of the line distance surveyed. We are using this as the basis

to estimate that at a minimum roughly one-half of the marsh area was inundated in summer; we are estimating winter inundation as 75%.

Because the wetland consists of a network of sinuous marshes which the GLO surveyors mapped only along section lines, we refined the boundaries on the GLO plat maps using soils information and the high-resolution DEM. We found an excellent correspondence between SSURGO hydric soils and the GLO mapping along section lines, which increased our confidence in the utility of the soils data for refining the map unit boundaries.

Descriptions along fifteen GLO-surveyed section lines include: Eastward between S. 14 and S. 23, T34NR3E, the surveyors recorded "[at 22 chains] Lake bears North and South" then "[at 23 chains] Offset north 5.00 chains to avoid deep water" and "[at 25.745 chains] East shore of lake. Water found one to four feet deep [underlining added]" then "[at 29 chains] Lake bears North and South" and "[at 32.75 chains] East shore of Lake. Water from two to three feet deep [underlining added]" and "[at 34 chains] Offset 5 chains into line" and "[at 60.5 chains] Marsh covered with Willow Hard Hack and flags. Water from 6 in. to two feet deep [underlining added]. Marsh bears North and South" and "[at 63.5 chains] Leave marsh. Enter Timber" on August 14, 1873. The line description includes "Marks of overflow on trees from two to six feet high [underlining added]. Timber Spruce, Cedar and Alder & Maple. Undergrowth, Vine Maple, Willow Gooseberry & rosebush. Northward between S. 10 and S. 11, T34NR3E on August 16, 1873, the line began "Enter low bottom timber generally alder and dead cedar," then "[at 5 chains] Marks of overflow on trees seven and eight feet deep [underlining added]," then "[at 6.5 chains] Water 6 in. deep [underlining added]" and "[at 24 chains] Leave low wet bottom enter green Timber" and "[at 39.5 chains] Enter Marsh. Covered with Willows. Hard Hack and rank grass. Marsh brs. N 65 E and S 65 W" then "[at 62.5 chains] Leave Marsh. Enter Spruce, Cedar, Alder and birch Timber" then "[at 62.5 chains] Marsh brs. N 76 E & 76 W" then "[at 78.75 chains] Leave Marsh enter Timber, Spruce Alder and Birch." The line description includes "Marks of overflow on trees from two to Eight

feet high [underlining added]. Timber, Spruce Cedar and Alder. Willow Maple & Birch, Undergrowth Willow and Hard Hack. Northward between S. 21 and S. 22, T34NR3E, on August 24, 1873, the notes indicate "[at 30 chains] Leave Marsh Enter Spruce Alder and Cedar Timber" then "[at 53.3 chains] Marsh covered with Crabapple. Standing Water from 6 in to two feet deep [underlining added] bears N. E. and S. W." then "[at 58 chains] Leave marsh enter Timber" and "[at 70.5 chains] Marsh covered with Flags and Standing water from 6 in. to two feet deep [underlining added]. Marsh bears East and West" then "[at 79.2 chains] Leave marsh and enter Timber." The line description indicates "…subject to overflow of from two to four feet [underlining added]. Timber, Fir Spruce Cedar Alder Willow and Crabapple. Undergrowth Same with Hard Hack." Eastward between S. 15 and S. 22, T34NR3E, the notes indicate "In order to avoid Marsh I offset from Corner North 5.00 chains. Through timber" then "[at 37.3 chains] Offset south, 5.00 chs to line; the line description indicates "Marks of overflow 1 to 4 feet deep [underlining added]. Timber, Fir, Cedar, Spruce, Alder and Crabapple. Undergrowth Same with Willow and Hard Hack." Northward between S. 15 and S. 16, T34NR3E on August 26, 1873, the notes indicate "[at 12.7 chains] Marsh bears E. and W." then "[at 15.2 chains] Leave Marsh and Enter Timber" then "[at 17.0 chains] Leave Timber Enter Marsh covered with rank grass, Flags, rushes and scattering willows. Standing water from 6 inches to two feet deep [underlining added]" and "[at 36 chains] Leave marsh Enter Timber;" the line description indicates "Marks of overflow from one to four feet deep. Timber, Fir, Cedar, Spruce, Alder, Willow and Crabapple. Undergrowth Same with Vine Maple. Eastward between S. 10 and S. 15, T34NR3E, on August 27, 1872, the survey notes include "[at 10.5 chains] Leave Timber Enter Marsh brs. E & W" then "[at 28.75 chains] Offset North four chains to avoid marsh" then "[at 45 chains] Enter Fir and Cedar Timber" then "[at 54 chains] Offset 4 chains to South of Line" and "[at 63 chains] Enter Marsh Covered with dead timbered Coarse Grass" and "[at 78 chains] Enter green timber, Leave Marsh." The line description includes "Marks of overflow from one to four feet. Timber Fir Cedar Spruce Birch and Alder. Undergrowth Same With Crabapple and Vine Maple." Northward between S. 9 and S. 10, T34NR3E, on August 27, 1872, "[at 3 chains] Enter marsh covered with Willow and Hard

Hack bears E and W" then "[at 18.75 chains] Leave Marsh Enter Alder and Birch Timber" and "[at 23.5 chains] Enter Marsh brs. N. E. and S. W." then "[at 34 chains] Marsh brs. N. 45 E & S. 45 W" and "[at 54.5 chains] Leave Marsh Enter fir and Cedar Timber." The line description indicates "For the 1st 56 chains subject to an overflow of from two to four feet." Eastward between S. 3 and S. 10, T34NR3E on August 28, 1872, the notes indicate "[at 36.25 chains] Foot of descent, enter Marsh Covered with dry willows and grass" and "[at 50 chains] Marsh [illegible] N. E. and S. W." then "[at 68.5 chains] Leave marsh Enter Spruce birch and Alder Timber;" the line description indicates "East half overflows some three or four feet deep [underlining added]. Timber Fir Cedar Spruce Birch and Alder. Undergrowth Salmonberry and Willow." Eastward between S. 16 and S. 21, T34NR3E, the notes indicate "[at 45 chains] Leave timber and Enter Marsh" and "[at 54 chains] From this point marsh brs. N. and S." then "[at 69 chains] Leave Marsh Enter Timber;" the line description includes "…subject to an annual overflow of from two to six feet [underlining added]. Timber Spruce Cedar Alder Maple Crabapple and Willow. Undergrowth Hard Hack and Willow." Eastward between S. 9 and S. 16 on August 31, 1972, "[at 19.75 chains] Enter Marsh brs. North and South" and "[at 28 chains] Leave Marsh Enter Timber" and "[at 33.5 chains] Leave Timber Enter Marsh brs. N. E. & S. W." and "[at 44.5 chains] offset South 2.00 chains to avoid water [underlining added]" and "[at 69 chains] Leave Marsh brs. N. E. and S. W." then "[at 72.5 chains] Offset North 2.00 chains onto line." The line description includes "…low and wet. Subject to an overflow of from 2 to 5 feet [underlining added]. Timber Fir Cedar Spruce. Alder and Willow. Undergrowth Willow Hard Hack and Coarse Grass." Northward between S. 22 and S. 23, T34NR3E, "[at 3.45 chains] Marsh covered with standing water two feet deep [underlining added] brs. NW and SE" then "[at 11 chains] Leave marsh and enter timber" then "[at 15.73 chains] Marsh covered with willow, hardhack and flags, standing water from 6" to 2 feet deep [underlining added]" then "[at 30 chains] Leave marsh, enter spruce cedar and maple timber" and "[at 40.5 chains] Marsh brs. E & W" then "[at 45 chains] Leave marsh and enter spruce, cedar and maple timber" on August 13, 1872. Northward between S. 23 and S. 24, T34NR3E, "[at 7 chains] Enter hardhack thicket" and "[at 9.5 chains] Leave

same & enter marsh covered with rank grass, & scattering hardhack, bears E. and W." then "[at 58.5 chains] Leave marsh, & enter thicket of willow and hardhack & alder" and "[at 60.5 chains] Enter timber, spruce, cedar & alder." The line description includes "Land nearly level…subject to overflow of from 2 to 6 feet [underlining added]. Timber, cedar, spruce, alder, willow & crabapple. Undgth hardhack rosebush, willow & vine maple." Eastward between S. 23 and S. 26, T34NR3E, on August 12, 1872, the notes begin "[at 3.5 chains] Lagoon, offset 5.00 chs., to avoid same" and "[at 11.25 chains] Lagoon, offset 125 lks to avoid same. Lagoon brs. Nearly E & W" and "[at 30 chains] Offset north 6.25 chs. into line" then "[at 38 chains] enter marsh covered with willow and hardhack, brs. NE & SW." Finally, eastward between S. 24 and S. 25, T34NR3E, the notes read "[at 3.5 chains] Enter marsh bears N.E. and S. W." and "[at 6.5 chains] Leave marsh & enter bottom," then northward between S. 25 and S. 26, T34NR3E, "[at 29.5 chains] Enter thick growth of alder" then "[at 55 chains] Leave alder bottom and enter marsh brs. NE & SW" and "[at 60.5 chains] Leave marsh and enter willow, Alder & crabapple bottom."

Main Olympia Marsh SKG_SAM350306 drains to Samish Bay (1,361 hectares) *and SKG_PDL340307 drains to Padilla Bay* (459 hectares). About one-half of the sample points (11 of 23) in the main part of Olympia Marsh lacked any witness trees and the land surface was too wet for the surveyors to build a mound (see Appendix A for detail on the surveyor's instructions). Spruce, alder, and willow were the most common bearing trees (Figure C-5).

We divided Olympia Marsh into the main part (described here), the upper part, and the series of marsh stringers to the west (separately described below). The GLO field descriptions for the main Olympia Marsh include notations from autumn as well as winter. Between these two it is clear that the marsh was inundated by several feet of water except in summer. The township description for T35NR3E includes the statement "In the S. E. part of the Tp. [township] is a large marsh extending from NW to SE which is overflowed from the beginning of the wet season until July [underlining added]."

The descriptions are: Surveying northward between S. 1 and S. 12 (T34NR3E), "Through Hard Hack Willow and flags. Water 18 in. to 2 ft deep [underlining added]," and "[at 3.75 chains] Leave marsh and enter crabapple thicket," then "[at 13 chains] Enter marsh brs, N and S," and "[at 70 chains] Leave marsh enter Spruce and Cedar Timber" on November 14, 1871. The line description includes "Marks of overflow on trees from 2 to 7 feet high [underlining added]. Timber Spruce, Cedar, Alder and Willow and Crabapple. Undergrowth, Willow and Hard Hack." The line between S. 1 and S. 2, T34NR3E, runs in and out of marsh, and the line description indicates "Undergrowth…in marsh Hard Hack and rank grass." In T35NR3E, on September 24, 1870 (near the end of the dry season, when the marsh should be at its driest), surveying north, "[at 40 chains] Leave timber and enter swamp covered with clumps of willows & hard hack brush," and "[at 80 chains] …attempted to make a mound but found the soil a kind of peat with water at the surface…;" the line description indicates "Land swampy covered with willow and hardhack bush subject to overflow to the depth of from two to three feet deep the wet season but nearly dry in summer [underlining added]." Travelling north between S. 35 and S. 36 on October 6, 1870, "[at 15 chains] Emerge from heavy timber into a swamp covered with Hardhack brush & vines," then "[at 50 chains] Swamp covered with grass and low bushes of Hardhack & swamp willow bears SE & NW," then "[at 80 chains]…the soil a kind of peat with water at the surface of which a permanent mound cannot be made [underlining added];" the line description indicates "Soil south of 50 chs. rich and fit for cultivation. North subject to overflow and unfit for cultivation. Timber fir Cedar Spruce Hemlock and Alder. Undergrowth Vine Maple & Salmonberry." The line between S. 25 and S. 36, on October 6, 1870, is described as "Soil in edge of swamp rich but in center is of a peat formation subject to overflow to an extent which renders it unfit for cultivation [underlining added]." The land between S. 24 and S. 25, T35NR3E, was described as "swamp" east of 5 chains, and the line was described on October 12, 1870 as "…soil rich bottom. Timber Cedar Spruce Hemlock Fir Alder & Willow. Undergrowth Willow Hardhack & Vines;" the same day, between S. 26 and S. 35, was entirely "In swamp," and the line was described as "…level swamp subject to overflow from two or three feet deep [underlining added] unfit for cultivation

but the soil is rich in edge of swamp covered with willow & crabapple." Surveying westward between S. 36, T35NR3E and S. 1, T34NR3E, is described as "marsh or swamp" between 12 and 65 chains; the line is described as "Land east of 65 chains mostly swamp unfit for cultivation subject to inundation by the river freshets or moderately high water 3 or 4 feet deep [underlining added]" on October 22, 1866. Between S. 25, T35NR3E and S. 36, T35NR4E, the line is described as "Land swampy subject to overflow unfit for cultivation, covered with willow and Hardhack brush" on September 27, 1870. The next day, the southern 25 chains of the line between S. 24 and S. 19, T35NR4E was described as "swamp." A few lines were surveyed in February, 1873. Moving northward between S. 31 and S. 32 on February 12, the notes indicate "[at 20 chains] Leave timber. Enter Marsh. Water 1 ft. deep [underlining added]" until timber is entered at 55 chains, then "[at 62 chains] Enter swamp again," and "[at 80 chains] Water 3 ft. deep [underlining added];" the line description includes "Timber Spruce & Cedar. Undergrowth Willow & Hardhack." The same month, between S. 30 and S. 31, T35NR4E is described as "Water 3 feet deep [underlining added]. Timber Spruce & Cedar;" at the midpoint (40 chains) along the line between S. 29 and S. 30, they indicated "The water being 2 feet deep [underlining added]" on February 13; and the line between S. 19 and S. 30, on February 14, is described as "Water 2 to 3 feet deep [underlining added]. Scattering spruce & Hemlock."

SKG_SAM350402 Butler Flats Area Wetland (216 hectares). The GLO field notes include two surveyed section lines. The first, between S. 18 and S. 19, T35NR4E, indicates "Land level. Water 2 to 3 feet deep [underlining added}. Soil 1st rate. Timber Willow" on February 15, 1873. The other indicates, traveling northward between S. 17 and S. 18, T35NR4E, "[at 1 chain] Enter Open Marsh" and "[at 57 chains] Leave Swamp. Ascend abruptly 40 feet." While there is no explicit mention of water depth along the second line, the survey point could not be established at mid-line, because of water; the same is true of the point along the first line. Additionally, the elevation distance between the two lines is less than the water depth given. For these reasons, we assume that most of the marsh was inundated in winter. Lacking

information on summer inundation, we assume the wetland was similar to the main Olympia Marsh, and lacked summer inundation.

SKG_SAM350304 Wetland South of Bow (79 hectares). The GLO survey crossed the wetland between S. 2 and S. 11, T35NR3E, on October 17, 1870, when it was described as "…swamp covered with Hardhack brush bears N and S." The GLO surveyors did not mention swamp or water between S. 11 and S. 12 on October 11, 1870. However, the Samish 1917 USGS 15' topographic map shows the wetland extending to the south from S. 11 to S. 12, with boundaries slightly smaller than those we have mapped. The map unit also corresponds to hydric soil types. We assumed that inundation was similar to the Butler Flats map unit.

SKG_SAM360301 Wetland North of Bow (212 hectares). The GLO survey northward between S. 34 and S. 35, T36NR3E on March 25, 1872, "[at 12 chains] Enter spruce and crabapple Swamp Covered with water to the depth of one to two feet [underlining added]" and "[at 70 chains] Leave swamp and enter cedar bottom;" the line description includes "Land level. Timber crabapple, Willow and spruce." Eastward between S. 27 and S. 34, the line begins in "Thick bushes and Timber" and then encounters "[at 54.54 chains] The lake or lagoon. Water 18 in. deep [underlining added]" and "[at 79 chains] Leave lake and enter cedar bottom." SSURGO hydric soils correspond generally with the western part of our map unit, which the GLO field notes also identify as inundated in March 1872. We estimate the winter inundation to have been about one-third of the total area, based on the GLO notes. Lacking information on summer inundation we assume it is not inundated, similar to the previously described, nearby wetland map units.

SKG_SAM350305 Sinuous Wetlands West of Main Olympia Marsh (260 hectares). The form and topography of this complex of wetlands suggests that, similar to the Upper Beaver Marsh area, these marshes followed the subdued topography of old river channels. The area is generally drained by the present-day Joe Leary Slough, described in the GLO notes as a "sluggish stream [illegible word] by

beaver dam" (at 18 chains east, between S. 22 and S. 27, T35NR3E). Because the wetland complex is sinuous and the GLO survey crossed it only along section lines, we made use of the SSURGO hydric soils mapping to shape the boundary and fill in areas between GLO survey lines.

The GLO field descriptions include between S. 26 and S. 27, T35NR3E on October 12, 1870, between 65 chains and 76 chains north " Swamp;" the line description indicates "Land in timber good, but in Swamp subject to overflow [underlining added]." Eastward between S. 23 and S. 26, the "swamp" was encountered intermittently with timber: "[at 4 chains] Leave timber and enter swamp bears N & S" then "[at 15.5 chains] Timber" and "[at 17.5 chains] Swamp" and "[at 25 chains] timber" then "[at 29 chains] Swamp" and "[at 56 chains] Timber;" the line description includes "The swamp covered with thick growth of hardhack brush" on October 13, 1870. Northward between S. 22 and S. 23, T35NR3E, "[at 35.5 chains] Leave timber enter swamp bearing E & W" then "[at 45.5 chains] Leave swamp enter timber;" the line description on October 13, 1870 indicates "Swamp covered with willow Hardhack and crabapple." Eastward between S. 22 and S. 27, T35NR3E, "[at 61 chains] Swamp covered with hardhack" and "[at 67.58 chains] Timber bears N & S;" the line description indicates "Swamp subject to overflow to the depth of about 12 inches [underlining added]." "Swamp" was encountered on the westernmost 15 chains between S. 16 and S. 21, T35NR3E on October 26, 1870. Because few lines are described as being subject to overflow, and the one quantitative measure indicates a relatively shallow depth (of 12 inches), we assume that the area was not inundated to a significant depth throughout the winter or summer.

SKG_SAM350405 Palustrine Scrub-Shrub Wetland South of Brickyard Creek (26 hectares). This wetland area is crossed by two lines in the GLO survey. Going northward on January 28, 1873, between S. 13 and S. 18, T35NR4E, "[at 5 chains] Enter swampy bottom bears N. W. & S. E." until "timber" is encountered at 10 chains. Eastward between S. 13 and S. 24, "[at 43 chains] Enter Willow & Hardhack Swamp brs. N & S." We assume neither this wetland or SKG350404 (below) was inundated to a significant depth.

SKG_SAM350404 Palustrine Scrub-Shrub Wetland South of Cook Road, West of Sedro Woolley (5 hectares). On January 28, 1873, the GLO surveyors came across this wetland between S. 22 and S. 35 "[at 22 chains] Enter willow swamp bears N & S" that continued to 35 chains, where they entered "fir timber."

SKG_SAM350403 (22 hectares). We mapped this wetland on the basis of SSURGO hydric soils mapping and assumed it not have been inundated.

SKG_UDL340405 Mud Lake Palustrine Scrub-Shrub Wetland (54 hectares). Northward on September 18, 1872 between S.1 and S. 2, T34NR4E, "[at 22.5 chains] Swamp bears E and W Water 2 ½ feet deep [underlining added]. Subject to overflow of 10 feet [underlining added]" then "[at 29 chains] A slough 50 lks Wide runs W." and "[at 35 chains] Spruce timber brs. N. E. & S. W. and "[at 52 chains] Swamp brs. N. E. and S. W. Water 2 ft. deep [underlining added]" then "[at 75 chains] dry ground;" the line summary indicates "…level swamp subject to overflow of from 6 to 10 feet [underlining added]." Because this area is subject to inundation by up to 10 feet of water, and was inundated in September (the end of the dry season), we assume that it was inundated in winter and largely inundated in summer.

Palustrine Forested Wetlands on the Skagit-Samish Delta

Bearing tree records for palustrine forested wetland indicate a spruce-alder swamp—together accounting for 58% of trees (Figure C-5) and 72% of the basal area (Figure C-5, 53% accounted for by spruce and 19% by alder). The trees were relatively closely spaced, the average distance to bearing trees being 5.7 m (Figure C-6).

SKG_SAM350401Upper (Forested) Olympia Marsh (758 hectares). The boundary between the main, lower-elevation portion (scrub-shrub) of Olympia Marsh and the upper (forested) part is generalized and approximate. We shaped the boundaries of the GLO-mapped wetland in the east and northeastern part of our wetland map unit using SSURGO hydric soils mapping and topography.

The field notes include the following: northward, on February 6, 1873, between S. 21 and S. 22, T35NR4E, "[at 41 chains] Enter Willow & Hardhack Swamp 3 feet deep [underlining added];" the line description adds "Timber Cedar Spruce Hard Hack Alder & Willow." Eastward between S. 15 and S. 22, T35NR4E, the line begins "Enter swamp" and "[at 39 chains] Enter Fir & Cedar Timber" also on February 6, 1873. Northward between S. 15 and S. 16, T35NR4E, notes indicate "[at 50 chains] Leave swamp. Enter timber bears E & W" then "[at 60 chains] Enter swamp bears E & W;" eastward between S. 10 and S. 15, the notes indicate "[at 38 chains] Leave swamp enter timber bears N & S;" and northward between S. 9 and S. 10, T35NR4E, "[at 10 chains] Leave swamp. Enter spruce bottom bears E & W" on February 7, 1873. Eastward between S. 9 and S. 16, T35NR4E , notes indicate "[at 27.5 chains] Descend abrubtly into swamp bears NE & SW." Northward between S. 20 and S. 21, T35NR4E, the notes read "[at 1 chain] Enter swamp" then "[at 70 chains] Enter timber;" the line notes include "Land level Water 2 feet deep [underlining added]…Timber Spruce Willow and Alder" on February 10, 1873. Northward between S. 19 and S. 20, T35NR4E, "hardhack swamp" is noted between 50 chains and 70 chains, and eastward between S. 17 and S. 20, "[at 20 chains] Leave timber enter swamp bears N. E. & S. W." then "[at 35 chains] Enter cedar timber" and "[at 45 chains] Enter swamp bears N & S" and "[at 70 chains] Enter timber bears N & S." Eastward between S. 16 and S. 21, T35NR4E on February 10, 1873, "[at 5 chains] Leave Timber Enter Swamp bears N and S. Water 2 feet deep [underlining added]" then "[at 60 chains] Leave swamp enter burn;" the line notes indicate "Timber Cedar & Spruce." Northward between S. 16 and S. 17, notes indicate "[at 10 chains] Leave timber Enter swamp bears E & W" then "[at 45 chains] Enter Swamp again bears E & W" then "[at 60 chains] Leave swamp brs. E & W Enter Timber bears N. E. & S. W." on February 11, 1873. Eastward between S. 20 and S. 29, T35NR4E, the notes begin "Enter swamp water 2 feet deep scattering spruce & cedar [underlining added]" then "[at 35 chains] Enter open marsh extends 5.00 to the N." and "[at 50 chains] Enter spruce & cedar bottom bears N & S" on February 14, 1873.

These field notes are from the first half of February, 1873. In about one-half of the area, the notes mention standing water two or three feet deep. Because this half is in the lower elevations of the map unit, it may reflect accurate reporting—in other words, the absence of standing water reported in the other half may not be due to uneven reporting, but due to differences between the two areas. We have used the proportion of area reported as inundated to make a conservative estimate of the winter-inundated area of about one-half of the wetland map unit.

SKG_DLT330305 Upper Fir Island Palustrine Forested Wetlands (177 hectares). On September 29, 1866, eastward between S. 1 and S. 2, T33NR3E, from 20 chains to 32 chains the GLO noted "swamp brs. S." Elsewhere it is described as "…swale, Crabapple & Willow, brs. SE" (at 22 chains northward between S. 1 and S. 2, T33NR3E) and "willow and hardhack & willow swale" (at 7 chains northward between S. 10 and S. 11, T33NR3E). We enlarged these wetlands from the area shown on the GLO plat maps, making use of hydric soils mapping and the DEM. We assume that the area was not inundated by water for significant periods of time.

SKG_DLT330403 Palustrine Forested Wetlands South of Mount Vernon (352 hectares). This wetland is the upper-elevation extension of the riverine-tidal wetland to the east of the South Fork Skagit; we used hydric soils and the DEM to refine boundaries from the GLO plat map. Eastward between S. 6, T33NR4E and S. 31, T34NR4E, the wetland is described as crabapple swamp: "[at 22 chains] Enter crabapple swamp" and "[at 25.3 chains] Lagoon 80 lks wide" then "[at 69.6 chains] Enter willow swamp N and S. [this describes the wetland mapped as SKG330401]". Similarly, eastward between S. 5 and S. 8, T33NR4E, "[at 40 chains] Enter alder and crabapple swamp;" the line is described as "Land level, swamp….Timber, Alder Spruce & crabapple. Undergrowth, hardhack & willow." Farther to the north, the area included in SKG330403 is described as "alder bottom" (northward between S. 31 and S. 32, at 30 chains, "leave swamp [mapped as SKG330401] enter alder bottom bears E & W." We assume that the area was not inundated by significant amounts of water for prolonged periods.

SKG_UDL340404 Wetland Between Mt. Vernon and Burlington (108 hectares). The GLO mapped this wetland in September 1872, when they mentioned four feet of water at one point and two feet at another point. Travelling eastward between S. 4 and S. 9, T34NR4E, they began "In overflowed swamp [underlining added]" then "[at 40 chains] The point for temporary ¼ Sec. Cor. Which it is impossible to set as the water is nearly 4 feet deep at this point [underlining added]." Northward between S. 8 and S. 9, T34NR4E, they note "[at 17 chains] Enter Swamp Water 2 feet deep [underlining added]" then "[at 25 chains] Slough 200 links wide runs S. W. Cross on drift" and "[at 40 chains] the ¼ Section Corner. Cannot be Established owing to the water [underlining added]." The line notes indicate "Subject to overflow 3 to 8 feet [underlining added]." The notes do not characterize the wetland's vegetation. The presence of so much water in late September, which is still within the low-flow season, suggests the area was probably perennially flooded.

Wetlands in the Upper Skagit and Sauk rivers

SKG_UPP350501Hansen-Coal Creeks Wetland (406 hectares). The extent of the wetland unit we mapped is smaller than as mapped by the GLO; we used the SSURGO hydric soils layer and topography to refine boundaries shown on the GLO plat map. Parts of the wetland are also mapped on the Wickersham 1918 USGS 15' quadrangle.

The GLO survey notes include: Northward between S. 15 and S. 16, on December 19, 1877, "[at 24 chains] Enter Crab-apple swamp N 70 E & S 70 W" then "[at 70 chains] Enter wide grass swamp E & W" then "[at 74.5 chains] Leave grass swamp." The line description indicates "Timber Fir Hemlock, Spruce Maple Alder & Crab-Apple. Undergrowth Same." Northward on December 23, 1877, between S. 16 and S. 17, "[at 49.5 chains] Enter swamp E & W. Water from 2 to 3 ft. deep [underlining added]" then "[at 75.5 chains] Leave swamp & ascend on table land 50 ft high;" the line notes indicate "Timber-Fir-Hemlock, Spruce, Cedar, Maple & Alder. Undergrowth Same With V. Maple." Westward between S. 18 and S. 19, on December 26, 1877, the notes indicate "[at 12.5 chains, the western edge of our mapped

wetland unit] Leave Beaver Swamp [underlining added]" then "[at 29 chains] Enter Open Prairie" and "[at 54 chains] Leave prairie and enter fir timber." Northward between S. 17 and S. 18, "[at 35 chains, the northern limit of our map unit] Leave beaver swamp [underlining added]. Eastward between S. 8 and S. 17, "[at 62 chains] Enter beaver swamp [underlining added] S. E. & N. W. water 2 to 3 feet deep [underlining added]" and "[at 64 chains] Leave same & ascend on table land 30 ft. high" on December 27, 1877. Northward between S. 20 and S. 21, "[at 52 chains] Enter Crab-Apple Swamp E. & W." then "[at 60 chains] Leave same enter Fir Timber" on December 22, 1877. Eastward between S. 16 and S. 21 on the same day, "[at 48 chains] Enter Crab-Apple & Willow Swamp N. E. & S. W." then "[at 54.5 chains] Leave same & enter Fir timber." On the basis of the proportion of survey line that is reported to have been inundated, we assume that a minimum of one-quarter of the area was inundated in winter; because of the abundance of beaver ponds, we assume that a small amount (arbitrarily estimated as 10%) was also inundated in summer.

SKG_UPP350502 Wiseman Creek Palustrine Wetland (66 hectares). This wetland is within the center of S. 14, and so the GLO survey could not have encountered it; we map it based on its presence on the 1918 Wickersham 30' USGS topographic map. We increased the area from that on the Wickersham map by about 40%, using SSURGO hydric soils mapping and topography. We have assumed that this wetland is comparable to the nearby *SKG350501* in its seasonal inundation.

SKG_UPP350503 Minkler Lake Palustrine Wetland (6 hectares). This wetland is within the center of S. 13, and so the GLO survey could not have encountered it; we map it based on its presence on the 1918 Wickersham 30' USGS topographic map. The shape of this wetland suggests it is formed in an abandoned channel meander, continuous with Minkler Lake. On the 1937 aerials a portion of the wetland appears to be inundated.

SKG_SAU341001 Wetland on Sauk River terrace (17 hectares). This wetland is within the center of S. 31, and so the GLO survey could not have encountered it; we map it based on its presence on recent topographic maps and SSURGO hydric soils mapping.

STILLAGUAMISH RIVER

Wetlands and Beaches on Fidalgo Island

Livingston Bay Marsh STL320305 (89 hectares). The GLO line notes between S. 20 and S. 29 include several references to "cranberry marsh" and the line description indicates "soil 1st rate. Clay loam wet. Undergrowth scotch pine, hardhack and cranberries" Between S. 29 and S. 28 the notes indicate "run through cattail flag" and "leave flags and enter brush" and the line description indicates "land level 1st rate (both lines surveyed July 20, 1859). Soils mapping (Ness and Ritchins, 1958) indicates the soils formed under marsh vegetation. The soils mapping also indicates beach-soil areas seaward of the marsh, and the USC&GS chart indicates grassland, consistent with an interpretation of beach dunes. Based on this information the area is mapped as palustrine scrub-shrub wetland, fringed with beach. The field notes do not indicate that the area was inundated in the summer, and do not include observations on indicators of winter inundation; we have assumed the marsh was not significantly inundated in summer or winter.

Small Fidalgo Island Tidal Estuarine Emergent Wetlands on Port Susan STL310301 (37 hectares) *and STL 320306* (2 hectares). These two wetlands, blind tidal channels within them, and small beaches, are mapped from USC&GS charting.

Fidalgo Island Estuarine Emergent Wetlands STL320303 (325 hectares) *and Estuarine Scrub-Shrub Wetlands STL320308* (28 hectares) *on Skagit Bay and between West Pass and North Pass*. The GLO notes between S. 26 and S. 27 indicate "land all level prairie, grass and brush one foot high, good grazing" (July 25, 1859). Between S. 25 and S. 26 the notes indicate "tide prairie covered with grass and

flags" (August 18, 1891), and between S. 23 and S. 26 (August 19, 1871) "land tide prairie subject to overflow at high tides 2 to 4 feet." The USC&GS chart maps the area as marsh. The small stringer of "forested floodplain" north of Juniper Beach and west of Davis Slough is encountered along the line between S. 26 and S. 27 as a "narrow grove of red cedar bearing NE & SW and corresponds to a stringer of sandy soils in the mapping of Ness and Ritchins (1958). A possible interpretation of this feature is a former beach deposit elevated slightly above the surrounding tidal marsh.

Mainland Estuarine Wetlands Contiguous with Port Susan and Skagit Bay

Estuarine Emergent STL310401 (109 hectares*) and Estuarine Scrub-Shrub STL310403* (71 hectares) *Marsh South of Hat Slough and Estuarine Emergent STL320404* (281 hectares) *and Estuarine Scrub-Shrub STL320406* (143 hectares) *North of Hat Slough*. Most estuarine wetland had been diked by the 1886 USC&GS chart T-1755. The GLO notes provide some bounds on the marsh at section lines and in a few locations mention "tide prairie" (e.g. between S. 25 and S. 26), but the marsh's extent is small relative to the number of section lines. We relied on the landward extent of relict tidal channel networks evident on the 1933 photographs. Along the line between S. 36 (T32NR3E) and S. 31 (T32NR4E) these channels provided a good constraint (within less than 100 m) between the upper limit of estuarine blind tidal channels (channels fed from Port Susan to the south) and the upper limit of riverine-tidal blind channels (fed by freshwater from the Stillaguamish River to the north), which also coincided with the transition from "tide prairie" to "timber" in the line description, which suggests that the limit of visible tidal channels is an accurate estimate of the upper limit of estuarine marsh, at least in areas where numerous channels are visible on the photos. In general, to draw a line between emergent and scrub-shrub vegetation we used the presence or absence of witness trees, but the boundary is broadly generalized because there are few survey points. The modern extent of emergent wetland in the South Fork Skagit River marshes was also used as a guide; there, emergent vegetation extends roughly 1 km up-delta. A visual indicator of historical conditions is provided by an April, 1886 photograph of Stanwood's

shoreline, the caption for which reads “the low-lying flat lands in the foreground [appearing to be estuarine emergent vegetation] were much like those to the north of town” (p. 30, Essex, 1971).

Estuarine Emergent Marsh STL320304 (411 hectares) *and Estuarine Scrub-Shrub Marsh STL320307 Marsh* (365 hectares) *North of West Pass on Skagit Bay* The upper limit of tidal marsh north of West Pass was drawn from GLO notes and from the boundary between tidal channels that drain toward the estuarine marsh versus toward the freshwater riverine-tidal marsh. Specific GLO note descriptions include “tide prairie” (between S. 23 and S. 24), “tide prairie covered with cattail flags” (between S. 13 and S. 14), and “overflowed at high tides, two to four feet, soil rich” (between S. 11 and S. 14); all observations were made between August 19 and August 21, 1871.

Delta-Area Freshwater Wetlands

Riverine-Tidal Scrub-Shrub Wetland North and West of Stanwood STL320403 (285 hectares). We map the wetland north and west of Stanwood (1-2 km up-valley from Florence in Sections 28, 29, 32, and 33) using the GLO field notes along the section lines and drawing the wetland’s boundary by making use of relict tidal channel networks or network fragments that make it possible to determine the directionality of flow (see Figure 2). These relict tidal channels are particularly visible on the 1933 photographs in S. 19 T32NR4E and S. 24 T32NR3E, including on the present site of Stanwood. A large tidal channel (Church Creek) bisects the portion of STL320403 to the west of Stanwood. We extended the wetland in the area of Church Creek, which is within S. 30 and thus not crossed by a GLO survey line, based on the elevation and the tidal nature of the central slough. The GLO field notes for STL320403 include, between S. 19 and S. 30, T32NR4E, “…swamp covered with hard hack, crabapple etc.” on September 26, 1872. Between S. 19 T32NR4E and S. 24 T32NR3E, “…a dense hardhack swamp extending west to the beach. Timber crabapple and hard hack” on June 8, 1859. We assume that the area is not appreciably inundated in summer, and inundated only periodically in winter (due to floods and high tides), owing to the absence of specific mention in the GLO notes of indicators of winter overflow.

Riverine-Tidal Forested Wetland South of Stanwood STL320302 (259 hectares). This wetland south of Stanwood, and on both sides of the Stillaguamish River is not shown on the GLO plat maps, but is identified as swamp in the GLO field notes, and is bisected by relict tidal channels on the 1933 aerial photographs. In the GLO notes, between S. 36 T32NR3E and S. 31 T32NR4E, traveling north "[at 63 chains] enter low dead timber" and "[at 76 chains] enter green timber and swamp." The transition to timber at 63 chains from the "tide prairie" to the south corresponds well with the point of transition where relict tidal channels visible on the 1933 photographs to the north connect to the Stillaguamish River (in the riverine-tidal forested wetland) and to the south to Port Susan (in the estuarine wetland). Between S. 30 T32NR4E and S. 25 T32NR3E, the line notes indicate "land first rate but wet and swampy. Timber fir, spruce, hemlock and alder. Undergrowth crabapple, briers, salmonberries etc." The area bisected by this survey line also shows relict tidal creeks on the 1933 aerials. Along the line between S. 30 and S. 31, T32NR4E, the surveyors summarize the line as "Timber spruce cedar and alder. Undergrowth vine maple, salmonberry, Briar and young willow. Entire line subject to overflow during winter months from 1 to 3 feet [underlining added]" on September 25th. We map the extent of the wetland in only the western half-mile covered by this line. We assume the area is not inundated in summer, and inundated periodically during high tides and floods in winter.

Riverine-Tidal Wetlands STL320402 (201 hectares) *and Palustrine Wetlands STL320401* (366 hectares) *on the North Side of the Lower Stillaguamish Valley.* We mapped this wetland complex on the basis of descriptions along several GLO survey lines that cross it. The cartographers working from the field notes did not draw the wetland boundaries, instead only showing wetland symbol along the lines. We have used topography, soils information, and the drainage network to draw the wetland's boundaries. The wetland occupies the lower-elevation part of the floodplain toward the north of the valley bottom. The topography suggests that this linear east-west depression includes in its axis a very old abandoned river channel, which may have taken off from the current channel near the Hwy 530 crossing of the "Old River" near the boundary between S. 36 and S. 35 T32NR4E, at the foot of Prestliens Bluff and the lower end of

Jackson's Gulch. We have divided the wetland into a tidally-influenced and a non-tidal portion, largely on the basis of elevation and the presence of a large tidal slough feeding the wetland's lower end.

In STL320402, the part of the wetland we have mapped as riverine-tidal, the GLO field descriptions include, between S. 28 and S. 33, T32NR4E "…swamp covered with hardhack, vine maple and willow…a swamp so dense with hardhack etc. that it is almost impossible to cut a line through" on September 23, 1872. Between S. 28 and S. 29 that same day the area is described as "hard hack crabapple & willow swamp," and between S. 32 and S. 33 three days earlier on September 20 as "Hard Hack and crabapple Swamp." Between S. 34 and S. 35, in STL320401 (the upper, non-tidal part of the complex), the wetland is characterized in the line description as "The swamp is covered with crabapple and vine maple and alder and very hard to get through. No timber worth mentioning along the line. There being but scattering cedar and spruce trees." On September 9, 1872, between S. 35 and S. 36, "[northward, at 31.5 chains, until 54 chains] Swamp covered with a dense undergrowth of crabapple, hardhack, and willow. It gives evidence of having been inundated [underlining added] and bears S69E and N10W" and "[at 40 chains] There are no bearing trees convenient as I am stuck in swamp which is (and has been the last 7 chains) covered with a growth of coarse grass about 5 feet in height;" the line description indicates that the marsh is "subject to overflow of several feet [underlining added]." Northward between S. 33 and S. 34 on September 16, 1872, the surveyors at 52.21 chains noted "Intersect a slough running E & W, probably a branch of Stillaquamish River. I chain across same 145 lks. [links];" that the channel was substantial enough for the surveyor to interpret this channel as a branch of the main river suggests that it had significant flow in summer. Farther along the line, they note that they "[at 72 chains] Enter Swale Covered with Coarse grass and Willow bushes."

The GLO field notes do not suggest that the wetland was significantly inundated in late summer when the survey was made (September 1872). There is only one field description of winter conditions ("subject to overflow of several feet"), which may reflect the lack of visual evidence for that in late September, or it

may reflect that the wetland does not have widespread winter inundation. We have tabulated the wetland as having no summer inundated area and a conservatively small amount (10%) of winter inundation.

Upper Mainstem and Forks

The GLO conducted their field survey in the upper mainstem in August and September 1875, the region's driest months. Their notes are thus helpful for delineating summer inundation.

Palustrine Scrub-Shrub Wetlands on the South Side of the Upper Mainstem STL310501 (32 hectares) *STL310502* (48 hectares) and *STL310503* (56 hectares). These three wetlands share a common landscape placement within shallow arcuate embayments in the south valley side. We lack detailed topographic maps or DEMs for the Stillaguamish, but the 10-m DEM made from USGS topographic maps suggests a slightly lower elevation in these areas. The areas presumably reflect very old (100s-1000s of years) abandoned river bends.

The GLO field notes describe STL310502 as simply "marsh" between S. 10 and S. 15, T31NR5E, on August 5, 1875, and "cranberry marsh" between S. 15 and S. 16, traveling northward, and beginning at the foot of the valley side, on the same day. The STL310503 map unit is described as "swampy ground" between S. 10 and S. 11 on August 26, 1875, and the same between S. 2 and S. 11 on September 1, 1875. The STL310501 area is not described as wetland (crossed for a short distance by the GLO survey along the line between S. 16 and S. 17) but we have mapped it on the basis of its similar landscape position, and having the same hydric soils as the other two wetlands. We modified the shape of STL310503 from that shown on the GLO plat map using the soils mapping and topography, consistent with the information in the field notes, by shrinking its boundary on the northeast portion into a separate oxbow wetland, and expanding it in the southwest. The field descriptions don't indicate summer inundation, and do not describe the area as subject to winter overflow; lacking information indicating otherwise we assume there is no significant inundation.

Small Wetlands on the Mainstem Floodplain STL310402 (2 hectares) *STL310504* (4 hectares) and *STL320405* (1 hectare). STL310402 is a small oxbow wetland intersected by the GLO survey between S. 2 and S. 11, T31NR4E, identified as a "slough," but the topography and 1933 photographs suggest it is more likely to have been an oxbow pond or emergent marsh. STL320405 is a small (1 hectare) oxbow wetland in S. 33 T32NR4E not intersected by a GLO survey line; we mapped it from the 1933 aerial photos and hydric soils mapping. The GLO notes describe STL310504 along the line between S. 9 and S. 10, T31NR5E as a "beaver marsh" on September 3, 1875.

Three Small Wetlands in Lower South Fork STL_SFK310505 (17 hectares), *STL_SFK310506* (10 hectares), and *STL_SFK310601* (3 hectares). STL_SFK310505 is within the center of S. 12, not crossed by GLO survey lines; it was mapped from hydric soils, topography, and its appearance on the 1933 aerial photos. STL_SFK310506 was mapped from hydric soils. STL_SFK310601: The GLO surveyors crossing the area between S. 6 and S. 7, T31NR6E wrote "[at 6 chains] swamp bears SW" to 10.3 chains, on September 20, 1875.

North Fork Palustrine Forested Wetland STL_NFK320601 (42 hectares). On November 18, 1890, the GLO surveyors noted between S. 11 and S. 12 T32NR6E, traveling northward "[at 45 chains] Enter swampy land course E & W;" they described the line overall as "heavily timbered." Most of the area we have mapped was also mapped as wetland on the 1899 USGS Stillaguamish 30' topographic map.

North Fork Palustrine Forested Wetland (Trafton Area) STL_NFK320602 (36 hectares). Described on November 16, 1890 between S. 16 and S. 21, T32NR6E as "swampy land."

North Fork Palustrine Forested Wetland STL_NFK320704 (24 hectares). Between S. 7 and S. 12 T32NR7E, described as "in swampy land heavily timbered and very dense undergrowth." Most of the wetland map unit was also mapped as wetland on the 1899 USGS Stillaguamish 30' topographic map.

North Fork Palustrine Forested Wetland STL_NFK320703 (15 hectares). The GLO plat map shows a wetland between S. 5 and S. 8 T32NR7E although it is not recorded in the field notes. The wetland boundary was drawn using hydric soils information; recent USGS topographic maps also show the area as a series of linked ponds. Currently (based on our field observations in the mid 1990s) the area is inundated by a series of closely nested beaver ponds.

North Fork Forested Scrub-Shrub Wetland STL_NFK320701 (8 hectares). Mapped as shown on the GLO plat map; the 1899 USGS Stillaguamish 30' topographic map shows a 2-hectare pond within the wetland map unit.

Small Wetlands in the North Fork: North Fork Palustrine Scrub-Shrub Wetland (Fortson Ponds Area) STL_NFK320801 (4 hectares). Mapped within S. 12 T32NR8E from hydric soils mapping. *North Fork Palustine Forested Wetland STL_NFK320702* (2 hectares). A small oxbow-shaped wetland in the middle of S. 16, mapped from hydric soils and 1933 aerial photos.

SNOHOMISH RIVER

Estuarine Wetlands

Estuarine Emergent Marsh SNH300502 (213 hectares) *and SNH290503* (227 hectares). We delineated emergent marsh from adjacent scrub-shrub marsh primarily from information in the GLO field notes—the presence of absence of bearing trees, and the line description. Line descriptions falling within the map unit include "tide prairie" (between S. 31 and S. 32, T30NR5E); "the land is low and covered with drift logs that have been here many years. At this point the land is forming very fast and a few years time will expose much on the point west of the line that is now under water" (between S. 5 and S. 6, T29NR5E); "land level tide prairie, good grass" (between S. 5, T29NR5E and S. 32, T30NR5E); "Land tide prairie and subject to overflow at extreme high tides" (between S. 5 and S. 8, T29NR5E).

The presence of a spruce at the corner of S. 4, 5, 8, and 9, and the mention of "extreme high tides" in the latter description was taken to indicate a transition between emergent and scrub-shrub marsh in the eastern part of the line between S. 5 and S. 8 (T29NR5E). The boundary between S. 8 and S. 9 was interpreted based on the line description indicating "…tide prairie…fine grass…" and the presence of bearing trees at the corner of S. 8, 9, 16 & 17 and at the corner of S. 4, 5, 8 and 9. To draw the boundaries between S. 4 and 5 (T29NR5E), S. 32 and 33 (T30NR5E), and S. 29 and 32 (T30NR5E) we made use of the line descriptions in combination with the 1933 aerial photos in areas where the tidal marsh remained undiked. The GLO surveyors the line between S. 4 and S. 5 (T29NR5E) as "Land level, fine grass, no timber…" but the absence of timber (generally used by the surveyors to mean dense trees) is consistent with the presence of scattered trees, and bearing trees were noted at the corner of S. 4, 5, 8, and 9. The line between S. 32 and S. 33 (T30NR5E) was described as "open marsh [unreadable] no timber or underbrush." We draw the line as crossing a small amount of scrub-shrub marsh, based on elevation and the 1933 photos, as consistent with this line description. Along S. 29 and S. 32 (T30NR5E) the notes indicate transitions ("…enter spruce swamp…enter tide prairie…enter spruce bottom") along the line, which are roughly consistent with those indicated on the 1933 photographs.

Estuarine Scrub-Shrub Marsh SNH300501 (381 hectares) *and SNH290502* (811 hectares). Section lines falling within the area mapped as scrub-shrub estuarine marsh, and their GLO field descriptions include: between S. 3 (T29NR5E) and S. 34 (T30NR5E) "…swampy and nearly worthless. The west 39.8 chains nearly all covered with flags and rose bushes and cut up with innumerable sloughs in all directions, and covered with high tide water…undergrowth in swamp salmon berry sallal and apple etc…the balance of the line passes over tide lands or deep water…"; between S. 9 and S. 6 (T29NR5E) "land level and mostly tide prairie"; between S. 16 and S. 17 "…tide prairie with high grass and flags"; "fine grass a few scattering juniper trees (between S. 4 and S. 9, T29NR5E); "…fine grass….subject to overflow at high tides, but can be reclaimed by dyking" (between S. 4, T295R5E and S. 30, T30NR5E); "…1st ½ mile covered with rose brush, the remainder tide prairie covered with good grass (moving northward between

S. 9 and S. 10, T29NR5E). The area also includes a line description that could also be consistent with emergent vegetation: “The land is subject to overflow from extreme high tides. No brush or timber. Fine tide grass” (between S. 3 and S. 4, T29NR5E). The area has been included in the scrub-shrub zone, however; the intent is to map a broad zone that is generally scrub-shrub, but which can contain areas of emergent vegetation. The GLO survey points include 3 of 15 in the map unit having no trees.

Trees were widely spaced; the average distance to bearing trees from GLO survey points was 161 links (32.4 m). Most (10 of 24) bearing trees (Figure C-7) were spruce (Sitka spruce, *Picea sitchensis*) and their diameter averaged 48 cm. Juniper (Rocky Mountain juniper, *Juniperus scopulorum*) was the next most common tree (8 or 24 trees), averaging 14 cm. This historical abundance of spruce and juniper is similar to our recent field observations in the Snohomish estuary. Incidental trees included 2 cedar, *Thuja plicata* (average diameter 11 cm), 2 fir, *Pseudotsuga menziesii* or *Abies grandis* (average diameter 23 cm), 1 yew *Taxus brevifolia* (7.5 cm diameter), and one crabapple, *Malus fusca* (10 cm diameter).

Riverine-Tidal Forested Wetlands

Ebey-Island Area Wetlands SNH290501 (2,632 hectares) *SNH300503* (102 hectares) *SNH280502* (130 hectares). We mapped an extensive area upstream of the estuarine wetland map units as riverine tidal forested wetland. Trees are almost seven-times more densely spaced in this area (see following paragraph) than in the estuarine scrub-shrub wetland. The GLO surveyors described the area as swamp, with occasional references to inundation during high tides in the March-April period of 1869 when the area was surveyed. The area was not uniformly covered with dense forest, with the field notes indicating areas having only scattered trees. The area is rendered on the USC&GS chart as marsh with coniferous tree symbols of varying spacing, with the spacing generally being greater near to the large sloughs; the symbol spacing is also dense on Otter Island. Undergrowth, most commonly roses and secondarily hardhack, was typically dense and described as “impassible.”

Line descriptions include the following: “Land level & swampy a few scattering trees. Rose briars & swamp dogwood [presumably red-osier dogwood, *Cornus stolonifera*] almost impassible” (between S. 15 and S. 22 in T29NR5E and nearly identical description between S. 21 and S. 22); “Land level and swampy all the way a few scattering Pine. Rose bushes very thick in many places (between S. 22 and S. 27, T29NR5E); “Land level & swampy rose brush very thick many places. The high tides cover the most of the land and we are compelled to wait for low tide” (between S. 27 and S. 28, T29NR5E, on April 1st, 1869); “Land level & swampy but little underbrush” (between S. 27 and S. 34, T29NR5E); “Land level & swampy a few scattering trees. Tall grass & rose bushes” (between S. 33 and S. 34, T29NR5E, nearly identical description between S. 28 and S. 33); “Land level & swampy but little timber. Underbrush swamp dog-wood, Scotch pine and Buck brush [hardhack, *Spiraea spp*.]” (between S. 26 and S. 27 T29NR5E); “Land swampy. Along the bank of slough is a strip of land about 4 chs wide covered with spruce and alder, the remainder is covered with crabapple and a small scrubpine” (between S. 34 and S. 35, T29NR5E); “Land level & swampy. Timber spruce alder & willow. Underbrush rosebushes & swamp dog-wood” (between S. 22 and S. 23, T29NR5E); “Timber spruce and alder. The land is covered with water at spring tide but can be reclaimed by diking” (between S. 10 and S. 15, T29NR5E).

The primary metric that we used to distinguish the scrub-shrub estuarine wetland from the riverine-tidal forested wetland is the distance to bearing trees. In the scrub-shrub estuarine wetlands, surveyors traveled almost seven times farther on average to find a suitable witness tree (32.4 m on average in the scrub-shrub area compared to 4.7 m in the forested area). Otherwise, tree cover in the two areas is broadly similar in size and composition with spruce trees being significantly larger (58 cm) than other species, excepting three cedar in the map area. Primary differences between the two areas are (1) that juniper (*Juniperus scopulorum*) is common in the estuarine scrub-shrub area, while pine (presumed to be shore pine, *Pinus contorta*) is common in the riverine-tidal forested area (Figure 5-2), (2) spruce, while still the most common tree in the riverine-tidal forest, is less dominant than in the estuarine scrub-shrub zone, and

(3) alder *(Alnus rubra*) and crabapple (*Malus fusca*) are common in the riverine-tidal forest, but not in the estuarine scrub-shrub zone.

Lower Pilchuck River wetlands SNH280602 (76 hectares). This wetland appears in the same form we have mapped it on the 1895 USGS Snohomish 30' topographic quadrangle. It is not mentioned in the GLO field notes for the line between S. 18 and S. 19, T29NR5E, surveyed on August 10, 1866. This argues against the area being inundated in summer; we also assume there is no winter inundation, lacking information.

Riverine-Tidal Scrub-Shrub Wetland

"Marshland" SNH280501 (1,800 hectares); continuous with SNH280502 (130 hectares), mapped as forested, and described earlier. The "Marshland" area is shown on GLO and USC&GS maps as a vast marsh on the south side of the Snohomish River. The USC&GS mapping suggests somewhat larger boundaries to the west than the GLO map, and analysis of the vegetation and topography to the east suggests a smaller boundary than mapped on the GLO map; the easternmost area depicted on the GLO map has a different vegetation pattern suggestive of river bottom, is higher in elevation, and the field notes refer to the area as river bottom subject to overflow from the adjacent Snohomish River.

Marshland is relatively level, mostly below the 5-ft contour on the most recently published topographic map (Everett and Snohomish quadrangles, 1953 with 1973 photo-revisions), and slopes upward in the east. The GLO notes indicate the marsh was subject to overflow "from rains and freshets in the river," suggesting the Snohomish River as well as adjacent upland drainage seasonally flooded the area. Morse (in Nesbit et al., 1885) describes it as "fresh-water marsh…." Tidal influence currently extends upstream in the Snohomish River beyond the upper end of the marsh, and would have increased the frequency of flooding in the area. What appear to be tidal creeks are visible on the 1933 and 1938 aerial photos in the lower three-quarters of Marshland. (Early aerial photo coverage does not extend to the peat-soil areas in the southwest portion of Marshland). We have mapped Marshland as "riverine tidal"

for these reasons. The upstream fourth of the marsh was probably transitional in its hydrology to a non-tidally influenced wetland, and inundated more from upstream river flooding, while the bulk of Marshland would have been inundated by tidal backwater flow in tidal creeks, upland creeks, and overbank flooding.

The GLO field notes suggest that Marshland was a patchwork of scattered-tree-covered areas, willow-hardhack shrub thickets, and open marsh. Eight of twenty (40%) of survey points lacked trees. Pine was the most common bearing tree, accounting for two-thirds (14 of 21) of bearing trees (Figure C-7). Pine trees were relatively small, averaging 19 cm. Forested areas were relatively sparse, with the average distance from survey points to trees being 15.7 m. Cedar, hemlock, and alder formed somewhat more dense stands, with average distances of 8.2 m. Spruce, and pine were more scattered, averaging 18.1 m from survey points. The open spacing of the pine and spruce is consistent with the frequent descriptive references to hardhack-willow thickets with scattered pines. This latter scrub/forest vegetation of hardhack-willow shrub with scattered pines or spruces accounted for about two-fifths (38%) of points. The remaining two-fifths (43%) of points had no trees near enough to serve as witness trees; most of these locations are described as willow-hardhack or as "open."

Line descriptions for the Marshland area include: "Land level. Soil near & east of river rich. West half of mile not so good, a sort of Peat. All subject to overflow from two to four feet [underlining added]". Timber spruce, cedar, fir & maple. Undergrowth vine maple, willow, crabapple & salmonberries" (between S. 4 and S. 9, T28NR5E); "Lands in swamps & level. Soil rich but subject to overflow from 2 to 5 ft [underlining added]"" (between S. 8 and S. 9, T28NR5E); "Swamp level Subject to overflow to depths of 3 to 4 feet [underlining added]". Timber Fir, Cedar, Hemlock, Spruce & Pine, Undergrowth Salal Willow & Hardhack" (between S. 9 & 16, T28NR5E); "Land swamp is overflowed 18 inches deep. Covered with willow and Hardhack brush" (between S. 10 and S. 15, T28NR5E, on March 1st, 1871); "Land swamp covered with hardhack willow and cranberries" (between S. 15 and S. 16,

T28NR5E); "Land swamp overflowed from 1 to 2 feet deep and subject to much greater overflow [underlining added]". Covered with willow and hardhack brushes" (between S. 15 and S. 22, T28NR5E, on February 28, 1871); "Swamp level soil rich. But subject to inundation from 2 to 6 feet deep [underlining added]". Timber Fir Hemlock Cedar & Pine. Undergrowth Willow Hardhack Salall and Salmonberry" (between S. 21 and S. 22, T28NR5E); "Land swamp overflowed 1 ½ feet and subject to overflow in times of freshets [underlining added]". Soil N ½ mile rich, on S ½ a kind of peat with Scrub Pine and Hardhack" (between S. 14 & S. 15, T28NR5E); "Land level. Soil a kind of peat. Subject to overflow to the depth of 2 to 4 ft [underlining added]" covered with Scrub Pine Tea bushes and Hardhack" (between S. 23 and S. 26, T28NR5E, on February 23, 1871); "Marsh rich but overflowed to the depth of 6 inches, and very miry unfit for cultivation" (between S. 26 and S. 27, T28NR5E, on February 23, 1871); "The ground is here [at a 40 chain distance along the line] overflowed to the depth of 2 ½ ft [underlining added]" and as we proceed further is getting deeper so I am unable to proceed further in this direction…bottom subject to overflow from freshets and rains from 2 to 4 ft deep [underlining added]"" (between S. 24 and S. 25, T28NR5E); "…subject to overflow from 2 to 6 ft deep [underlining added]" … (between S. 13 and S. 14, T28NR5E, on February 20, 1871); "Level swamp covered with willow and Hardhack brush and Subject to overflow from 2 to 6 feet [underlining added]"" (between S. 23 and S. 24, T28NR5E, on February 18, 1871); "Soil rich but subject to overflow from rains and freshets in the river to a depth of 2 to 6 feet [underlining added]" (between S. 25 and S. 26, T28NR5E).

Much of Marshland was flooded with a few feet of water at the time of the survey in February 1871. There were 23 survey points. Of these, field notes indicate the depth of water at 11, where depth averaged 0.67 m, and at an additional two points the water was too deep for access. Five additional points had too much water to allow the surveyors to build a mound, and three more points were described as "swamp." Thus, between 13 and 21 of 23 points had standing water. The water at three points was greater than a meter in depth, and the two points too deep to access were presumably deeper, meaning that at least five points were deeper than 1 m. Most points were described as "subject to overflow" to depths greater than

the water that was present at the time of the survey. At eleven points the surveyors provide quantitative estimates of seasonal flood depth which was on average 0.67 m. The published plat map shows "subject to overflow 2 to 6 ft" (0.6 to 1.8 m). Using the survey points as to estimate the proportion that was inundated in February 1871 indicates an approximately 80% area.

The extent of summer inundation might be suggested by the widespread absence of trees and the prevalence of willows. Additionally, the soils in about one-fifth of the area of Marshland are mapped as the Mukilteo Muck soil series (Debose and Klungland, 1983), organic soils developed under sedges and rushes. Earlier soils mapping (Mangum, 1909) shows most of the Marshland area as "muck and peat."

Marshland is designated "cranberry swamp" on the GLO map. Cranberries are mentioned at one location in the field notes. It is interesting to note that in the Fraser River delta, a reconstruction of historical vegetation by North and Tevarsham (1984) includes "cranberry swamp" as a map unit. Similar to the Snohomish's Marshland, the Fraser delta area has "'some hardhack and pine;' described in one instance as 'low pine brush mostly deadened by fire with great abundance of cranberries'" [North and Teversham (1984) identify the pine as *Pinus contorta*]. North and Tevarsham also indicate that ethnobotanic literature suggests it is likely that Indians cultivated the Fraser cranberry swamp.

The native name for the Marshland area, as accessed by the river, according to the transcription of T. T. Wateman' early ethnography by Hilbert et al. (2001), was

> "Ctcgwa'lltc, or "the outer edge of something," for rather high land along the margin of the river. The area lying [in] back of this high level is an extensive cranberry marsh" (Hilbert et al. 2001).

This one-word Lushootseed place name encapsulates much of the information that we gleaned from the GLO survey and from modern topographic mapping.

Palustrine Marshes

French Creek Marsh SNH280601 (1,517 hectares). The French Creek marsh is shown as 1,400 ha on GLO maps and is on the north valley side upstream of the town of Snohomish. The marsh appears to have been more densely vegetated than Marshland. All survey points (14 points) had trees close enough to serve as witness trees, and the average distance to trees was 6.3 m. Pine, spruce, and crabapple were the dominant trees; alder, cedar, and willow were less common (Figure C-8). All trees were similar in size except for crabapples, which were smaller in diameter. Similar to conditions in Marshland, pines tended to serve as witness trees alone, without other trees, and were somewhat more widely spaced, averaging 9.4 m from survey points compared to 5.5 m for other trees. As in Marshland, pine-covered areas appear to be sparser than tree cover in other parts of the marsh.

According to newspaperman and Snohomish resident Eldridge Morse, writing in 1877 (Northern Star Newspaper, April 4, 1877), the marsh had two identifiable portions. A forested band of trees divided the marsh into an upper and lower half:

> "It is nearly cut in half by a swath of spruce and cedar timber...The part below this belt, called the lower marsh, ...is splendid pasture land in the summer and fall. [It] is overflowed by freshets in winter and spring...The upper marsh is beaver meadow, covered with grass, hardhack and tea brush *[(Ledum groenlandicum)* with] no timber of any size."

Witness tree data do not contradict Morse's description; the distance to trees is greater in the upper part of the marsh, but there are too few points to make a comparison on that basis. However, the descriptions of water depth and beaver dams do contradict Morse's description as only the upper part being "beaver marsh." Surveyors in July and August 1866 describe most of the French Creek marsh as having been inundated by water on account of beaver dams. Further evidence of inundation are that soils in about one-third of the marsh (31%) are mapped as Mukilteo Muck (Debose and Klungland, 1983), which as indicated previously is a very deep soil formed "in organic material derived dominantly from sedges."

The GLO field descriptions include: Northward between S. 2 and S. 3, T27NR6E "[at 8.5 chains] "Enter an impenetrable marsh and ascertain that I can proceed no further on this line, the remainder lying mostly in an impenetrable marsh which embraces the greater portion of sections 2 and 3, I abandon running as an impracticable undertaking" on August 17, 1871. (All of the following observations are from T28NR6E, in July and August 1866.) Northward between S. 35 and S. 36 T28NR6E "[at 12 chains] Enter [illegible word] swampy land in places overflowed 6 inches [underlining added], bearing N. E. & S.W." then "[at 63 chains] …leave the swampy valley bearing N. W. and S. E. and ascend" on July 19, 1866. Northward between S. 34 and S. 35, T28NR6E, the line narrative begins "Begin the swampy prairie;" the line description includes "Land level wet and swampy….Timber scattering pines. Undergrowth Alder Willow and Crabapple" also on July 19, 1866. Northward between S. 33 and S. 34, "[at 10 chains] wet swampy valley land bordering on Brushy prairie bears N 20 W S 20 E" and "[at 69.5 chains] Deep Creek 40 lks wide runs slowly N 20 W;' the line description includes "Land swampy and in places overflowed to the depth of 12 inches in consequence of Beaver dams in Deep Creek [underlining added]...Timber scattering Spruce Pine & Cedar. Undergrowth Willow and Crabapple" on July 25, 1866. Eastward between S. 27 and S. 34, "[at 15 chains] Enter Hardhack prairie bears N. W. & S. W.;" the line description includes "Land level and swampy….Timber scattering Spruce and Pine, Undergrowth same with Willow and Crabapple." Northward between S. 27 and S. 28, the line is described as "Land swampy and generally overflowed to the depth of 12 inches in consequence of Beaver dams [underlining added]…Timber Spruce & Cedar. Undergrowth same with crabapple" on July 25, 1868. Eastward between S. 22 and S. 27, "[at 7 chains] Enter hardhack prairie bears N 70 W S 10 E" on July 31, 1866. Northward between S. 21 and S. 22, "[at 13 chains] Enter open prairie bears West and S. E." and "[at 32 chains] Leave the prairie bearing N 50 W S 20 E" also on July 31, 1866. Northward between S. 28 and S. 29, "[at 47 chains] Intersect overflow land to the depth of 6 inches bears [underlining added] N. W. and S. E.;' the line description includes "The Soil in the valley now overflowed in consequence of beaver dams [underlining added], is first rate. Timber Cedar Fir and Spruce. Undergrowth same, with Alder, Crabapple

and Willow" on August 1, 1866. The line description between S. 21 and S. 28, on August 1, was "Land level mostly overflowed to the depth of 6 inches [underlining added]….Timber Spruce Pine and Hemlock. Undergrowth same with Crabapple." Northward between S. 20 and 21 on August 2, 1866, "[at 24 chains] Enter thick Willows on the bottom of French Creek, liable to annual inundations to the depth of 36 inches, now covered with water to the depth of 8 inches [underlining added], bears E and W" then "[at 36.6 chains] French Creek 48 lks wide, 7 feet deep, runs N 60 W. There is a large Beaver dam on the creek about 6.00 chs from the line down stream and N 60 W" then "[at 60 chains] Leave the willow thicket and overflowed bottom [underlining added] and enter scattering Pine timber undergrowth a dense Crabapple thicket E & W." The line description includes "Land level and mostly overflowed now to the depth of 4 to 8 inches. Liable to annual inundation 36 inches [underlining added]….Timber scattering Pine, undergrowth same with Willow and Crabapple." Eastward between S. 16 and S. 21, also on August 2, "[at 44 chains] Leave the open overflowed valley and gradually ascend;" the line description includes "Land in the valley mostly overflowed to the depth of 4 inches [underlining added]…Timber scattering Pine undergrowth Crabapple." Northward between S. 16 and S. 17, "[Leave the wet valley bears S 80 E and extends N 70 W about 40 chs" on August 2, 1866. Eastward between S. 17 and S. 20, "[at 37 chains] Ener swampy bottom bears N & S" then "[at 47.2 chains] Leave the swampy timbered crabapple thicket, the land still wet and liable to inundation from 20 to 25 inches. [underlining added]"

Because the French Creek marsh was surveyed in late July and August, the region's dry season, the recorded water depths can be taken as an indication of the extent of summer inundation. The inundation is not great—one foot or less. Owing to its location, it seems likely that the French Creek marsh was less affected by Snohomish River floodwaters than it was by impoundment of upland runoff by beaver dams. The linear distance for which the notes explicitly mention inundation is about one-third of the total surveyed length. As indicated elsewhere, using this as a measure of inundated area is almost certainly a conservative estimate, because the surveyors do not appear to have consistently noted inundation. The notes excerpted above describe winter inundation as two to three feet.

Palustrine Scrub-Shrub Wetlands in Sturgeon Creek SNH300505 (3 hectares) and Palustrine Forested Wetlands in Quilceda and Sturgeon Creeks *SNH290504* (3 hectares). We mapped these small wetlands primarily from 1933 aerial photographs.

SKYKOMISH RIVER

Palustrine Wetlands

The Skykomish valley historical map includes several small (2 to 60 ha) wetlands on the northern side of the valley. Most of these appear to be related to old river bends or oxbows. Notes on individual wetlands follow.

SKY270701 (59 hectares). The GLO survey crossed the wetland between S. 2 and S. 3, T27NR7E, which resulted in the notation "impenetrable marsh bears E & W." We shaped the boundary of the map unit using hydric soils mapping.

SKY270702 (29 hectares). This area was not crossed by a section line or visited by the GLO survey. The 1938 aerials show the area has been largely cleared of trees with remaining patches of forest, and widespread ponded water is visible. The mapped area is coincident with hydric soils, including muck soils.

SKY270703 (21 hectares) and *SKY270704* (4 hectares). These areas were not crossed by a section line or visited by the GLO survey. The 1938 aerials show the area has been largely cleared of trees with remaining patches of forest. Ponded water is not visible on the photos. The mapped area is coincident with hydric soils, including muck soils.

S*KY270705* (10 hectares). This area was not crossed by a section line or visited by the GLO survey. The 1938 aerials show the area has been cleared of vegetation. Ponded water is not visible on the photos. The

mapped area is coincident with hydric soils, which have been used to delineate the area, which is adjacent to (and in the same arcuate depression as) a pond mapped by the GLO.

SKY280701 (20 hectares). This area was crossed by a section line but was not noted as a wetland in the GLO field notes. The 1938 aerials show the area has been mostly cleared of vegetation. Small areas of ponded water are visible on the photos. The mapped area is coincident with hydric soils, which we used to delineate the area.

S*KY280801* (28 hectares). Three separate wetlands in close proximity. The westernmost wetland was not crossed by a GLO survey line; soils mapping shows hydric soils. The middle wetland was not crossed by the GLO survey. It is mapped as a wetland on recent USGS topographic maps, and as hydric (muck) soil. On recent aerial photos there appear to be small ponds in an overall arcuate pattern. The easternmost wetland was crossed by the GLO between S. 34 and S. 35 (T38NR8E) and described as a "swamp."

S*KY280802* (10 hectares). This area was not crossed by a section line or visited by the GLO survey. The area appears on the 1938 aerials as forested with widespread ponded water. The area coincides with hydric (muck) soils.

S*KY280803* (6 hectares). This sinuous wetland in the lower Sultan River valley follows old river channels. It was not crossed by a GLO survey line. Recent appear to show local water ponding. The area coincides with hydric soils.

S*KY280804* (4 hectares). This arcuate wetland on a terrace in the lower Sultan River valley is continuous with a pond that is visible on recent aerial photos and shown on recent topographic maps. It was not crossed by GLO survey line. The area coincides with hydric (muck) soils.

SNOQUALMIE RIVER

Freshwater Wetlands

SNQ260601 (1,016 hectares). The largest wetland in the Snoqualmie valley occupied nearly the entire valley on the left bank side from RM 2 to RM 12 (see Figure 2). The GLO field notes indicate that the area was primarily a thick growth ("…almost unpassable…") of shrubs and small trees. The shrubs were described as hardhack, crabapple, willow, alder, and tule. Some areas are described as "cranberry marsh." The tree cover was described as "…a few scattering scrubby spruce and cedar" or "…a few scattering scrubby spruce, entirely worthless." From this information the area appears to have been primarily a scrub-shrub wetland with scattered, larger conifers. This interpretation is supported by images of a 3-km^2 remnant of the marsh shown on 1938 aerial photographs, which suggest a brushy marsh with scattered conifers (Figure C-10). Bearing tree data (Figure ____) also support the description of marsh tree cover as spruce having a small diameter, and small-diameter alder, maple, and vine maple.

The marsh system was characterized in the GLO notes as seasonally "subject to overflow" by as much as 8 feet of water, which is consistent with the modern elevation of the lowland area being several meters below the riverbank. At the time of the survey on April 4, 1873, the water was described as "… 6 to 18 inches deep [underlining added]." Descriptions on the GLO field notes include: Between S. 1 and S. 2 (T26NR6E) "…low scrubby open timber….subject to overflow at high water to the depth of from 6 to 8 feet [underlining added]. Timber in the last ¼ mile [moving north] low scrubby pine undergrowth crabapple willow & hard hack." Between S. 1 and S. 12, T26NR6E, "[moving east, at 41 chains] leave scrubby spruce timber & enter cranberry marsh N & S." "Mostly cranberry marsh, subject to overflow to the depth of 8 feet [underlining added]. Timber a few scattering scrubby spruce & cedar. Undergrowth hard hack & tule." Between S. 11 and S. 14, T26NR6E, "[moving east, at 34.5 chains] Enter swamp almost impassable [underlining added]." "[at 60 chains] Leave spruce swamp enter open marsh." "…land level, low swampy. Subject to overflow to the depth of from 2 to four feet [underlining added]. Timber, a few scattering scrubby spruce entirely worthless. Undergrowth alder & crabapple with hard hack & tule,"

on April 10, 1873. Between S. 2 and S. 11, T26NR6E, "[moving east, at 46.5 chains] Foot of hill, enter [illegible] swampy bottom." "[at 50 chains} Leave spruce & cedar timber & enter open swamp." "…low level swamp and subject to overflow in winter to the depth of from 2 to 4 ft [underlining added]. Timber a few scattering scrubby spruce & pine. Undergrowth same with spruce alder crabapple willow & hard hack & nettle." Between S. 11 and S. 12, (T26NR6E), "Land level & swampy water on it to the depth of from 6 to 18 inches at time of high water it is subject to overflow to the depth of from 4 to 8 feet [underlining added] ….timber none. Saw a few scattering scrubby spruce. Undergrowth hard hack & willow with tule," on April 5, 1873. Between S. 26 and S. 35, T27NR6E, "Land unfit for cultivation. This land is subject to inundation 2 to 6 feet [underlining added]." Between S. 35 and S. 36, T27NR6E, "[moving north, at 2 chains] open swamp [illegible word] unfit for cultivation." "[at 40 chains] This corner cannot be witnessed owing to the depth of water [underlining added] and absence of timber." "Land level soil dark rich brown. Timber sparse Spruce Maple & Cottonwood. Undergrowth Hard Hack and Maple. Plants Wild [illegible] and Cranberry," on August 10, 1871.

The DEM shows some subdued, sinuous topography within this marsh, presumably created by ancient river meanders, and the water depth would have varied locally. The notes, plat maps, and more recent mapping and photos also show several perennial ponds, which are accounted for separately as ponds. Given the great depths to which the GLO surveyors described the winter inundation, we have assumed that a conservative estimate is that most (at least 75%) of the area would have been inundated in winter.

SNQ260701 Cherry Valley Area Marsh (289 hectares). The GLO field notes describe the area as "swamp" (between S. 7 and S. 8, T26NR7E), and between S. 6, T26NR7E and S. 31, T27NR7E as "hard hack thicket & marsh ground" on September 23, 1873. Between S. 6 and S. 7, T26NR7E, "[moving east, at 22.5 chains] It being impracticable to extend the line further on account of swamp…" on May 27, 1874.

SNQ270601(142 hectares). We used the boundaries for the marsh as drawn on the GLO plat map. The GLO survey approached this marsh from four directions but turned back in each case because the marsh was "impenetrable. The corner to S. 23, S. 24, S. 25, and S. 26, T27NR6E, was described as being in an "impenetrable marsh." The marsh between S. 23 and S. 24 was not surveyed because of this. Similarly, between S. 25 and S. 26, at 27.5 chains, they wrote "Impenetrable open marsh…" ceased surveying, and described the line as "…land subject to overflow 1 to 10 feet [underlining added]." Between S. 23 and S. 26, at 41 chains, "Low bottom subject to inundation by water 2 to 6 feet in depth [underlining added]," and at 60 chains, "the edge of an inaccessible marsh," in August 15, 1871.

SNQ270602 (11 hectares). The GLO field notes describe the marsh between S. 25 and S. 36, T27NR6E, as "[at 18.5 chains] Open marsh…this marsh is impenetrable…" on August 11, 1871. The GLO also mapped nearby *SNQ270603* (3 hectares).

SNQ250701 (67 hectares). The extent of this wetland was mapped using the GLO survey notes, which record the surveyors approaching the wetland from each direction, and then avoiding it as an "impassable swamp." They wrote, between S. 12, T25NR6E and S. 7, T25NR7E, "[at 64 chains, moving north] Enter swamp…almost impassable." Then [at 74.5 chains] "at this point the swamp becomes impassable." Between S. 1 and S. 2 or T25NR6E, [moving east, at 74.3 chains] Margin of impassable swamp." Travelling between S. 6 and S. 7, T25NR7E, [at 48.5 chains} "enter swampy ground" and [at 63 chains] "impracticable to extend line" on October 20, 1873. The wetland is partially coincident with the area mapped as the "Ames Lake Creek peat area" by Rigg (1958), which is significantly larger than the area we mapped. We interpret the field references to the wetland's impassability as indicating significant winter inundation; we assume three-quarters of the area was winter inundated.

SNQ250702 (three wetlands totaling 24 hectares). About 5 hectares of the area is mapped as wetland on the Carnation USGS topographic map. The SSURGO data base shows the area as having hydric soil and King County maps the area as wetland.

SNQ250704 (55 hectares). The GLO survey crossed this feature between S. 9 and S. 10, T25NR7E: "[traveling north, at 4 chains] enter swampy ground…[at 49.2 chains] enter hard hack swamp…[at 62.5 chains] south side of marshy lake." The line was described as "Land level subject to overflow fr. 1 to 7 ft [underlining added]. Covered with c-apple V Maple Alder & C" on October 10, 1873.

SNQ250705 (171 hectares). About one half the area is mapped as wetland on the current Fall City and Carnation USGS topographic maps. The wetland is elongate in a north-south direction, and is crossed in an east-west direction by the line between S. 20 and S. 29 and by S. 29 and S. 32, neither of which make mention of the wetland, but the plat map shows a wetland drawn along the boundary between S. 29 and S. 32. King County mapping shows the area as wetland. The recent USGS Fall City and Carnation topographic sheets shows 49 hectares as wetland, which we have taken as an estimate of winter inundated area.

SNQ250707 (7 hectares). Mapped wetland was not crossed by a GLO survey line. The SSURGO data shows it as a hydric soil, and King County wetland mapping shows it as wetland. About 2 hectares of the area is mapped as wetland on Fall City USGS topographic quadrangle; we have used this latter number as an estimate of winter inundation.

SNQ250708 (47 hectares). The GLO survey crossed a small part of the marsh along the line between S. 33 and S. 34, T25NR7E, and recorded "[moving north, at 52.5 chains] E. end of cranberry marsh" on June 1, 1865. The SSURGO data shows it as a hydric soil, and King County wetland mapping shows it as wetland. About one-half (25 hectares) of this area is mapped as wetland by the recent Fall City USGS topographic quadrangle; we have used this latter number as an estimate of winter inundation.

SNQ240703 (90 hectares). Crossed by lines between S. 9 and S. 10, S. 10 and S. 11, S. 11 and S. 14, and S. 13 and S. 13, T24NR7E but not described as wetland. The SSURGO data shows it as a hydric soil, and King County wetland mapping shows it as wetland. Most of the area we have mapped as wetland is mapped as such on the USGS Fall City topographic quadrangle. Twenty-four hectares of this area is

mapped as wetland by the recent Fall City USGS topographic quadrangle; we have used this to estimate the extent of winter inundation.

SNQ240704 (26 hectares). The GLO survey mentions "swampy ground" beginning 3.5 chains moving eastward between S. 13 and S. 23, T24NR7E on August 16, 1867. The wetland, as we have mapped it, is also crossed by the survey line between S. 15 and S. 14 T24NR7E, surveyed in August 17, 1873, but not noted. The SSURGO mapping shows part of the map unit as hydric soil, and King County wetland mapping shows the entire area as wetland.

SNQ240705 (17 hectares). The GLO survey does not cross this wetland mapped in S. 24 of T24NR7E. About one-half of the wetland is mapped on the Snoqualmie USGS topographic map. King County mapping shows the map unit as a wetland. About one-third (6 hectares) of this area is mapped as wetland by the recent Snoqualmie USGS topographic quadrangle; we have used this as an estimate of winter inundation.

Several wetland map units fall completely within sections and so were not visited by the GLO surveyors. We mapped them using soils, King County wetland mapping, topography or the 1936 aerial photographs. We assume that none were inundated in summer or winter. *SNQ260604* (30 hectares). Within S. 25. We mapped this wetland on the basis of hydric soils and topography. *SNQ240702* (14 hectares). The GLO survey does not cross this wetland mapped in S. 9 of T24NR7E; we map it based on King County wetland mapping. About two hectares are shown as wetland on the Carnation USGS topographic map, which we take as an estimate of winter wetted area. *SNQ260605* (two wetlands totaling 8 hectares). Within S. 36; mapped using hydric soils and King County wetland mapping; 3 hectares are mapped as wetland on the USGS Carnation topographic map.

Several wetland map units were crossed by the GLO surveyors and were not identified as wetlands, and we mapped them as wetlands using soils and topography or the 1936 aerial photographs. We assume that none were inundated in summer or winter. *SNQ250706* (41 hectares). Crossed by GLO between S. 21 and

S. 28, but not mentioned. We map it using hydric soils and wetland mapping. *SNQ250703* (11 hectares). The GLO survey crossed the wetland on the line between S. 3 and S. 10,and does not make mention in the notes on October 11, 1873. We map it using hydric soils and wetland mapping. *SNQ260606* (9 hectares). The GLO surveyors did not mentioned the area in their notes between S. 36, T26NR6E, and S. 1, T25NR6E, on April 1, 1873; we mapped it using King County wetland mapping. *SNQ260602* (83 hectares): the GLO surveyors did not note this as a wetland between S. 23 and S. 24, T26NR6E; we mapped it using hydric soils and topography.

REFERENCES CITED

Debose, A. and M. W. Klungland. 1983. Soil survey of Snohomish County Area, Washington. 197 p.

Essex, A. 1971. *The Stanwood Story.* The Stanwood News, Stanwood, WA. 125 p.

Hilbert, V., J. Miller, and Z. Zahir (editors). 2001. Puget Sound Geography, Original Manuscript from T. T. Waterman. Lushootseed Press, Federal Way, WA. 375 p.

Klungland, M. W. and M. McArthur. 1989. *Soil survey of Skagit County area, Washington*. U. S. Government Printing Office. 372 p.

Mangum, A. W. and Party. 1909. *Reconnaissance soil survey of the eastern part of Puget Sound.* U. S. Soils Bureau, Government Printing Office, Washington, D.C.

Nesbit, D. M. with Contributions from U. S. Coast Survey, S. L. Boardman, Eldridge Morse, and others. 1885. Tide marshes of the United States. *USDA Miscellaneous Special Report* No. 7, Government Printing Office, Washington, D. C.

Ness, A. O. and C. G. Ritchins. 1958. *Soil survey of Island County, Washington*. U. S. Department of Agriculture Soil Conservation Service and Washington Agricultural Experiment Station. United States Government Printing Office, Washington, D.C. 58 p.

North, M. E. A., and J. M Teversham. 1984. The vegetation of the floodplains of the Lower Fraser, Serpentine and Nicomekl Rivers, 1859 to 1890. *Syesis* 17: 47-66.

Northern Star Newspaper, Snohomish, Washington Territory. 1877.

Rigg, G. B. 1958. Peat resources of Washington. *Washington Division of Mines and Geology Bulletin 44.*

U. S. Army Corps of Engineers. 1897. Index Map of Skagit River, From its Mouth to the Town of Sedro, Washington. Surveyed under direction of Captain Harry Taylor, Corps of Engineers, USA, March & April, 1897, by J. M. Clapp, Asst. Engr.

U. S. War Department. 1876-1906. Annual Reports of the Chief of Engineers, U. S. Army, to the Secretary of War.

Table C-1. Assumptions used in developing inundated area estimates.

ASSUMPTION CODE	ASSUMPTION
A1	Derived from proportion of line in which water depth is recorded (e.g. if 8 km of 12 km cumulative length of line is noted as inundated, we infer that approximately 75% of the area is inundated).
A2	Field notes described the seasonality of inundation for the wetland as a whole (e.g. “overflowed from the beginning of the wet season until July”).
A3	Wetland appears to have been inundated in the 1930s photographs, or more recent photographs, or part of the wetland appears inundated, with the amount estimated from the photos.
A4	Winter inundation is assumed if field notes or aerial photographs from summer observations indicate, with consistency throughout the wetland, that the area is subject to inundation, and the inundation is at least a few feet.
A5	Tidally influenced freshwater wetland for which field observations of overflow indicators (and hydrologic inference) indicate area is primarily inundated by river flooding for prolonged periods in winter.
A6	If there is field evidence for summer inundation, we assume that winter inundation is at least as great (more, if there is evidence to support that).
A7	Small wetland, for which relatively few field observations are available, but which indicate winter inundation; necessary to estimate the proportion of area inundated.
A8	Assume that if the area is not inundated in the winter, it is not inundated in the summer.
B1	If flooding is noted to have been caused by beaver dams, it is assumed to include at least summer inundation.
B2	Lacking any other information, *forested* riverine-tidal wetlands are assumed to be inundated periodically in winter, during certain high tides and river floods only.
B3	*Forested* palustrine wetlands are assumed to be dry in the summer unless there is evidence to the contrary.
B4	If area is identified as swamp or marsh but no water depths are given and no indications of winter overflow are given, assume no winter inundation.
B5	Assumed similar to nearby, larger wetland for which more data is available.
B6	Summer field notes do not describe inundation.
B7	Soils information used to estimate summer inundation.
B8	Insufficient information to assume inundtion.
B9	Estimate winter inundation from area mapped as wetland on topographic map.

Table C-2. Wetland area, inundated area (winter, summer, and freshwater tidal and saltwater tidal), and assumptions used in developing inundated areas.

ID	TYPE	AREA	WINTER INUND. AREA	WINTER INUND. AREA ASSUMP.	SUMMER INUND. AREA	SUMMER INUND. AREA ASSUMP.	FRESH TIDALLY INUND. AREA	SALT TIDALLY INUND. AREA
NKS_DLT380201	EEW	29	*NA*	*NA*	*NA*	*NA*		29
NKS_DLT380202	RTS	718	538.5	A4	239.3	A4		
NKS_DLT390203	PSW	34	17.0	B5	8.5	A3		
NKS_LMA390204	PSW	74	55.5	B5	37.0	B5		
NKS_LMA390205	PSW	45	33.8	B5	22.5	B5		
NKS_LMA390206	PSW	6	4.5	B5	3.0	B5		
NKS_LMA390207	PSW	68	51.0	B5	34.0	B5		
NKS_LMA400201	PSW	773	579.8	A6, A4	386.5	A1		
NKS_LMA400202	PSW	32	24.0	B5	16.0	B5		
NKS_LMA400301	PSW	711	355.5	A1	177.8	B1		
NKS_LMA400302	PSW	171	128.3	B5	85.5	B5		
NKS_LUM380101	EEW	316	*NA*	*NA*	*NA*	*NA*		316
NKS_LUM380102	ESW	224	*NA*	*NA*	*NA*	*NA*		224
NKS_LUM380103	RTS	314	235.5	A4	0.0	B6		
NKS_LUM390201	RTS	185	138.8	A4	0.0	B6		
NKS_LUM390202	PSW	50	37.5	A7	12.5	B5		
NKS_SDY380104	EEW	49	*NA*	*NA*	*NA*	*NA*		49
NKS_SDY380105	PSW	21	5.3	B9	0.0	A2		
NKS_SFK380501	PFW	604	30.2	B9	0.0	B3		
NKS_SFK380502	PSW	18	0.0	B4	0.0	B3		
NKS_UMA390401	PSW	10	0.0	B4	0.0	B3		

Table C-2. continued.

ID	TYPE	AREA	WINTER INUND. AREA	WINTER INUND. AREA ASSUMP.	SUMMER INUND. AREA	SUMMER INUND. AREA ASSUMP.	FRESH TIDALLY INUND. AREA	SALT TIDALLY INUND. AREA
SKG_DLT320301	EEW	143	*NA*	*NA*	*NA*	*NA*		143
SKG_DLT320302	ESW	121	*NA*	*NA*	*NA*	*NA*		121
SKG_DLT330301	ESW	545	*NA*	*NA*	*NA*	*NA*		545
SKG_DLT330302	EEW	1236	*NA*	*NA*	*NA*	*NA*		1236
SKG_DLT330303	ESW	1096	*NA*	*NA*	*NA*	*NA*		1096
SKG_DLT330304	RTF	614	0.0	B2	0.0	B3		
SKG_DLT330305	PFW	177	0.0	B4	0.0	A8		
SKG_DLT330307	RTF	131	0.0	B2	0.0	B3		
SKG_DLT330308	RTS	805	603.8	A2	402.5	B1		
SKG_DLT330309	EEW	87	*NA*	*NA*	*NA*	*NA*		87
SKG_DLT330401	RTS	1019	764.3	B5	509.5	B5		
SKG_DLT330402	RTF	441	0.0	B2	0.0	B3		
SKG_DLT330403	PFW	352	0.0	B4	0.0	B3, A8		
SKG_PDL330306	EEW	139	*NA*	*NA*	*NA*	*NA*		139
SKG_PDL340301	RTS	634	475.5	A2	317.0	B1		
SKG_PDL340302	RTS	363	272.3	B5, A6	181.5	B5		
SKG_PDL340303	RTS	894	670.5	A6	447.0	A1		
SKG_PDL340304	EEW	1916	*NA*	*NA*	*NA*	*NA*		1916
SKG_PDL340305	ESW	484	*NA*	*NA*	*NA*	*NA*		484
SKG_PDL340306	ESW	888	*NA*	*NA*	*NA*	*NA*		888
SKG_PDL340307	PSW	459	459.0	A2	0.0	A2		
SKG_SAM350301	RTF	867	0.0	B2	0.0	B3		
SKG_SAM350302	EEW	1265	*NA*	*NA*	*NA*	*NA*		1265
SKG_SAM350303	ESW	622	*NA*	*NA*	*NA*	*NA*		622
SKG_SAM350304	PSW	79	59.3	A7, B5	0.0	B5		
SKG_SAM350305	PSW	260	0.0	B4	0.0	B3, B5		
SKG_SAM350306	PSW	1361	1361.0	A2	0.0	A2		
SKG_SAM350401	PFW	758	379.0	A1	0.0	B3		
SKG_SAM350402	PSW	216	162.0	A7, B5	0.0	B5		
SKG_SAM350403	PSW	22	0.0	B4	0.0			
SKG_SAM350404	PSW	5	0.0	B4	0.0	A8		
SKG_SAM350405	PSW	26	0.0	B4	0.0	A8		
SKG_SAM360301	PSW	212	70.7	A1	0.0	B5		
SKG_SAU341001	PSW	17	0.0	B4	0.0	A8		
SKG_UDL340404	PFW	108	108.0	A6	81.0	A1		
SKG_UDL340405	PSW	54	54.0	A6	40.5	A7		
SKG_UPP350501	PSW	406	101.5	A1	40.6	B1		
SKG_UPP350502	PSW	66	16.5	A1	6.6	B1		
SKG_UPP350503	PSW	6	4.5	A6	3.0	A3		

Table C-2. continued.

ID	TYPE	AREA	WINTER INUND. AREA	WINTER INUND. AREA ASSUMP.	SUMMER INUND. AREA	SUMMER INUND. AREA ASSUMP.	FRESH TIDALLY INUND. AREA	SALT TIDALLY INUND. AREA
SNH280501	RTS	1800	1440.0	A1	360.0	B7		
SNH280502	RTF	130	*NA*	*NA*	*NA*	*NA*	130	
SNH280601	PSW	1517	1137.8	A6	505.7	A1		
SNH280602	PFW	76	0.0	B4	0.0	B6		
SNH290501	RTF	2632	*NA*	*NA*	*NA*	*NA*	2632	
SNH290502	ESW	811	*NA*	*NA*	*NA*	*NA*		811
SNH290503	EEW	227	*NA*	*NA*	*NA*	*NA*		227
SNH290504	PFW	3	0.0	B2	0.0	B2		
SNH300501	ESW	381	*NA*	*NA*	*NA*	*NA*		381
SNH300502	EEW	213	*NA*	*NA*	*NA*	*NA*		213
SNH300503	RTF	102	*NA*	*NA*	*NA*	*NA*	102	
SNH300504	RTF	9	*NA*	*NA*	*NA*	*NA*	9	
SNH300505	PSW	3	0.0	B2	0.0	B2		
SNQ240702	PFW	14	0.0	B8	0.0	B3		
SNQ240703	PFW	90	24.0	B9	0.0	B3		
SNQ240704	PFW	26	0.0	B8	0.0	B3		
SNQ240705	PFW	17	6.0	B9	5.7	A3		
SNQ250701	PSW	67	50.3	A7	0.0	B8		
SNQ250702	PSW	24	3.0	B9	0.0	B8		
SNQ250703	PFW	11	0.0	B8	0.0	B8		
SNQ250704	PFW	55	0.0	B8	0.0	B3		
SNQ250705	PFW	171	49.0	B9	8.6	A3		
SNQ250706	PSW	41	0.0	B8	0.0	B8		
SNQ250707	PSW	7	2.0	B9	0.0	B8		
SNQ250708	PSW	47	25.0	B9	0.0	B8		
SNQ260601	PSW	1016	1016.0	A4	0.0	B8		
SNQ260602	PSW	83	0.0	B8	0.0	B8		
SNQ260604	PSW	30	0.0	B8	0.0	B8		
SNQ260605	PSW	8	0.0	B8	0.0	B8		
SNQ260606	PSW	9	0.0	B8	0.0	B8		
SNQ260701	PSW	289	216.8	B5	0.0	B8		
SNQ270601	PSW	142	142.0	A4, B5	0.0	B8		
SNQ270602	PSW	11	8.3	B5	0.0	B8		
SNQ270603	PSW	3	2.3	B5	0.0	B8		
SKY270701	PFW	59	0.0	B4	0.0	B3		
SKY270702	PFW	29	14.5	B4	0.0	B3		
SKY270703	PFW	21	0.0	B4	0.0	B3		
SKY270704	PFW	4	0.0	B4	0.0	B3		
SKY270705	PFW	10	0.0	B4	0.0	B3		
SKY270901	PFW	6	0.0	B4	0.0	B3		
SKY280701	PFW	20	0.0	B4	0.0	B3		
SKY280801	PSW	28	0.0	B4	0.0	B4		
SKY280802	PFW	10	0.0	B4	0.0	B3		
SKY280803	PFW	6	0.0	B4	0.0	B3		
SKY280804	PSW	4	0.0	B4	0.0	B4		

Table C-2. continued.

ID	TYPE	AREA	WINTER INUND. AREA	WINTER INUND. AREA ASSUMP.	SUMMER INUND. AREA	SUMMER INUND. AREA ASSUMP.	FRESH TIDALLY INUND. AREA	SALT TIDALLY INUND. AREA
STL310301	EEW	37	NA	*NA*	*NA*	*NA*		37
STL310401	EEW	109	NA	*NA*	*NA*	*NA*		109
STL310402	PEW	2	2.0	A6	2.0	A1		
STL310403	ESW	71	NA	*NA*	*NA*	*NA*		71
STL310501	PSW	32	0.0	B4	0.0	B6		
STL310502	PSW	48	0.0	B4	0.0	B6		
STL310503	PSW	56	0.0	B4	0.0	B6		
STL310504	PEW	4	3.0	B1	2.0	B1		
STL320302	RTF	259	0.0	A7	0.0	B6		
STL320303	EEW	325	NA	*NA*	*NA*	*NA*		325
STL320304	EEW	411	NA	*NA*	*NA*	*NA*		411
STL320305	PSW	89	0.0	B6	0.0	B4		
STL320306	EEW	2	NA	*NA*	*NA*	*NA*		2
STL320307	ESW	365	NA	*NA*	*NA*	*NA*		365
STL320308	ESW	28	NA	*NA*	*NA*	*NA*		28
STL320401	PSW	366	36.6	A7	0.0	B6		
STL320402	RTS	201	20.1	A7	0.0	B6		
STL320403	RTS	285	0.0	A7	0.0	B6		
STL320404	EEW	281	NA	*NA*	*NA*	*NA*		281
STL320405	PEW	1	1.0	A4	1.0	A3		
STL320406	ESW	143	NA	*NA*	*NA*	*NA*		143
STL_NFK320601	PFW	42	0.0	B4	0.0	B4		
STL_NFK320602	PFW	36	0.0	B4	0.0	B4		
STL_NFK320701	PFW	8	2.0	B4, A3	2.0	B4, A3		
STL_NFK320702	PFW	2	0.0	B4	0.0	B4		
STL_NFK320703	PFW	15	7.5	B1	3.8	B1		
STL_NFK320704	PFW	24	0.0	B4	0.0	B4		
STL_NFK320801	PSW	4	0.0	B4	0.0	B4		
STL_SFK310505	PSW	17	0.0	B4	0.0	B4		
STL_SFK310506	PFW	10	0.0	B4	0.0	B4		
STL_SFK310601	PSW	3	0.0	B4	0.0	B4		

Table C-3. Estimated historical inundated wetland area aggregated for individual watersheds.

WATERSHED	WETLAND AREA	WINTER INUNDATED AREA	SUMMER INUNDATED AREA	FRESHATER TIDAL INUNDATION	SALTWATER TIDAL INUNDATION
Nooksack	4,500	2,200	1,000	0	600
Skagit	18,900	5,600	2,000	0	8,500
Stillaguamish	3,300	100	<100	0	1,800
Snohomish	7,900	2,600	900	2,900	1,600
Skykomish	200	<100	0	0	0
Snoqualmie	2,200	1,500	<100	0	0

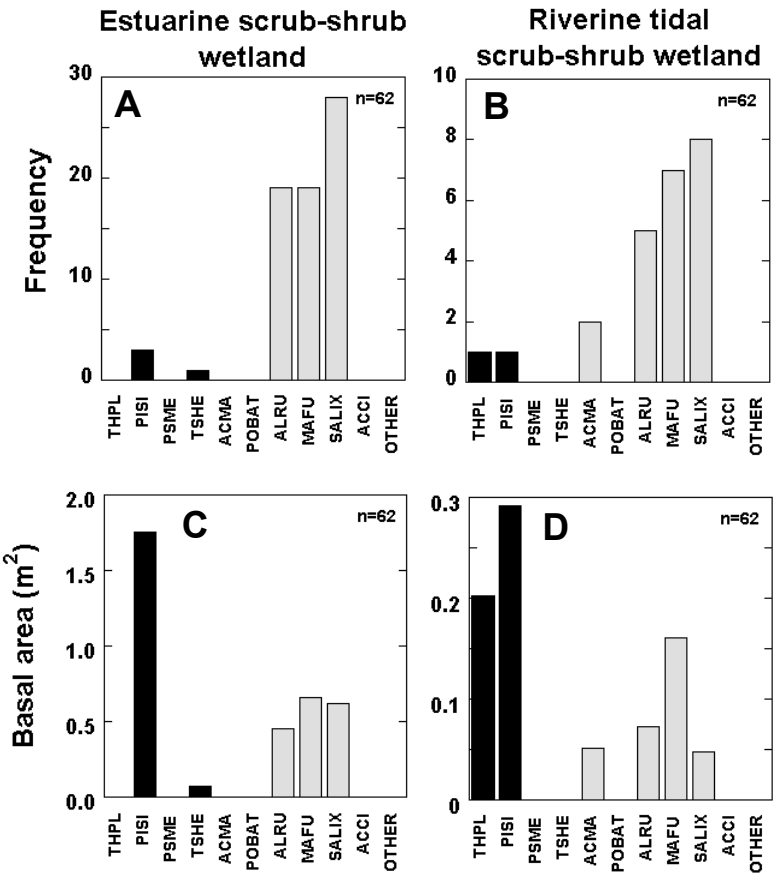

Figure C-1. GLO bearing trees in wetlands on the Nooksack delta. Frequency (A) and basal area (C) in estuarine scrub-shrub wetland, and frequency (B) and basal area DF) in riverine-tidal scrub-shrub wetland. Conifers have dark-shaded bar. THPL: western redcedar (*Thuja plicata)*; PISI: Sitka spruce (*Picea sitchensis)*; PSME: Douglas fir (*Pseudotsuga menziesii)* TSHE: western hemlock (*Tsuga heterophylla)*; ACMA: bigleaf maple (*Acer macrophyllum)*; POBAT: black cottonwood (*Populus trichocarpa)*; ALRU: red alder (*Alnus rubra)*; MAFU: Pacific crabapple (*Malus fusca)*; SALIX: willow (*Salix* spp.*);* ACCI: vine maple (*Acer circinatum)*.

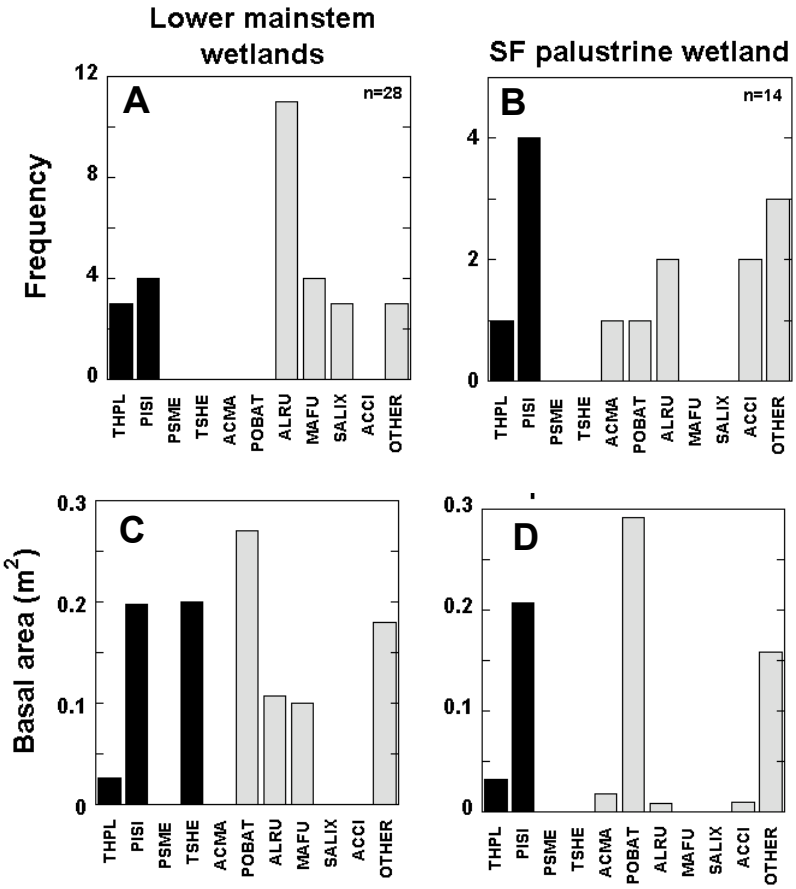

Figure C-2. GLO bearing trees in wetlands of the Nooksack River watershed; frequency (A) and basal area (C) in lower mainstem wetlands; frequency (B) and basal area (D) in South Fork Palustrine wetlands.. Conifers have dark-shaded bar. Species abbreviations are as in Figure 5-1.

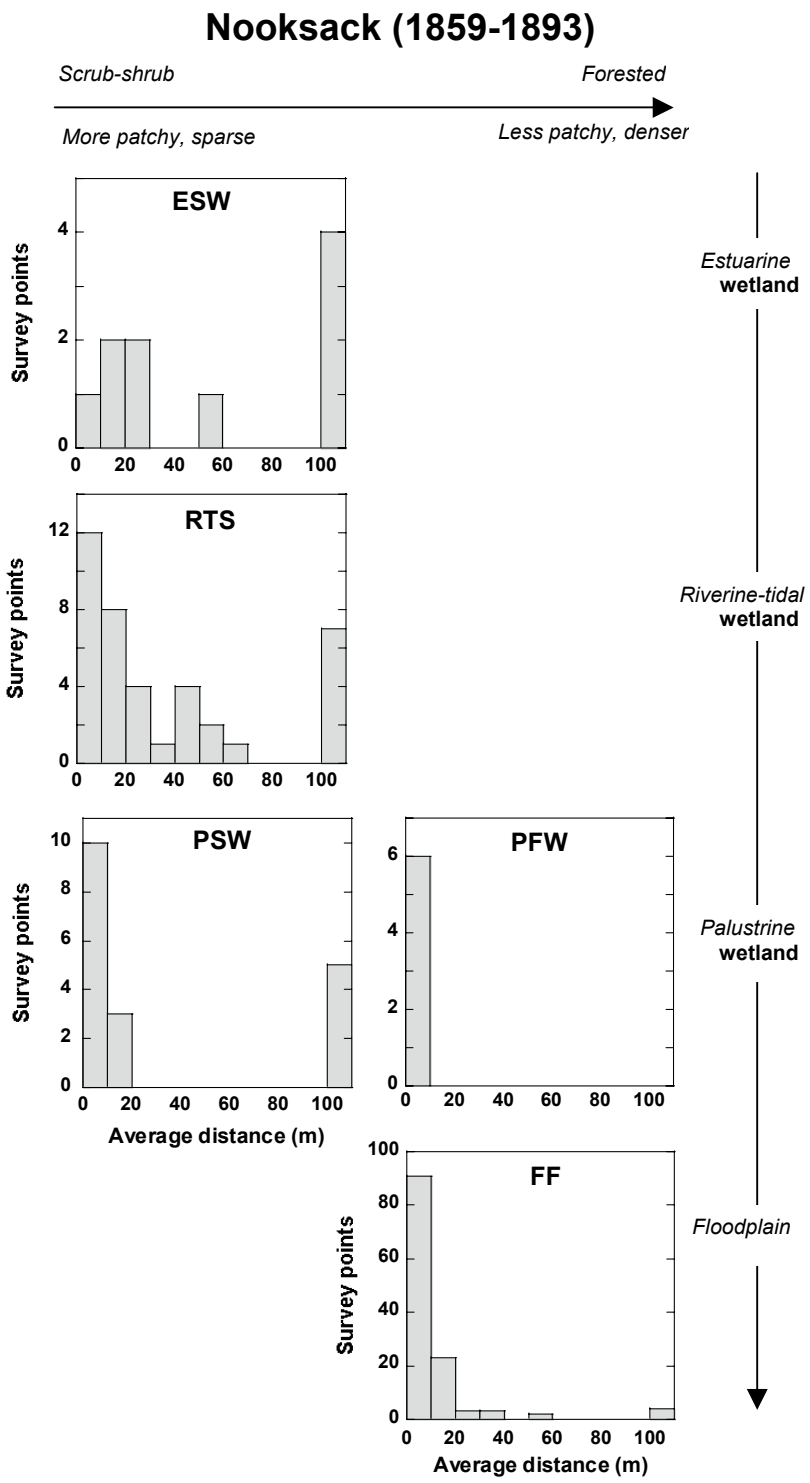

Figure C-3. Distributions of distances to bearing trees, averaged at survey points, for several cover types on the Skagit River delta.

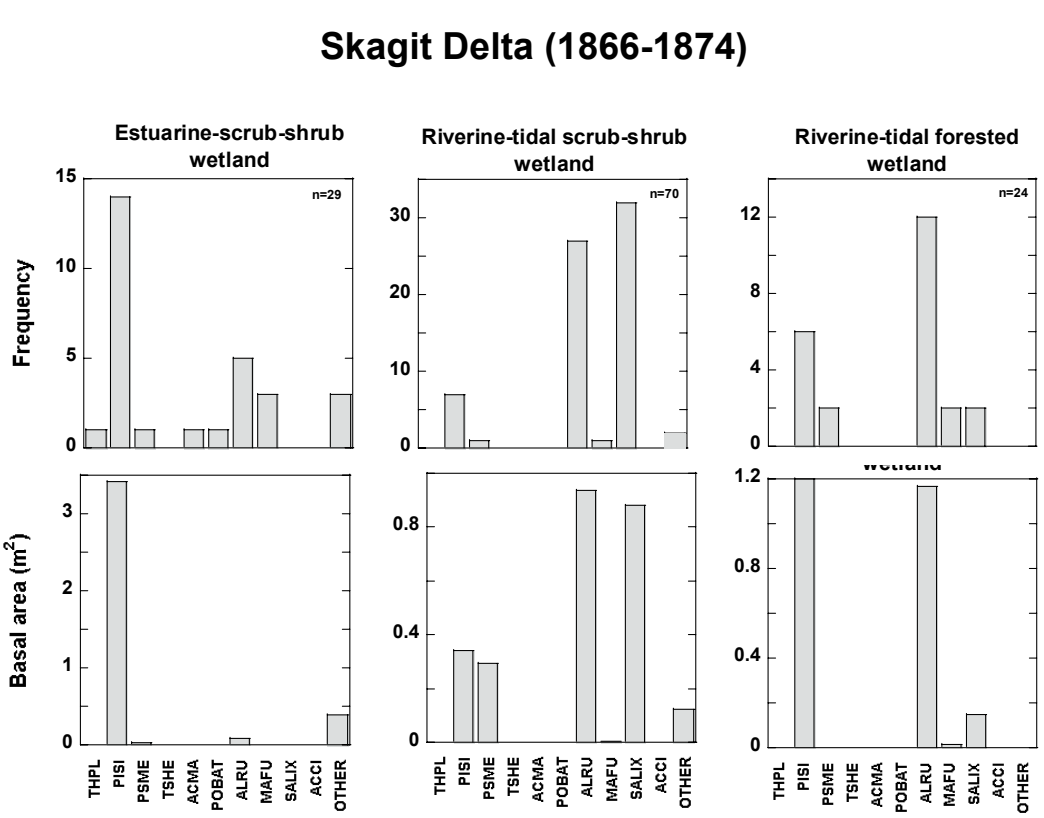

Figure C-4. Bearing trees from GLO field notes on the Skagit River. Top tier, from left to right: frequency of trees in estuarine scrub-shrub wetland, riverine-tidal scrub-shrub wetland, and riverine-tidal forested wetland. Bottom tier is cumulative basal area in the same areas. Abbreviations are as in Figure 5-1. "Other" species include: dogwood *(*western flowering dogwood*, Cornus nuttallii)*, hazel (beaked hazelnut*, Corylus cornuta var. californica*); bearberry or barberry (uncertain, possibly Oregon grape, *Mahonia aquifolium*); chittemwood (cascara*, Rhamnus purshiana*), cherry (bitter cherry, *Prunus emarginata);* elder (red elderberry*, Sambucus racemosa*).

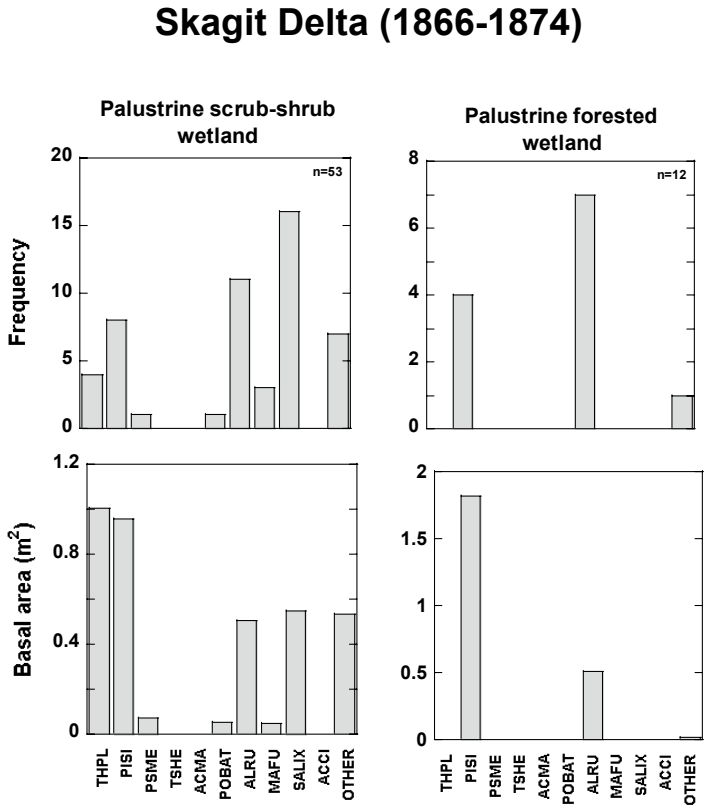

Figure C-5. Bearing trees from GLO field notes on the Skagit River. Top tier (L) frequency of trees in palustrine scrub-shrub wetland, and (R) palustrine forested wetland. Bottom tier is cumulative basal area in the same areas. Abbreviations are as in Figure 5-1.

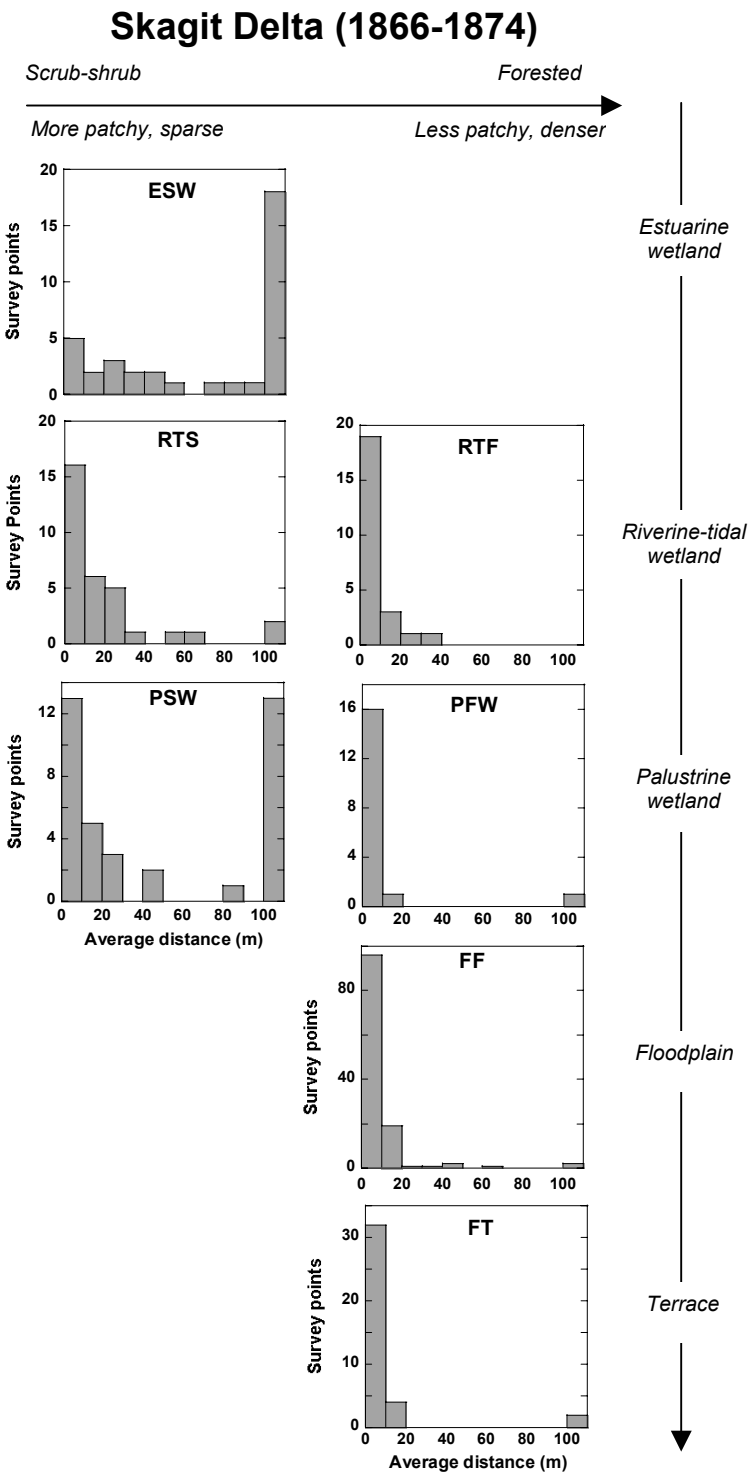

Figure C-6. Distributions of distances to bearing trees, averaged at survey points, for several cover types on the Skagit River delta.

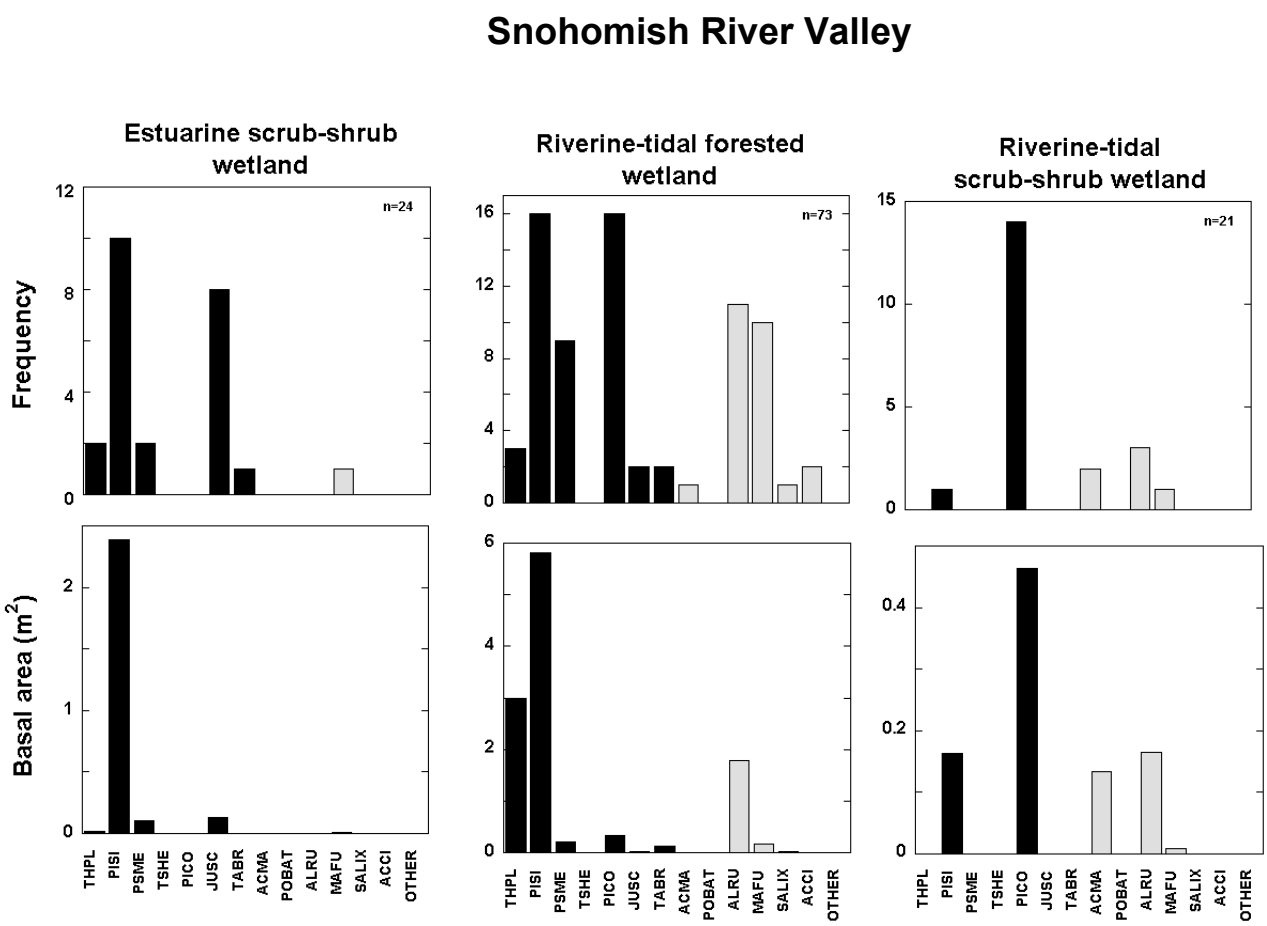

Figure C-7. Bearing trees from GLO field notes on the Snohomish River valley. Top tier, from left to right: frequency of trees in estuarine scrub-shrub wetland, riverine-tidal forested wetland, and riverine-tidal scrub-shrub wetland. Bottom tier is cumulative basal area in the same areas. PICO: shore pine (Pinus contorta); JUSC: Rocky Mountain juniper (Juniperus scopulorum); TABR: western yew (Taxus brevifolia). Other abbreviations are as in Figure 5-1. Conifers have dark-shaded bar."Other" species include chittemwood (cascara*, Rhamnus purshiana*).

Snohomish River Valley

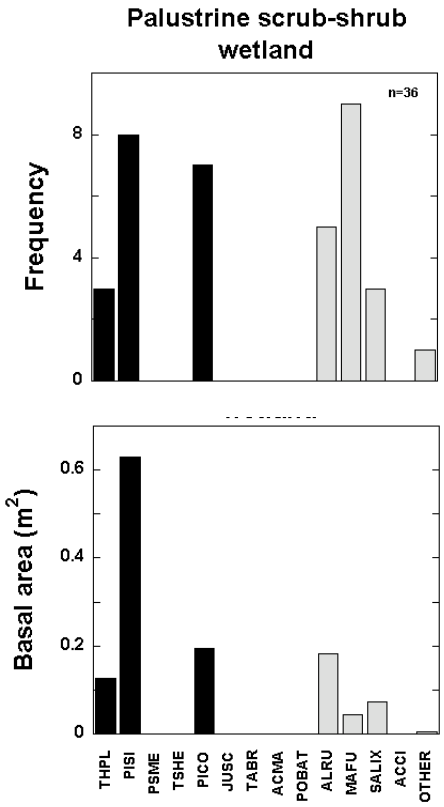

Figure C-8. Bearing trees from GLO field notes on the Snohomish River valley. (A) Frequency, in palustrine scrub-shrub wetland, and (B) Cumulative basal area in the same areas. Conifers have dark-shaded bar. Species abbreviations are as in Figure 5-7. "Other" species include: dogwood *(*western flowering dogwood*, Cornus nuttallii)*, hazel (beaked hazelnut*, Corylus cornuta var. californica*); bearberry or barberry (uncertain, possibly Oregon grape, *Mahonia aquifolium*).

Figure C-9. Views of scrub-shrub "spruce marsh" in the Snohomish River estuary, in October 2002. Note prevalence of Sitka spruce *(Picea sitchensis)* and Rocky Mountain juniper *(Juniperus scopulorum)*.

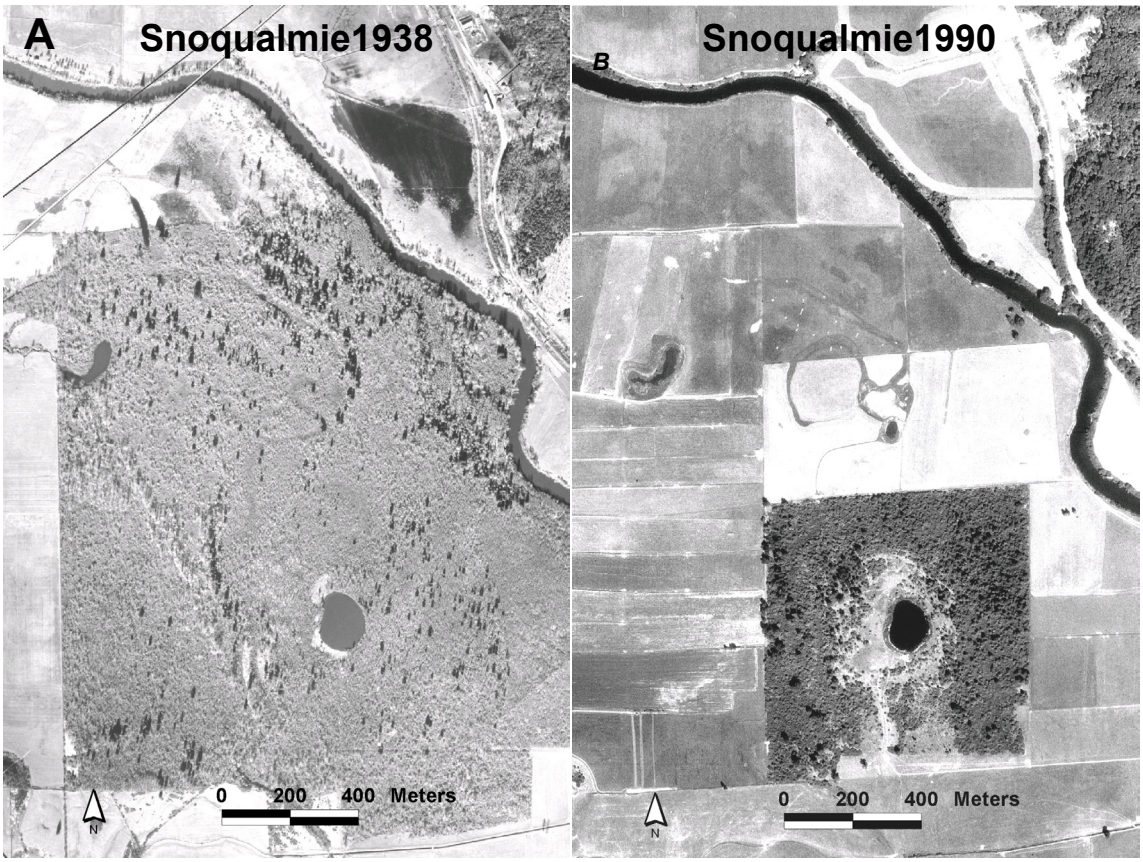

Figure C-10. Remnant patch, on south side of Snoqualmie River, of wetland-pond complex (SNQ260601)at approximately RM 6 along the Snoqualmie River in 1938 and 1990. Photo also shows remnant of wetland SNQ270601 (an “impenetrable marsh” in September of 1873)on the north side of the river in 1938.