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Estimates of Coastal Subsidence from Great Earthquakes in the Cascadia Subduction Zone, Vancouver Island, B.C., Washington, Oregon, and Northernmost California

By
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ESTIMATES OF COASTAL SUBSIDENCE FROM GREAT EARTHQUAKES IN THE CASCADIA SUBDUCTION ZONE, VANCOUVER ISLAND, B.C., WASHINGTON, OREGON, AND NORTHERNMOST CALIFORNIA.

By Curt D. Peterson[1], Elson T. Barnett[1], Greg G. Briggs[1], Gary A. Carver[2], John J. Clague[3], and Mark E. Darienzo[1]

ABSTRACT

In this report, we estimate amounts of coseismic subsidence at the Cascadia subduction zone (CSZ), based largely on plant macrofossil data. Paleosubsidence can be estimated to ±0.5 m on the basis of relative peat development and diagnostic fossil assemblages. Three regional data sets document the spatial and temporal variability of episodic coseismic subsidence at the Cascadia margin.

The first data set includes two different types of paleosubmergence records in coastal Oregon. In northern Oregon all coastal wetlands with peaty deposits extending to at least 1.5 m depth record episodic subsidence. Coastal localities in central and southern Oregon show either episodic subsidence or continuous submergence.

The second data set comprises paleosubsidence estimates for the last great Cascadia earthquake (about A.D. 1700) from Vancouver Island, Washington, Oregon, and northernmost California. Coseismic subsidence ranges from a maximum of 2±0.5 m in southwest Washington, to generally 1±0.5 m in northern Oregon and western Vancouver Island, to 0±0.5 m in central Oregon. Paleosubsidence from this event is variable (0–1 m) over small distances (several kilometers) in large bays of southern Oregon and northernmost California. Inland sites from Vancouver Island and the Columbia River constrain the landward reach of regional paleosubsidence from this latest great earthquake.

The third data set includes subsidence estimates from older earthquakes between 300–3,500 years ago. Up to five earthquake events are inferred at nine bays in Washington and Oregon. The long-term paleosubsidence records at most of the localities are characterized by significant variability between events. The range of variation between detectable events shows a regional trend, with the largest variation (0±0.5–2±0.5 m) occurring in southwest Washington and the smallest variation (0±0.5 m) occurring on the central Oregon coast.

The study results provide constraints for evaluating post-subsidence shoreline erosion and coastal flooding in the CSZ. They are also of use in helping to test fault dislocation models and associated tsunami excitation parameters.

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INTRODUCTION

Great subduction-zone earthquakes can result in coastal subsidence of one to several meters (Plafker, 1972; Heaton and Hartzell,1986). At the Cascadia subduction zone (CSZ), prehistoric events of episodic coseismic subsidence are recorded by wetland soils that were abruptly buried by intertidal bay mud (Atwater, 1987). At least five such events are inferred between 300 and 3,500 years B.P. at bays in Oregon (Darienzo and Peterson, 1995) and Washington (Atwater and Hemphill-Haley, 1996) (Figure 1). Some of the buried peats are capped by sand deposits attributed to near-field tsunamis. The most recent coastal subsidence (A.D. 1700) is linked to widespread paleoliquefaction in the lower Columbia River valley (Obermeier, 1995).

Coseismic subsidence results in coastal flooding and beach erosion (National Academy of Sciences, 1972) that may persist for decades. It has been estimated that 50 m of beach retreat would result from a possible coseismic subsidence of 75 cm at Siletz Bay, Oregon (Doyle, 1996). Such catastrophic beach erosion would lead to accelerated bluff undercutting and sea cliff failures. The frequency of seasonal flooding in the bay would also increase depending on the amount of abrupt sea-level rise.

Estimates of coseismic subsidence from presumed (prehistoric) Cascadia earthquakes can be derived from the examination of paleotidal indicators recorded in late Holocene marsh deposits. In addition to the prediction of erosion and flooding hazards the subsidence estimates are needed for testing fault dislocation models (Savage, 1983; Hyndman and Wang, 1995) and modeling tsunami runup (Baptista and others, 1996).

In this report we compile reported and published data that constrain estimates of coastal subsidence associated with great Cascadia earthquakes and/or local fault ruptures. The results from this compilation should be of use to coastal planners, engineers, and coastal residents for the mitigation of Cascadia earthquake hazards.

BACKGROUND

Indicators of Paleotidal-Level Change

Subsidence estimates are based on a variety of paleotidal-level indicators taken from deposits above and below the submergence "event" horizon (Figure 2). Paleotidal-level indicators used at the Cascadia subduction zone (CSZ) include plant macrofossils (Atwater, 1987), diatoms (Darienzo and Peterson, 1990; Jennings and Nelson, 1992; Hemphill-Haley, 1995), foraminifera (Guilbault and others, 1995), and sand-to-clay ratios (Peterson and Darienzo, 1996). The usefulness of these paleotidal indicators depends on widespread applicability, preservation potential, and recognition of sudden submergence in stratigraphic sequences.

Plant macrofossils provide the most reliable evidence of prolonged emergence and persistent submergence in the Pacific Northwest coastal zone. This is due to their in situ development and their tolerance of brief submergence by storm surges, river floods, and El Niño-driven rises in sea level (Peterson and Darienzo, 1996). Plant macrofossils can also be used through a broad range of paleotidal elevations and salinity conditions (Table 1).

Microfossils provide independent records of paleotidal-level change. However, their regional applicability is restricted by several environmental conditions. For example, the foraminifera microfossils are limited to marine/brackish water conditions, and like the diatoms and pollen, they are susceptible to transport prior to deposition. Diatoms grow in a wide range of salinities, from full-marine to freshwater (Whiting and McIntire, 1985; Hemphill-Haley, 1993) but might not differentiate between different intertidal levels in freshwater settings.

Plant macrofossils record paleotidal elevations in two ways. Some species are diagnostic of particular elevation ranges, such as Sitka spruce roots (supratidal) and *Salicornia* (middle-intertidal) (Jefferson, 1975). The relative abundance of roots, rhizomes, stems, and leaves (peat) also provides an indication of tidal elevation, particularly where plant parts are decayed beyond recognition. As wetland surfaces emerge above the reach of tides, the production of organic materials outpaces the tidal supply of silt and clay (Redfield, 1972). Increases in peat development generally correspond to increases in elevation of the intertidal setting. The abundance of peaty material can be estimated visually in the field and/or by loss on ignition (LOI) in the lab (see "Methods"). Reconnaissance investigations of paleosubsidence events are based on observations of buried wetlands, i.e., rooted-peaty layers, in cutbanks and cores.

There are two substantial drawbacks to the use of plant macrofossils in paleosubsidence studies. Firstly, they suffer from oxidation in supratidal settings. Supratidal conditions start at 1.5–2 m above mean tidal level (MTL) in many bays along the Cascadia margin. Secondly, because the elevation range of most intertidal plants is large, and peat development is variable, the plant macrofossils are relatively insensitive to minor changes in some intertidal levels.

Contact Relations for Coseismic Subsidence

Sharp burial contacts have been used to help identify coseismic paleosubsidence in Cascadia margin studies (Atwater and others, 1995). However, gradual burial contacts above buried wetlands do not rule out the possibility of abrupt paleosubsidence. For example, paleotsunami deposits have been traced laterally to coseismic subsidence contacts that are gradational, i.e., greater than 1 cm in width, in Alsea Bay and Yaquina Bay (Peterson and Priest, 1995; Peterson and Darienzo, 1996). Burial contacts from the Alaskan 1964 earthquake are reported to range from sharp to gradational within a single outcrop in settings that experienced 1–2 m of coseismic subsidence (Rodney Combellick, pers. comm., 1996). Tidal settings characterized by fresh water and small amounts of paleosubsidence might be expected to yield the slowest responses to abrupt subsidence. In such settings the widespread distribution and continuity of buried wetland horizons are probably better indicators of coseismic subsidence than sharp burial contacts.

Tectonic Versus Settlement Subsidence

During great earthquakes submergence can occur from tectonic subsidence and/or sediment compaction. Whereas tectonic subsidence is important in testing fault dislocation models, the total subsidence is important in assessing potential flooding hazards. Discrimination of the two components of subsidence is aided by examination of shallow peaty deposits that extend over compaction-resistant substrata. In this report we identify some shallow marsh sites that overlie indurated Pleistocene deposits or bedrock. Anomalous coseismic settlement might be localized around channel bank slumps or sand geyser fields (National Research Council, 1985). To reduce bias from localized coseismic settlement we document paleotidal-level change from multiple sites in the paleosubsidence localities.

Last Great Cascadia Earthquake (circa A.D. 1700)

Of the last half dozen subsidence events at the Cascadia margin, an event or series of events, regionally dated at 300 ±150 years ago, is the most thoroughly documented (Atwater and others, 1995). The time of subsidence has been constrained in some localities by high-precision radiocarbon dating and tree-ring dating of subsidence-killed trees to about A.D. 1700 (Atwater and others, 1991; Nelson and others, 1995; Jacoby and others, 1995). A singularity of subsidence and paleotsunami deposition appears to have occurred at this time from Vancouver Island to northernmost California (Clague and Bobrowsky, 1994; Darienzo and Peterson, 1995; Carver and others, 1996), implying long rupture length(s) for this event.

Another important factor is the young age of the last great CSZ earthquake. The brief period (300 years) since the earthquake increases both the preservation potential of fossil paleotidal indicators, and the relative similarity between past and present tidal-basin conditions. We do not expect successive dislocation events at each locality to repeat the same amounts of coseismic subsidence. In this report subsidence records of presumed pre-A.D. 1700 earthquakes are compiled from several coastal sites in Washington and Oregon. These results allow a test of whether the last great CSZ earthquake might be representative of earlier events.

METHODS

In this first regional compilation of paleosubsidence estimates we rely primarily on plant macrofossil evidence from tidal basins. Diatoms are used to verify some subsidence records and to establish tidal influence (brackish water) in prehistoric time. Foraminifera are used to verify subsidence records at Vancouver Island and Humboldt Bay, California (Figure 1) where diatom analyses have not been performed. Other paleosubsidence data, e.g., pollen, FeS abundance, and clay-sand abundance, are available for some of the Cascadia bays, but they are currently too restricted in distribution for use here. The tidal basins used in this compilation are large bays, fjords, or tidal-riverine systems, with year-round mean tidal ranges (MTR) of 1–3 m. These requirements preclude the use of wetlands in small coastal streams or back-dune lakes for estimating the amount of prehistoric coseismic subsidence.

Calibration of Paleotidal-Level Indicators

Paleotidal-level indicators, such as plant fossils, are calibrated by establishing their tidal ranges in modern settings. Surveys of modern plant assemblages, total organic abundance, and diatoms have been conducted in some CSZ bays. Previously published results are supplemented by new data obtained for this compilation. The new data are from representative traverses of modern tidal wetlands at Grays Harbor, Neawanna Creek, Tillamook Bay, and Siletz Bay in the central Cascadia margin (Figure 1).

About 20 sites per traverse were surveyed for dominant plants, elevation, and plant macrofossils. This corresponds to 3–5 samples each for four tidal settings, forest edge, high marsh, low marsh, and colonizing marsh, based on recognized plant assemblages (Table 1). Elevation surveys were performed with a total station (local accuracy ±1 cm) and tied into registered bench marks (regional control ±0.1 m). Core tops from the modern marsh surfaces were logged for (1) presence or absence of in situ marsh plant roots or rhizomes, (2) presence or absence of in situ tree roots, and (3) relative abundance of peat, i.e., partially decomposed leaves, stalks, rhizomes, and vertically descending roots. Visual estimates of peat abundance include peat=>80% peat, muddy peat=50–80% peat, peaty mud=20–50% peat, slightly peaty mud=5–20% peat, rooted mud=<5% peat, and barren mud=no marsh-plant roots or rhizomes. Rooted mud and slightly peaty mud also differ qualitatively in that rooted mud contains vertically descending roots and/or rhizomes but not horizontally matted leaves and stems, i.e., peaty material.

Laboratory analyses include semi-quantitative analysis of diagnostic diatoms (Darienzo, 1991, Briggs, 1994), quantitative analysis of diagnostic diatoms (Barnett, 1997) and measurement of total organic carbon content by loss on ignition (LOI). Identified diatoms that are diagnostic of freshwater, brackish, and marine conditions are shown in Table 1. Semi-quantitative analyses of diatom assemblages (Darienzo, 1991, Briggs, 1994) are reported as dominantly freshwater (FW), freshwater>brackish-marine (FBW), and brackish-marine>freshwater (BW).

Quantitative analyses of diatom assemblages are reported as percentage of identified oligohalobous (freshwater), mesohalobous (brackish), and polyhalobous (marine) diatoms in three samples each per tidal level setting. Fifty diatoms are identified to species level for each of the three samples, i.e., 150 total identified diatoms per tidal setting. Individual species counts and species variability between samples and between tidal settings are presented by Barnett (1997). All diatoms, i.e., whole valves or major valve fragments, in each of fifty fields per tidal level setting are tallied to establish relative diatom abundance. Diatoms are counted at 500x magnification and identified to species at 1,250x magnification using standard taxonomy references (Barnett, 1997).

For the total-organic loss-on-ignition (LOI) analysis thin intervals of target horizons, i.e., 3–5 cm thick or 5–10 grams of sediment, are sampled by hand. Prior studies in Alsea Bay (Peterson and Darienzo, 1996) showed that small peat samples (5–10 g) do not adequately represent small changes in peat development on the basis of organics lost on ignition. This is due to the patchy distribution of roots, rhizomes, and other organics in buried wetland deposits. However, an evaluation of previous LOI results (Darienzo, 1991) required sampling techniques similar to those used in previous studies. Peaty samples are air dried, weighed, then combusted at 550°C for 3 hours, then reweighed for organic carbon loss. The combusted organic carbon (LOI) is reported as the percentage of the air-dried sample weight.

Compilation of Marsh Subsurface Records

This study is largely based on reported and/or published core logs and cutbank sections (reference sites) from about two dozen bays (localities) in the CSZ. All reference site UTM coordinates presented in this report are based on NAD1927. Detailed core logs and dating and correlation of the coseismic events within the bays are addressed in cited theses and publications. For this regional compilation, we have divided the reported paleosubsidence data into three sets. The first data set includes reference sites from Oregon that generally demonstrate either coseismic subsidence or continuous submergence of coastal wetlands. The second data set includes superior reference sites from throughout the Cascadia margin that record the magnitude of subsidence associated with the A.D. 1700 event. Key reference sites identified in the data set are substantiated by surrounding core sites, as documented in the first data set and/or cited references. The third data set on paleosubsidence includes 10 representative localities from the central Cascadia margin that record the amounts of paleosubsidence from events prior to the A.D. 1700 earthquake.

RESULTS AND DISCUSSION

Modern Marsh-Wetland Surveys

The results of new marsh surveys (Barnett, 1997) at Grays Harbor (Elliot Slough and Johns River), Seaside (Neawanna), Tillamook Bay (Kilchis River delta), and Siletz Bay (Schooner Creek) are presented in Table 2, along with previously published marsh data from seven other bays. The older surveys include fewer replicate stations, and only the high-marsh and colonizing-marsh settings were routinely analyzed for total organics by loss on ignition (LOI).

The distribution of plants summarized in Table 2 supports previous work which shows a general correspondence between tidal level and diagnostic plant assemblages. Supratidal forest edges are about 2 m above the upper edge of barren tidal flats. Forest edges are characterized by incipient growth of spruce, alder, and/or willow. High marshes, average about 1 m above corresponding tidal flats and contain *Potentialla*, *Grindilla*, and *Juncus*, sp. The low marshes, contain *Salicornia*, *Disticilus,* and *Triglochin*. *Triglochin*, *Carex,* and *Scirpus* are common colonizers of modern tidal flats.

Plant communities define relative tidal levels along a forest-mudflat traverse to about 0.5 m (Table 2). However, some freshwater-dominated marshes lack plant species that can discriminate between high or low marshes. Many of the salt marshes lack plant species that discriminate between low and colonizing marshes. In such instances, other tidal-level indicators are required to differentiate tidal settings. Finally, the vegetation surveys are all from tidal settings where the mean tide ranges (MHW-MLW) are between 1.4 and 2.5 m. The elevation separation of the tidal vegetative zones is expected to diminish with decreasing tidal range.

Relative Peat Development

Abundance of total organics provides an additional constraint on tidal level (see "Background"). Summaries of the visual estimates of peat development (dominant lithology) and loss on ignition (LOI) are presented in Table 2. Dominant lithology typically ranges from peaty mud or muddy peat in high marshes to rooted mud in colonizing marshes. Rooted mud distinguishes colonizing marsh from established marsh and mud tidal flat along all surveyed traverses. In contrast, forest-edge, high-marsh, and low-marsh settings are not reliably distinguished from one another on the basis of dominant lithology. As previously noted (see "Background"), reconnaissance surveys of subsided wetlands are based on observations of rooted-peaty layers buried by bay mud, i.e., field descriptions of dominant lithologies. A semi-quantitative evaluation of observed dominant lithology is provided by laboratory combustion (loss on ignition) of peaty material.

Loss-on-ignition (LOI) data demonstrate a significant decrease in total organic content from high marsh to colonizing marsh along each traverse (Table 2). Decreases in LOI range from 24 to 80 percent over these transitions. The colonizing marsh settings yield 15 percent or less total organics in 9 of 11 traverses. By comparison, there is much greater variation in LOI values in high-marsh and forest settings. High-marsh settings varied from 20 to 42 percent total organics. Forest soils yielded 16–60 percent total organics. The wide ranges of LOI values for the forest soils are likely the result of variable oxidation of organic materials. Whereas relative peat development discriminates colonizing marsh, it does not distinguish between forest edge and high marsh, or between high marsh and low marsh.

Diatom Salinity Indicators of Tidal Level

Diatoms were collected from the modern wetland traverses surveyed in Grays Harbor, Seaside, Tillamook Bay, and Siletz Bay. Identified diatoms are grouped into three salinity-tolerance divisions (Table 1). The percentages of each salinity division (fresh/brackish/marine) for each tidal level setting are shown in Table 2. The relative abundances of all diatoms are also shown for corresponding samples.

Relative percentages of freshwater diatoms distinguish between high-marsh and low-marsh settings in the wetland traverses studied (Table 2). At the Johns River site in Grays Harbor the freshwater diatoms vary as follows: low marsh (15 percent), high marsh (61 percent), and forest edge (63 percent). The high marsh and forest edge settings have about the same percentage of freshwater diatoms. The forest edge settings from most of the study sites also retain a significant percentage of marine diatoms. The origin(s) of the marine diatoms in the forest soils have yet to be established but might arise from wind drift of spray.

In the modern wetlands the total abundance of all diatoms generally shows a decrease from high-marsh to forest-edge settings. For example, ranges of abundance include (1) colonizing marsh (15–30 diatom valves per field), (2) low and high marsh (20–60 diatom valves per field), and (3) forest edge (5–15 diatom valves per field) (Table 2). The factors causing such large variability of diatom abundance in the same tidal level setting from different marsh localities are not known.

In summary, the diatom analyses confirm previous reports of increasing freshwater diatom abundance in higher tidal-elevation settings (Darienzo, 1991) and declining total abundance from marsh to forest soils (Hemphill-Haley, 1995). Whereas the diatoms do differentiate between high and low marsh, they do not reliably distinguish between high marsh and forest edge, or between low marsh and colonizing marsh. Statistical treatment of diatom data is presented in Barnett (1997).

Critical Limits of Tidal-Level Change

Based on the results presented above it is clear that none of the paleotidal-level indicators discussed above can individually distinguish the modern forest edge, high marsh, low marsh, and colonizing marsh settings. However, tree roots differentiate forest-edge from all marsh settings, and rooted mud differentiates colonizing marsh from barren tidal flat and established low marsh. Upcore transitions between these distinctive environments permits quantitative evaluation of the amount of corresponding paleosubmergence. Microfossil assemblages serve as independent tests of paleosubmergence in brackish water bays but are not used here for quantitative estimates of paleosubsidence. Large variabilities of individual species abundances and total diatom abundances within same tidal-level settings (Barnett, 1997) indicate effects of biological factors that are beyond the scope of this single-season sampling study.

Transitions from forest edge to tidal flat or colonizing marsh are assumed to represent tidal-level changes in excess of 1.5 m (Table 3). This is a conservative limiting value as forest edge and tidal flat environments are unbounded (Table 1). For this reason, such transitions are assigned tidal-level change values of 2±0.5 m (Table 4). Upsection transitions from low marsh to forest edge or from colonizing marsh to high marsh are assigned tidal-level change estimates of 1±0.5 m. Upsection transitions of vertically adjacent environments, such as forest edge to high marsh, high marsh to low marsh, and low marsh to colonizing marsh, are problematic. Overlap of plant communities and inherent variability of associated environmental indicators (Tables 3 and 4) place these transitions below the limits of tidal-level change that are recognized in this study (±0.5 m) (Table 2). Such transitions are assigned tidal-level change estimates of 0±0.5 m.

Empirical evidence that about 0.5 m of submergence is needed to cause substantial lithologic change in marshes of freshwater and dilute-brackish estuaries is provided by several casual observations. Removal of dikes in Salmon, Siletz, and Alsea Bays during the last decade effectively raised mean sea level by 10–40 cm in desiccated/compacted pasture lands. Measured relative subsidence of 20–30 cm has had little impact on recolonized plant assemblages or peat development, compared to adjacent (unaltered) marshes in these bays. However, dike breaching in marshes with higher salinity in South Slough, Coos Bay, has caused hypersalinity and retarded plant recolonization there (Mike Graybill, pers. comm., 1993).

Another measure of local marsh response to submergence is provided by small slump blocks (1–2 m^2 in surface area) that have dropped (10–100 cm) into tidal channels of Netarts and Tillamook Bays. Nearly horizontal marsh blocks that have dropped some 10–30 cm below surrounding high-marsh surfaces show no substantial changes in plant assemblages or peat accumulation relative to the adjacent intact marsh. Large amounts of subsidence (50–75 cm) have clearly retarded the apparent plant growth on the slumped marsh blocks. Low-marsh slump blocks have yet to be examined for their response to small amounts of subsidence in these Oregon bays. Additional macrofossil and microfossil analyses of the marsh slump blocks are warranted to rigorously establish the minimum subsidence that can be detected by the tidal-level indicators in Pacific Northwest estuaries.

Macrofossil-Lithologic Categories of Paleotidal-Level Change

Many of the wetland stratigraphic records from Oregon do not contain documentation of identified plant body parts. Plant fossils are decomposed beyond recognition in many of the older buried peaty horizons. As a result, tree roots, rooted mud (identified fossils), and relative peat development (lithology or LOI) are used to establish fossil-lithologic categories of paleotidal level (Figure 3). Upsection stratigraphic changes that cross six fossil-lithologic categories are assumed to represent 2±0.5 m subsidence. Upsection changes that span only one or two categories are arbitrarily assigned 0±0.5 m subsidence. All other transitions are assigned 1±0.5 m subsidence.

There are two significant limitations to the use of these fossil-lithologic categories. Firstly, small amounts of subsidence, i.e., less than 0.5 m, might not result in significant changes of peat development. The requirement that stratigraphic sections cross three fossil-lithologic categories runs the risk of missing minor subsidence events. So, adjacent reference sites that show minor but consistent lithologic changes across two fossil-lithologic categories (Figure 3) are qualitatively designated as possible submergence sites, i.e., 0±0.5 m (+). Secondly, colonizing marsh plant roots can grow to a depth of 0.5 m subsurface. Paleosubsidence could be underestimated by 0.25–0.5 m based on the presence of colonizing plant roots descending down into initially barren "tidal flat" mud. This underestimation of paleosubsidence is most likely to occur in areas that experience rapid interseismic rebound relative to sedimentation rate (Guilbault and others, 1995).

Tests of Precision In Estimating Paleosubsidence

An estimated resolution of tidal-level change is based on the observed elevation ranges of modern wetland settings, i.e., ±0.25 m about corresponding means (Table 2). Uncertainties in distinguishing between some vertically adjacent environments leads to the estimated paleosubsidence resolution of ±0.5 m (Table 4). To test the precision of paleotidal-level estimates based on the fossil-lithologic categories above, we analyzed previously published stratigraphic records from four localities. Paleosubsidence data were compiled for the ca. A.D. 1700 earthquake from small marshes at Willapa, Netarts, Siletz, and Alsea bays (Table 5). Ten core logs were analyzed for each of the Oregon bays, whereas tens of cutbank sites formed the data base for Willapa Bay (Brian Atwater, pers. comm., 1996).

The analysis yields consistent interpretations of paleosubsidence at Willapa (=2±0.1 m), Netarts(=0.9±0.2 m), and Alsea(=0.2±0.3 m), where the deviations from the mean are one standard deviation (Table 5). However, the Siletz Bay marshes show substantial variability of estimated paleosubsidence (0.6±0.5 m). We infer that the split in paleosubsidence estimates at Siletz Bay reflects an actual paleosubsidence value near the 0.5 m cutoff.

The tests of precision shown in Table 5 validate the estimated resolution of ±0.5 m when applied to the 0-m, 1-m and 2-m criteria cutoffs, for three out of the four localities. Therefore, paleosubsidence is reported to the nearest 1 m, i.e., 0±0.5 m, 1±0.5 m, and 2±0.5 m. Averages of interpreted paleosubsidence from several sites at each locality can be used to reduce potential bias from the midpoint cutoff values, i.e., 0.5 and 1.5 m subsidence.

The subsidence ranges above are established for tidal basins with mean tidal ranges (MTR) that fall within 2±0.5 m (see "Methods"). Tidal wetlands with lower MTR (1–1.5 m) are designated as tidally restricted, and they are assigned subsidence values that are reduced by 0.5 m. In localities where MTR has not been established, a vertical separation between forest edge and colonizing marsh that falls under 1.5 m is used to identify the tidally restricted settings.

Distribution Of Coastal Paleosubsidence Records

Paleosubsidence data for 329 reference sites in coastal Oregon (Columbia River to Coquille River) are presented in the Appendix. Reference sites are located to the nearest 10 m UTM coordinates as approximated from the original air photos and topographic maps (1:24,000 scale) marked in the field. Subsurface depth to the first buried wetland is listed, as are the number of possible subsidence events and the thickness of peaty deposits.

The Oregon reference sites are distributed unevenly in 16 localities including the Columbia River, Youngs Bay, Neawanna, Cannon Beach, Tillamook, Netarts, Nestucca, Salmon, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, Coquille, and Elk River (Appendix). All suitably long core logs from northern Oregon display evidence of episodic subsidence, as defined by two or more abrupt burial events in 1.5 m of peaty deposits (Briggs, 1994; Barnett, 1997). In contrast, some reference sites on the central and southern Oregon coast demonstrate continuous submergence, i.e., no abrupt subsidence events recorded in the last one or two thousand years.

Stratigraphic data have been published for southwest Washington localities, including Copalis, Grays Harbor, Willapa Bay, and Columbia River (Atwater, 1988; Atwater, 1992; Atwater and Hemphill-Haley, 1996). The southwest Washington sites consistently demonstrate evidence of episodic wetland burial. There are published core logs for Humboldt Bay in northern California (Vick, 1988; Clarke and Carver, 1992, Vallentine, 1992, and Li, 1992) and from the Tofino and Ucluelet areas on Vancouver Island in British Columbia (Clague and Bobrowsky, 1994; Guilbault and others, 1995). The Humboldt Bay localities include episodically subsided sites. Some sites in Humboldt Bay and Eel River delta show no abrupt subsidence for the most recent events, i.e., less than 1,000 RCYBP, indicating locally variable response to some earthquake events. The two localities from the west coast of Vancouver Island contain short intertidal records. However, one subsidence event assigned to the A.D. 1700 plate-boundary earthquake is consistently recorded at many sites at both Tofino and Ucluelet (Clague and Bobrowsky, 1994).

There are two major gaps in the distribution of coastal paleosubsidence localities: (1) northwest Washington and southwest coast of Vancouver Island and (2) the Oregon-California border area between Coquille and Humboldt Bay (Figure 1). These two areas have little or no coastal plain and lack large tidal marshes. The two contiguous data gaps represent more than 50 percent of the coast in the northern and southern parts of the Cascadia margin. Tidally sensitive sites are absent at distances greater than 20 km inland from the coast in most of Oregon and northern California. This precludes investigations of the maximum landward reach of coseismic paleosubsidence, based on tidal marsh stratigraphy.

Estimated Paleosubsidence From the A.D. 1700 Event

Paleosubsidence estimates for the most recent (A.D. 1700) great Cascadia earthquake at 100 reference sites are compiled in Table 6. Maximum values of 2±0.5 m are recorded in the southwest Washington localities. Because the maximum elevation range of the paleotidal-level indicators used here is 2±0.5 m, possible subsidence greater than 2.5 m is not addressed in this compilation. Estimated paleosubsidence drops to 1±0.5 m along the northern Oregon coast, and at Tofino-Ucluelet coastal areas on Vancouver Island. Little or no paleosubsidence (0±0.5 m) is estimated for some coastal sites in central Oregon. Subtle evidence of possible paleosubsidence, denoted by 0±0.5 m (+) in the data base, is found to be localized in bays of southern Oregon. Larger amounts of estimated subsidence (1±0.5 m) are also localized in prominent synclines and fault valleys of Coos and Humboldt Bays.

Paleosubsidence associated with the A.D. 1700 event in central Vancouver Island drops from 1±0.5 m at the coast to 0±0.5 m at Port Alberni, about 60 km inland (Table 6). West-east traverses of Grays Harbor, Washington, show a possible increase of subsidence, about 0.5 m, over west-to-east distances of 20–30 km. For the lower Columbia River valley the paleosubsidence estimates range from 0–1 m at the coast to about 1–2 m at a distance of about 15–20 km inland, to 0 m at a distance of 40–50 km inland (Table 6). Netarts and Tillamook Bay (Figure 1) which are separated by about 7 km distance east-west, display similar amounts of paleosubsidence (1±0.5 m). Inland reference sites near Toledo (Yaquina Bay) and Karnowsky Creek (Siuslaw) show 0.5–1 m greater subsidence than their seaward counterparts, located some 10–15 km to the west.

Eleven reference sites in this compilation are denoted as tectonic subsidence sites (Table 6). Peaty sections at these sites overlie shallow bedrock or other compaction-resistant substrata. Comparisons of the tectonic sites with other reference sites at the same localities show no consistent differences between the amounts of subsidence. Furthermore, 17 reference sites in south-central Oregon show no evidence of paleosubsidence greater than the 0.5 m cutoff during the widespread A.D. 1700 event. This suggests that coseismic settlement during this event was less than the resolution of paleosubsidence estimates (±0.5 m) used here.

Comparison of pre-A.D. 1700 Paleosubsidence Events

Paleosubsidence estimates for presumed earthquakes from A.D. 1700 to 3,500 RCYBP are compiled for nine bays in the central Cascadia margin (Table 7). Data are currently insufficient to correlate the youngest 3–5 events within and between some of the bays. For this reason, the latest 3–5 recorded events are used for analysis, independent of relative age. At reference sites where there is no evidence of abrupt subsidence, an assumed number of events per core length is based on event records from nearby core sites (Appendix).

Five of the bays have multiple burial records listed for a single site, in order from youngest (at top) to oldest (at bottom). All of the bays contain compilations of multiple burial records from several reference sites, yielding a composite reference site. About 3–5 events from several individual sites are stacked to form the composite reference site. The composite reference sites are compiled to reduce bias from a single event or from a single reference site within each locality. The results of the compilations for both single and composite reference sites indicate substantial variability of estimated paleosubsidence between different events. The largest variability is found in southwest Washington (0±0.5 to 2±0.5 m) and the least variability is found at the western ends of Siuslaw and Umpqua bays (0±0.5).

By comparison to the longer periods of record the A.D. 1700 event is near the upper end of predicted paleosubsidence for Grays Harbor and Willapa Bay (Table 7). The A.D. 1700 event is generally representative of the middle range of paleosubsidence records for the northern Oregon coast, but it falls near the bottom of the predicted range for Alsea Bay and western Yaquina Bay. With the exception of Joe Ney and South Slough sites (Table 6) the A.D. 1700 event is generally not recorded in Coos Bay. Searches for the A.D. 1700 event have been hampered in several bays, e.g., Tillamook, Coos, Coquille, and Elk, where rapid progradation of tributary bay-head deltas restricts the areal extent of subsidence-sensitive wetlands. Focused studies utilizing close-spaced coring traverses of the bay-head deltas are needed to better establish the possible evidence of the youngest prehistoric subsidence events in such settings.

CONCLUSIONS

(1) Plant macrofossils and relative peat development in tidal basin wetlands serve as tidal-level indicators that can establish paleotidal-level change to the nearest 0-, 1-, and 2-m intervals in the Cascadia margin. Microfossil diatoms and forams independently confirm paleosubsidence events under appropriate environmental conditions.

(2) A regional compilation of several hundred late Holocene stratigraphic sections from Oregon bays demonstrates consistent records of episodic subsidence in northern Oregon but a mix of either continuous submergence or localized episodic subsidence in the south-central Oregon bays.

(3) Estimated paleosubsidence from the A.D. 1700 Cascadia plate-boundary earthquake varies from about 2 m in southwest Washington, to 0–1 m along the northern Oregon coast and central west coast of Vancouver Island, to 0 m on the central Oregon coast. Subsidence of 0–1 m is locally recorded in prominent fold axes and/or fault valleys of large bays in southern Oregon and northern California. Several bays in north and central Oregon demonstrate increasing subsidence (at least 0.5 m) with increasing distance inland from the coast.

(4) The estimated paleosubsidence for the A.D. 1700 earthquake is generally representative of (1) the largest vertical-displacement events for southwest Washington, (2) middle events for the northern Oregon coast, and (3) middle to smallest events for some localities of the central and southern Oregon coast.

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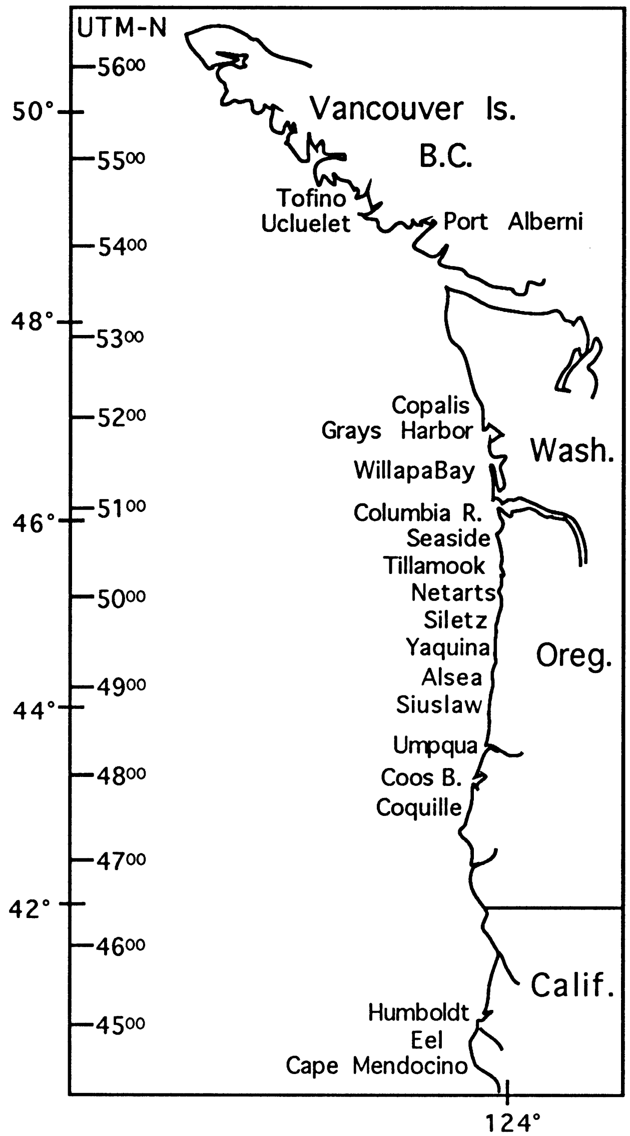

Figure 1: Map of Cascadia margin coastline with locality names.

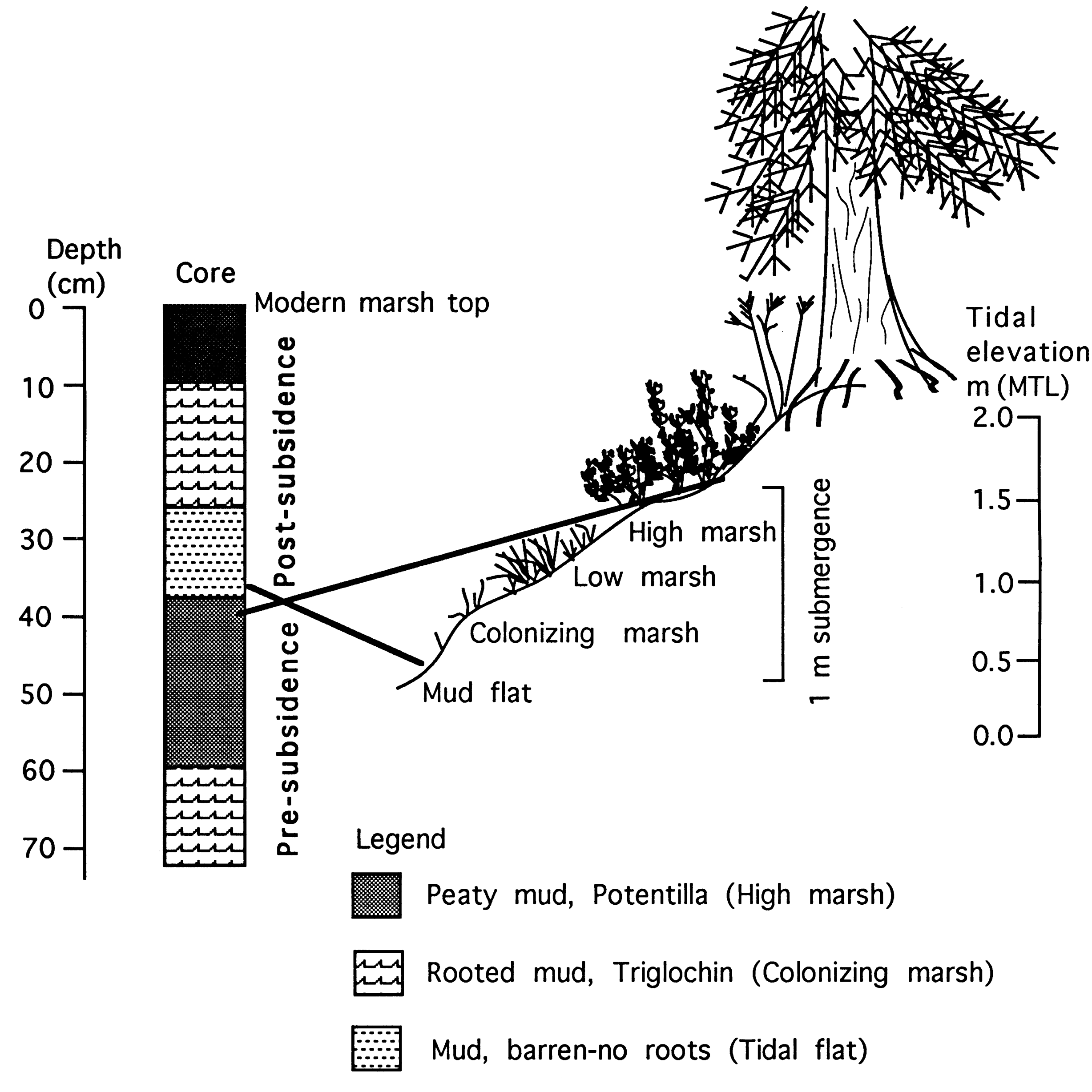

Figure 2: Wetland burial sequence showing positions of paleotidal level indicators immediately above and below the burial contact.

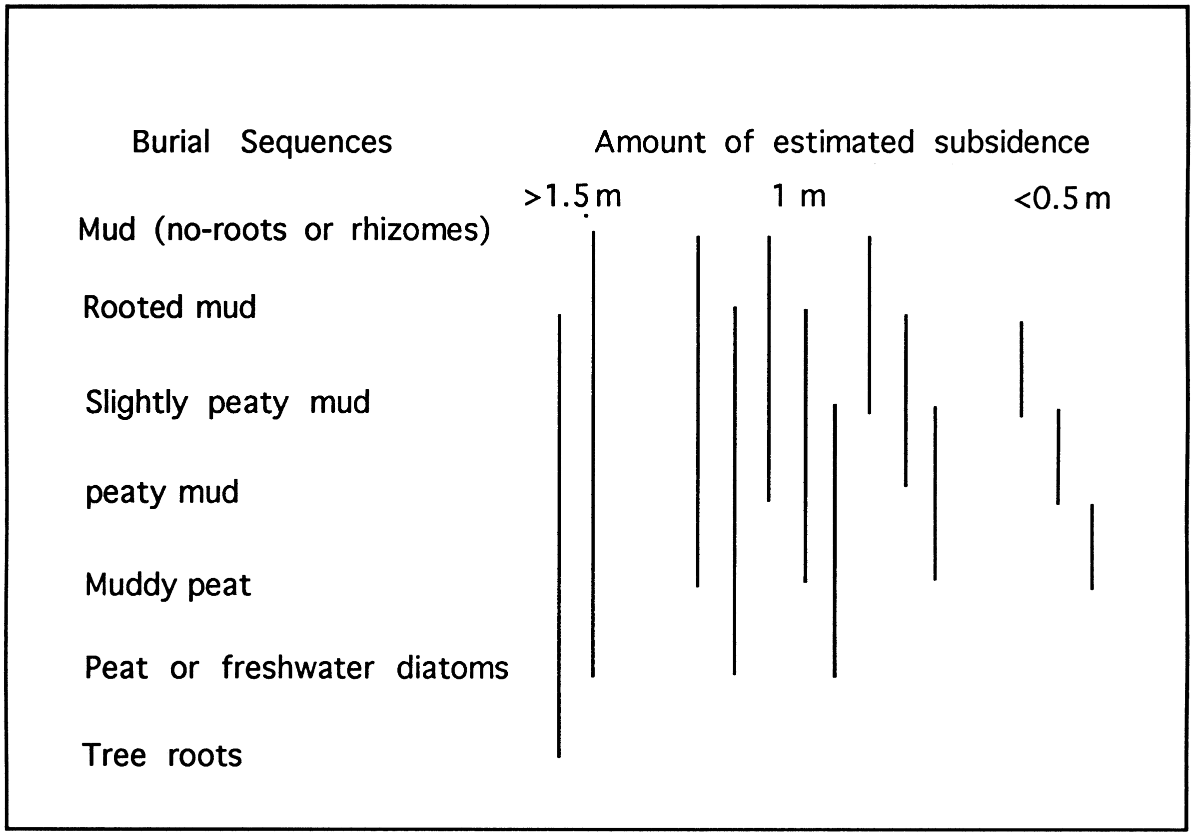

Figure 3: Diagram of fossil-lithologic categories of paleotidal level and corresponding amounts of paleosubsidence (0±0.5, 1±0.5, and 2±0.5 m) based on category transitions.

TABLE 1 COASTAL MARSH PLANTS, DIATOMS, AND TIDAL-LEVEL INDICATORS FROM OREGON BAYS	
SOME DIAGNOSTIC MARSH PLANTS	
(Jefferson, 1975)	
LOW MARSH	HIGH MARSH
Triglochin maritimum	*Deschampsia caespitosa*
Scirpus americanus	*Juncus balticus*
Salicornia virginica	*Potentilla pacifica*
Distichlis spicata	*Grindelia integrifolia*
SOME DIAGNOSTIC DIATOMS FROM FRESH-AND BRACKISH-MARINE ENVIRONMENTS	
(Darienzo, 1991 and Briggs, 1994)	
FRESH WATER	BRACKISH-MARINE
Melosira sp.	*Paralia sulcata*
Pinnularia sp.	*Biddulphia aurita*
Cymbella sp.	*Grammatophora sp.*
Eunotia sp.	*Coscinodiscus sp.*
Epithemian sp.	*Actinoptychus sp.*
Tabellaria sp.	*Camplyodiscus sp.*
Gomphonema sp.	*Navicula pusilla*
Stauroneis sp.	*Nitzschia trybionella*
	Nitzschia punctata
	Opephora marina
	Diploneis bombus
	Diploneis smithii
	Diploneis interrupta
	Melosira nummuloides
	Auliscus sp.
	Aulacodiscus sp.
	Epithemia turgida
	Rhopalodia sp.
	Surirella sp.

DIAGNOSTIC DIATOMS: OLIGOHALOBOUS, MESOHALOBOUS, POLYHALOBOUS

(Barnett, 1997)

OLIGOHALOBOUS	MESOHALOBOUS	POLYHALOBOUS
Amphora libyca	*Biddulphia aurita*	*Achnanthese brevipes*
Diploneis ovalis	*Cyclotella striata*	*Actinoptchus senarius*
Epithemia turgida	*Diploneis dydma*	*Amphora proteus*
Eunotia pectinalis	*Diploneris interrupta*	*Biddulphia dubia*
Gomphonema augustatum	*Diploneris psuedovalis*	*Cocconeis scutellum*
G. parvulum	*Gyrosigma eximium*	*Coscinodiscus radiatus*
Navicula mutica	*Navicula phyllepta*	*Dephineis surirella*
N. pussilla	*Nitzschia fasciculata*	*Gramattophora oceanica*
N. radiosa	*Nitzchia lanceola*	*Hyalodiscus scoticus*
Pinnularia lagerstedi	*Nitzschia levidensis*	*Paralia sulcata*
Rhoicospenia curvata	*Nitzschia navicularis*	*Thalassiosira eccentrica*
Surirella brebissonii	*Pinnularia viridis*	*Thalassiosira pacifica*
Tabellaria fenestrata	*Synedra fasciculata*	*Trachyspenia austrailis*

SOME TIDAL-LEVEL INDICATORS FROM MODERN WETLAND SOILS

WETLAND SETTING	ELEVATION (m) MTL	APPARENT WETLAND DEVELOPMENT
Upland forest	>2.0	Oxidized forest soil
Wetland forest/shrub	2±0.5	Muddy peat-peat with tree/shrub roots, dominantly freshwater diatoms
High marsh	1.5±0.5	Peaty mud-muddy peat, mostly fresh- some brackish-water diatoms (in saline bay)
Low marsh	0.75±0.5	Slightly peaty mud-peaty mud, dominantly brackish water diatoms (in saline bay)
Colonizing marsh	0.5±0.25	Rooted mud-rare roots and rhizomes, dominantly brackish water diatoms (in saline bay)
Mud flat	<0.5	Mud-no marsh plant roots or rhizomes

Notes:

Diatoms from compilations by Darienzo (1991) and Briggs (1994) and Barnett (1997).

Wetland setting and lithologies compiled from Darienzo and Peterson (1990), Darienzo (1991), and Peterson and Darienzo (1996)

MTL= mean tidal level (0.0 meters MTL).

TABLE 2 SUMMARY OF SAMPLE AND ELEVATION DATA FROM MODERN WETLAND SETTINGS

Locality	Traverse	Setting	Distinctive	Dominant	otal organic	Diatoms	Diatoms	Elevation	Elevation	Elevation
MTL˜MSL	mid-point		plants	lithology	mean %LOI	%F/B/M	#Abund	minimum	maximum	mean
	UTM N									
	UTM E									
Grays Harbor	Elliot Slough							m MSL	m MSL	m MSL
	5202900	Forest lower edge	Alder, willow	mp	16	65/12/23	11	2.1	2.3	2.2
	440600	Marsh	Carex	pm	13	39/37/24	24	0.7	1.8	1.2
	Approx. MTR	Colonizing marsh	Carex	rm	7	17/27/56	14	0.1	0.6	0.3
	2.5 m	Tidal flat upper edge		m				0.1	0.2	0.2
	Johns River							m MSL	m MSL	m MSL
	5194500	Forest lower edge	Spruce	mp	17	63/8/29	5	1.9	2.3	2.1
	424100	High marsh	Potenilla, Grindelia	mp	20	61/13/26	13	1.7	1.9	1.8
	Approx. MTR	Low marsh	Salicornia, Triglochi	slpm	14	20/45/35	40	0.9	1.1	1
	2.2 m	Colonizing marsh	Triglochin	rm	7	5/37/58	16	0.2	0.5	0.3
		Tidal flat upper edge		m						
Willapa Bay	Niawiakum									m MTL
	5162400	Forest lower edge	Spruce, cedar	-	-					2.2
	431200	High marsh	Potenilla	pm	-					1.6
	Approx. MTR	Low marsh	Triglochin, Distichlis	pm	-					0.8
	2.2 m	Colonizing marsh	Triglochin	rm	-					0.1
		Tidal flat upper edge		m						-0.1
Seaside	Neawanna N.							m MSL	m MSL	m MSL
	5093100	Forest lower edge	Alder, spruce	mp	32	70/12/18	5	2.3	2.8	2.5
	429200	High marsh	Potenilla	pm	39	65/18/17	15	1.2	1.4	1.3
	Approx. MTR	Low marsh	Triglochin	slpm	20	17/49/34	58	0.3	0.5	0.4
	1.4 m	Colonizing marsh	Salicornia	rm	17	19/46/35	23	0.1	0.3	0.2
		Tidal flat upper edge		m	-			0.1	0.2	0.1
	Neawanna S.									m MTL
MTL=0.6+MS	5092400	Forest lower edge	Alder, spruce	mp	49					1.8
	428800	High marsh	Potenilla,Juncu.	pm	30					1.3

		Low marsh	Triglochin	slpm	15					0.7
		Colonizing marsh	Triglochin	rm	-					0.3
		Tidal flat upper edge		m						-0.3
Tillamook Bay	Kilchis							m MSL	m MSL	m MSL
	5038800	Forest lower edge	Spruce, alder	mp	60	55/20/25	7	1.8	2.3	2.1
	432500	High marsh	Potenilla, Juncus	pm	25	55/19/26	14	1.3	1.4	1.4
	Approx. MTR	Low marsh	Triglochin	slpm	16	31/39/29	29	0.9	1	1
	1.6 m	Colonizing marsh	Triglochin	rm	19	18/38/44	32	0.4	0.6	0.5
		Tidal flat upper edge		m				-	-	-
Netarts Bay	South Marsh									m MTL
	5024300	Very-high marsh		mp	-					1.7
	425000	High marsh	Potenilla., Grindelia	mp	28					1.3
	Approx. MTR	Low marsh	Salicornia, Triglochi	pm	-					0.5
	1.7 m	Colonizing marsh	Triglochin., Scirpus	rm	8					0.4
		Tidal flat upper edge		m						0.2
Nestucca	Duck									m MTL
	5004200	Forest lower edge		-	-					-
	425300	High marsh	Potenilla	mp	40					1.1
	Approx. MTR	Low marsh	Distichlis, Salicornia	pm	-					0.6
	1.8 m	Colonizing marsh	Triglochin	rm	10					-0.1
		Tidal flat upper edge		m						-0.2
Siletz Bay	Schooner							m MSL	m MSL	m MSL
	4975800	Forest lower edge	Spruce, alder	p	37	64/13/23	17	1.9	2.2	2.1
	420300	High marsh	Potenilla	mp	23	63/17/20	42	1.2	1.3	1.2
	Approx. MTR	Low marsh	Carex, Distichlis	pm	20	30/23/47	24	0.6	1.1	0.9
	1.5 m	Colonizing marsh	Carex	rm	8	27/33/40	28	0	0.4	0.2
		Tidal flat upper edge		m				0	0.2	0.1
MTL=0.3+MS	Spit									m MTL
	4972300	Forest lower edge	Spruce	p	-					2
	418900	High marsh	Potenilla	mp	42					1.1
	Approx. MTR	Low marsh	Distichlis, Salicornia	slpm	-					0.8
	1.4	Colonizing marsh	Triglochin	rm	15					0.4
		Tidal flat upper edge		m						0.2

Yaquina Bay	Hatfield									m MTL
M TL=0.1+MS	4940200	Forest lower edge		-	-					-
	417400	High marsh	Potenilla, Grindelia	mp	21					1.3
	Approx. MTR	Low marsh	Distichlis, Salicornia	pm	-					1.2
	1.9 m	Colonizing marsh	Triglochin	rm	15					1
		Tidal flat upper edge		m						0.6
Alsea Bay	Central Marsh							m MTL	m MTL	m MTL
	4918200	Forest lower edge	Spruce, shrub	-	-			1.9	-	-
	419000	High marsh	Potenilla, Grindelia	mp	35			1.4	1.8	1.6
	Approx. MTR	Low marsh	Salicornia, Triglochi	pm	-			0.6	1.1	0.9
	1.8 m	Colonizing marsh	Triglochin	rm	7			0.3	0.6	0.5
		Tidal flat upper edge		m				0.3	0.6	0.4
Notes:										
Locality: Bay name and conversion between local and mean tide level (MTL) and mean sea level (MSL) from NGVD 1929 if measured.										
Traverse mid-point in UTM coordinates from USGS 7.5 minute topographic maps, rounded to the nearest 100 m.										
Approximate Mean Tidal Range in meters (Approx. MTR) taken from NOAA Tide Tables 1996.										
Setting: Forest (lower edge), high marsh, low marsh, colonizing marsh, and tidal flat (upper edge), based on criteria from Jefferson (1975).										
Distinctive plants: Plants with leaves, stems, or rhizomes that can be identified in buried soils.										
Triglochin m.=Triglochin., *Scirpus a*.=Scripus., *Salicornia v*.=Salicornia., *Distichlis s*.=Distichlis., *Potentilla p*.=Potentilla.,										
Grindelia i.=Grindelia, Juncus b.=Juncus., *Carex l*.=Carex, *Picea s*.=Spruce, and other trees (Alder, Willow, Cedar).										
Lithology: Mud (no roots or rhizomes)=m, rooted mud (<5% peaty)=rm, slightly peaty mud (5-20% peaty)=slpm,										
peaty mud (20-50% peat)=pm, muddy peat (50-80% peat)=mp, peat (>80% peat) =p; based on apparent roots/peat abundance.										
Total organics: Percent total organic carbon lost on ignition (LOI).										
Diatoms: Percentage (%) of oligohalobous (fresh=F), mesohalobous (brackish=B) and polyhalobous (marine=M).										
Percentage of diagnostic diatoms are from three samples (50 identified diatoms per sample)										
yielding 150 identified diatoms counted per tidal setting.										
Diatom Abundance is average number of whole valves and major fragments per field, as averaged from fifty microscope fields (500x).										
Elevations: Surveyed to local mean tidal level (MTL) or NGVD 1929 mean sea level (MSL).										
Assumed survey error to elevation datum (MTL, MSL) is ±0.1 m.										
Non-statistical errors for MTL vary between bays and traverses: ±0.3 m Neawanna, ±0.15 m Nestucca, ±0.08 m Siletz,										
±0.03 m Hatfield (Darienzo, 1991) and ±0.05 m Niawiakum (NOAA predicted tide tables).										
Data compiled from D. Pettit and C. Peterson (unpublished data, 1989), Darienzo and Peterson (1990), Darienzo (1991),										
Peterson and Darienzo (1996), and Barnett (1997).										

TABLE 3 VERTICAL DIFFERENCES BETWEEN MEAN ELEVATIONS OF WETLAND SETTINGS					
Traverse	Forest edge-	Forest edge-	Forest edge-	High marsh-	High marsh-
	tidal flat edge	colonizing marsh	low marsh	tidal flat	colonizing marsh
	elevation difference	elevation difference	elevation difference	elevation difference	elevation difference
	(m)	(m)	(m)	(m)	(m)
Elliot	2.0	1.9	-	1.0	-
Johns River	-	1.8	1.1	-	1.5
Niawiakum	2.3	2.1	1.4	1.7	1.5
Neawanna N.	2.4	1.5	2.1	1.2	1.1
Neawanna S.	2.1	1.5	1.1	1.6	1.0
Netarts S.M.	-	-	-	1.1	0.9
Kilchis	-	1.6	1.1	-	0.9
Duck	-	-	-	1.3	1.2
Schooner	2.0	1.9	1.2	1.1	1.0
Siletz Spit	1.8	1.6	1.2	0.9	0.7
Hatfield	-	-	-		0.6
Alsea Central	-	-	-	1.2	1.1
	Mean 2.1	Mean 1.7	Mean 1.3	Mean1.0	Mean 1.0
Traverse	Forest edge-	High marsh-	Low marsh-	Colonizing marsh-	
	high marsh	low marsh	colonizing marsh	tidal flat edge	
	elevation difference	elevation difference	elevation difference	elevation difference	
	(m)	(m)	(m)	(m)	
Elliot	-	-	-	0.1	
Johns River	0.3	0.8	0.7	0.2	
Niawiakum	0.6	0.8	0.7	0.1	
Neawanna N.	1.2	0.9	0.2	0.1	
Neawanna S.	0.5	0.6	0.4	0.6	
Netarts S.M.	0.7	0.8	0.1	0.2	
Kilchis	-	0.4	0.5	-	
Duck	-	0.5	0.7	0.1	
Schooner	0.9	0.3	0.7	0.1	
Siletz Spit	1	0.3	0.4	0.2	
Hatfield	-	0.1	0.2	0.4	
Alsea Central	-	0.7	0.1	0.1	
	Mean 0.7	Mean 0.5	Mean 0.4	Mean 0.2	

TABLE 4 PALEOSUBSIDENCE ESTIMATES FROM WETLAND TIDAL-SETTING INDICATORS

Burial sequence upper//lower	Plants upper// lower	Lithology upper//lower	Diatoms upper//lower	Mean elevation change (range) (m)	Mean elevation change (mean) (m)	Estimated subsidence (m)
Tidal flat//forest edge	No roots// tree roots	mud//peaty-	BW//FW	1.8-2.4	2.1	2 ± 0.5
Colonizing//forest edge	//tree roots	rooted mud//peaty-	BW//FW	1.5-2.1	1.7	2 ± 0.5
Low marsh//forest edge	Salicornia, Distichlis //tree roots	peaty-//peaty-	BW//FW	1.1-2.1	1.3	1 ± 0.5
Tidal flat//high marsh	No roots// Potentilla, Grindelia	mud//peaty-	BW//BW-FW	0.9-1.7	1	1 ± 0.5
Colonizing//high marsh	//Potentilla, Grindelia	rooted mud//peaty-	BW//BW-FW	0.6-1.5	1	1 ± 0.5
High marsh//forest edge	Potentilla, Grindelia //tree roots	peaty-//peaty-	BW-FBW//FW	0.3-1.2	0.7	0 ± 0.5
Low marsh//high marsh	Salicornia, Distichlis //Potentilla, Grindelia	peaty-//peaty-	BW//BW-FW	0.1-0.9	0.5	0 ± 0.5
Colonizing//low marsh	//Salicornia, Distichlis	rooted mud//peaty-	BW//BW	0.1-0.7	0.4	0 ± 0.5
Tidal flat//colonizing	No roots//	mud//rooted mud	BW//BW	0.1-0.6	0.2	0 ± 0.5

Notes:

Burial sequence: Upper (post-submergence) (//) lower (pre-submergence).

Distinctive Plants: Plants with leaves, stems or rhyzomes that can be identified in buried soils.

Triglochin m. = Triglochin., *Salicornia v*. = Salicronia., *Distichlis s*. = Distichlis., *Potentilla p*. = Potentilla, *Grindelia i*. = Grindelia, tree roots (spruce, alder, willow, cedar).

Lithology: mud (no roots or rhizomes), rooted mud (< 5% peat), peaty-(5-100% peat)

Diatoms: dominantly freshwater or upland (FW), and brackish water (BW).

TABLE 5 TEST OF PALEOSUBSIDENCE ESTIMATES FOR FOUR LOCALITIES

Locality	Reference site	Plant fossils	Lithology	Subsidence
				(±0.5 m)
Willapa Bay				
Niawiakum	Outcrop17	//spruce	m//p-mp	2
	Outcrop18	Triglochin//spruce	rm//pm-mp	2
Bay Center	Outcrop16	Triglochin//spruce	rm//p-mp	2
				Mean ±1std
				2±0.1
Netarts Bay				
South Marsh	N5		rm//pm	1
	N5A		rm//p	1
	N6		rm//p	1
	N7		rm//mp	1
	N8		rm//pm	1
	N9		rm//pm	1
	N10		rm//slpm	0
	N12		rm//pm	1
	N13		rm//pm	1
	N11		rm//pm	1
				Mean ±1std
				0.9±0.2
Siletz Bay				
Spit Marsh				
	SB2		rm//pm	1
	SB4		pm//pm	0
	SB9		rm//mp	1
	SB10		rm//slpm	0
	SB11		rm//mp	1
	SB14		slpm//pm	0
Schooner Ck.	24		rm//pm	1
	25		rm//pm	1
	26		rm//pm	1
	28		rm//slpm	0
				Mean ±1std
				0.6±0.5

Alsea Bay						
Central Marsh	AB4		rm//slpm	0		
	AB5		rm//mp	1		
	AB6		rm//slpm	0		
	AB7		rm//slpm	0		
	AB8		mp//mp	0		
	AB9		pm//pm	0		
	AB10		rm//slpm	0		
	AB11		pm//mp	0		
	AB16		rm//pm	1		
	AB19		mp//mp	0		
				Mean ±1std		
				0.2±0.3		
Notes:						
Locality: Bay name and reference site. Core and outcrop UTM coordinates are given in Table 6 and Appendix 1						
//=contact, so above contact//below contact.						
Plant macrofossils: Indicators above and below the event contact are separated by '//', upper//lower.						
Lithology: mud (no roots or rhizomes)=m, rooted mud(<5% peat)=rm, slightly peaty mud(5-20% peat)=slpm,						
peaty mud (20-50% peat)=pm, muddy peat (50-80% peat)=mp, peat (>80% peat) =p.						
Subsidence: Estimates of paleosubsidence are given as 0, 1 or 2 m (±0.5 m). See text for estimate criteria.						
Cutbank outcrops at sites 16, 17, and 18 in central Willapa Bay are each tens of meters in length.						
The standard deviation (1std) from the subsidence mean is assumed to be not more than 0±0.1						
for the Willapa Bay sites.						
Data Sources:						
Willapa Bay, Atwater (1988), and Atwater and Hemphill-Haley (1995)						
Netarts Bay, Darienzo (1991)						
Siletz Bay, Darienzo (1991), and Peterson and others (1996)						
Alsea Bay, Peterson and Darienzo (1996)						

TABLE 6 PALEOSUBSIDENCE ESTIMATES FOR 1700 AD EVENT IN THE CASCADIA MARGIN											
Locality	Reference site	UTM N	UTM E	Plant Macrofossils	Lithology	Total % organics	Diatoms fresh %	Diatom abundance # per field	Forams	Subsidenc (m)	Referenc
Vancouver Is.											
	Tofino1			//Juncus, Potentilla	rm//mp	19//				1 ±0.5	12
	Tofino2				rm//mp	//62				1 ±0.5	12
	Tofino4				rm/pm				Mili. fusca//Jada. macr	0.5-1	12,15
	Tofino5	5442000	292000	Carex//Juncus	rm//pm					1 ±0.5 t	12
	Ucluelet9				rm//mp					1 ±0.5	12
	Ucluelet10				rm//mp					1 ±0.5	12
	Port Alberni	5457000	367000	Triglochin//Triglochin	pm//pm					0 ±0.5	12
Copalis											
(r)	#7	5218700	411500	Triglochin//Distichlis	rm//mp					1 ±0.5	2
(r)	#6	5218900	411900	Triglochin//Spruce	rm//p					1 ±0.5	2
Grays Harbor											
	Oceanshores	5112200	412200		rm//mp					1 ±0.5	
	Oceanshores	5111900	412100	//spruce	rm//pm					2 ±0.5	
	Elliott Slough	5203100	441000	//spruce	rm//pm					2 ±0.5 t	
	Elliott Slough	5202600	440800	//spruce	m//mp					2 ±0.5	2
	Elliott Slough	5202700	440800	//Spruce	rm//pm	8//43	22//66	12//4		2 ±0.5	5
	Chehalis R.	5199100	444300	Carex//spruce	rm//pm					2 ±0.5	2
	Blue Slough	5199300	444900	//spruce	m//pm					2 ±0.5	2
	Chenois Creek	5209900	421700	//spruce	m//mp					2 ±0.5	2
	Johns R.#13	5194500	425000	//Potentilla	m//pm					1 ±0.5	2
	Johns R.#14	5193500	424900	//Potentilla	m//mp					1 ±0.5	2
	Johns River	5193900	424900		rm//p	9//56	8//52	16//16		1 ±0.5	5
Willapa Bay											
	S.F. Willapa R.	5168800	443900	Carex//spruce	rm//pm					2 ±0.5	2
	Bear River	5133500	426300	//spruce	m//p					2 ±0.5	2
	Bay Center	5164300	426300	Triglochin//spruce	rm//p					2 ±0.5	2
	Niawiakum17	5164200	430400	//spruce	m//p					2 ±0.5	2
	Niawiakum18	5162600	431200	Triglochin//spruce	rm//pm					2 ±0.5	2
	Oysterville	5159100	421600	//spruce	m//p					2 ±0.5	2
Columbia R.											
	Warrenton	5111700	433500		rm//p					1 ±0.5	1,20
	Wallooskee R.	5110250	439000	//spruce	slpm//pm					1 ±0.5	1
	Deep River24	5131200	446200	//spruce	m//pm					2 ±0.5	2
	Deep River25	5130800	446400	//spruce	m//pm					2 ±0.5	2
*	John Day R.#	5114000	442300	//spruce	rm//mp					2 ±0.5	1,23
*	John Day R.#	5113900	442200		rm//mp					1 ±0.5	1,23
*	John Day R.#	5113900	442100	//spruce	rm//mp					2 ±0.5 t	1,23
	Blind Slough 1	5116400	455800	//spruce	m//p					2 ±0.5	1,23
	Blind Slough 2	5116400	455900	//spruce	rm//mp					2 ±0.5	1,23
	Price Island	5122100	465700	spruce//spruce	pm//mp					0 ±0.5	1,3

	Price Island	5122300	465600		rm//pm					1 ± 0.5	1,23
	Hunting Is.	5119400	467600	Scirpus//	rm//slpm					0 ± 0.5 (+	1,3
	Wallace Island	5109500	479000		slpm//slpm					0 ± 0.5	1,3
Seaside											
(r)	Neawanna2	5092300	428900		pm//mp	20//37				0 ± 0.5 (+	1,13
(r)	Neawanna8	5095000	429400		rm//pm					1 ± 0.5 t	1,13
(r)	Neawanna12t	5093100	429200		rm//pm	12//40	10//68	15//13		1 ± 0.5	1,5
Tillamook											
	Garibaldi	5045600	430000	//shrub roots	slpm//mp					1 ± 0.5 t	1,5
	Flower Pot	5038400	427300		rm//pm	14//53	0//60	2//2		1 ± 0.5	1,5
	TFUBayCity	5039800	431400		rm/mp	4//46	8//72	19//8		1 ± 0.5 t	1,5
Netarts											
	Oyster Farm	5029900	426800	Triglochin//Juncus	rm//mp	3//36				1 ± 0.5 t	1,13
	Wee Willies	5027700	427200		m//pm					1 ± 0.5	1,13
	N5	5024200	424400		slpm//pm		FW//FBW			0 ± 0.5 (+	1,13
	N7	5024300	424900		rm//mp		BW//BW			1 ± 0.5 t	1,13
Nestucca											
	Nes. Duck3	5004200	425500		rm//pm	10//26				1 ± 0.5	1,13
	Nes. Duck1	5004200	425600		rm//mp					1 ± 0.5 t	1,13
Salmon R.											
	SR#2	4987000	422300	Triglochin//	rm/mp					1 ± 0.5	1
Siletz											
	Schooner Ck.	4975700	420400		rm//pm	13//19	14//58	12//9		1 ± 0.5	1,5
	SB 28	4975700	420800		rm//slpm					0 ± 0.5 (+	1,21
(r)	SB32	4974300	420200		slpm//pm					0 ± 0.5 (+	1,21
(r)	SB33	4973300	421100		rm//pm					1 ± 0.5 t	1,21
(r)	SB9	4972100	418800		rm//mp					1 ± 0.5	1,13,21
	SB14	4971900	418800		slpm//pm					0 ± 0.5 (+	1,21
*	Siletz River	4971800	421200		rm//pm	9//21	12//64	30//12		1 ± 0.5	1,5
Yaquina											
	YB13	4940000	417300		slpm//pm					0 ± 0.5 (+	1,21
	Hatfield	4940170	417400		rm//rm	14//13	BW//BW			0 ± 0.5	1,13,22
	Oysterville2	4935600	420000		slpm//pm		BW//BW			0 ± 0.5 (+	1,13,22
	YB14	4936000	423000		rm//mp					1 ± 0.5	1,22
	Blind1	4936100	424000		rm//pm					1 ± 0.5	1,13
(r)*	Olalla Ck.	4942600	427000		slpm//mp					1 ± 0.5	1
Alsea											
	AB21	4920300	418600		mp//mp	41//32				0 ± 0.5 t	1,19
	AB8	4918800	419200		mp//mp	37//48				0 ± 0.5	1,19
	AB10	4918300	419200		rm//slpm					0 ± 0.5 (+	1,19
	AB12	4918300	420500		pm//mp	24//30				0 ± 0.5 (+	1,19
Siuslaw											
(r)	NF. Siuslaw20	4871000	413600		p//p					0 ± 0.5	1,6
	Demming223	4968600	415600		mp//mp		FBW//FBW			0 ± 0.5	1,6
(r)	Bernhard213	4870500	418800		pm//mp					0 ± 0.5 (+	1,6
(r)	Karnowsky21	4872500	420400		slpm//mp		BW//BW			1 ± 0.5	1,6
Umpqua											

	Gardiner310	4843300	410100		pm//pm					0±0.5	1,6
	Providence328	4840400	409600		slpm//slpm		BW//BW			0±0.5	1,6
(r)	Butler311	4839600	413800		p//mp					0±0.5	1,6
(r)	Schofield301	4836500	412500		slpm//pm					0±0.5 (+	1,6
Coos Bay											
(r)	North Sl.431	4813100	400900		mp//mp					0±0.5	1,6
(r)	Kentuck450	4807900	404000		pm//pm		FBW//BW			0±0.5	1,6
(r)	Pony Sl.470	4805200	400100		p//p					0±0.5	1,6
	Coalbank456	4800100	402000		slpm//slpm					0±0.5	1,6
(r)	Shingleh.460	4797000	401300		pm//pm					0±0.5	1,6
	Joe Ney7	4798900	394300		rm//pm					1±0.5	1
	South Sl.408	4796700	393900		rm//rm					0±0.5	1,6,14
(r)	South Sl.SS15	4793500	395500		rm//rm					0±0.5	1
(r)	South Sl.SS5	4794000	392500		rm//slpm					0±0.5 (+	1
(r)	South Sl.WC1	4792300	393100		rm//pm					1±0.5	1
Coquille											
	Bandon508	4776400	386100	//spruce	pm//p					0±0.5 (+	1,7
	Prosper502	4778100	388100		slpm//slpm					0±0.5	1,7
(r)	SevenMile505	4780300	390400		slpm//slpm					0±0.5	1,7
(r)*	SevenMile511	4780300	391100		rm//pm					1±0.5	1
(r)	Hachet514	4780400	394700		pm//pm					0±0.5	1
(r)*	19Mile516	4783300	395800		rm//slpm					0±0.5 (+	1
Clam Beach											
	Mad R. Mouth	4536100	405800							Uplift	8
Humboldt B.											
(r)	MRS7	4529200	405000	Triglochin//spruce	slpm//mp					1±0.5	8,25
(r)	MRS3	4525000	403200	Salicornia//Grindelia	rm//mp				Mili. fusca//	1±0.5	8,16,25
	JC#	4522600	409200		m//m					0±0.5	24
	JCD	4522200	408900	//Grindelia	m//p					1±0.5	24
	ES2	4517600	404230	//Grindelia	m//p					1±0.5	24
	SBA	4506000	398100		m//m					0±0.5	24
	Two Islands	4503500	397300	//Grindelia	m//mp					1±0.5	24
Eel River											
(r)	ERC03	4504300	392200		m//m					0±0.5	17
(r)	ERBTND1			//spruce	sand//soil					1±0.5	17
C. Mendocino											
	Singley Flat	4476000	381000							Uplift	10,18
Notes:											
UTM: Location coordinates from USGS 7.5 minute topographic maps, rounded to the nearest 100 m.											
(r) =tidally restricted reference site, modern mean tidal range 1-1.5 m.											
(*) =shallowest subsidence event unsupported by locality radiocarbon date or paleotsunami deposit.											
All other sites are correlated to 1700 AD event by radiocarbon and/or paleotsunami deposits.											
//=contact, so above contact//below contact.											

Plant Macrofossils: Indicators above and below the event contact are separated by '//', upper//lower.

Lithology: Mud (no roots or rhizomes) = m, rooted mud (<5% peat) = rm, slightly peaty mud (5-20% peat) = slpm, peaty mud (20-50% peat) = pm, muddy peat (50-80% peat) = mp, peat (>80% peat) = p.

Total Organics: Percent total organic carbon lost on ignition (LOI).

Microfossils: Semi-quantitative diatom analyses by Darienzo include: dominantly freshwater or upland (FW), mostly fresh and some brackish (FBW), and mostly brackish water (BW).

Quantitative diatom analyses by Barnett include: percent fresh water species in total count of diagnostic species (Table 1).

Diatom Abundance: Total number of diatom valves per field, averaged for 50 fields per sample.

Forams: *Miliammina fusca* = Mili. fusca, *Jadammina macrescens* = Jada. macr.

Subsidence: 0, 1, or 2 m (±0.5 m).

Subtle evidence of possible subsidence that is less than 0.5 m cutoff (see text) is denoted as 0±0.5 (+).

Sites indicating tectonic subsidence (shallow peat over consolidated Pleistocene deposits) are denoted by 't'.

Localities with evidence for net late Holocene episodic emergence are denoted by 'uplift'.

References:

1: Appendix 1, this report
2: Atwater (1988)
3: Atwater (1994)
4: Atwater (unpublished data)
5: Barnett (1997)
6: Briggs (1994)
7: Briggs and Peterson (1993)
8: Carver and Burke, 1989
9: Carver and Carver (1996)
10: Carver and others (1994)
11: Clarke and Carver (1992)
12: Clague and Bobrowsky (1994)
13: Darienzo (1991)
14: Darienzo and Peterson (1995)
15: Guilbault and others (1995)
16: Jacoby and others (1995)
17: Li (1992)
18: Merritts (1996)
19: Peterson and Darienzo (1996)
20: Peterson and others (1993)
21: Peterson and others (1996)
22: Peterson and Priest (1995)
23: Peterson (unpublished data)
24: Vallentine (1992)
25: Vick (1988)

TABLE 7 PALEOSUBSIDENCE ESTIMATES FOR CASCADIA EARTHQUAKES, 300-3,500 YEARS BP.					
Grays Harbor	Grays Harbor	Willapa Bay	Willapa Bay	Netarts Bay	Netarts Bay
Blue Slough	Blue Slough,	S.F. Willapa R.	S.F. Willapa R.,	N5A	N5A,N5,10,11
4 records	Chehalis R.,	5 records	Niawiakum	5 records	Composite
2±0.5-1700 A	Elliott Slough	2±0.5-1700 A	#17,18,	1±0.5-1700 A	15 records
1±0.5	Composite	1±0.5	Composite	1±0.5	1±0.5
2±0.5	11 records	2±0.5	13 records	1±0.5	1±0.5
2±0.5	2±0.5	2±0.5	2±0.5	0±0.5	1±0.5
Mean=1.7	1±0.5	2±0.5	2±0.5	1±0.5	0±0.5
	2±0.5	Mean=1.8	2±0.5	Mean=0.8	1±0.5
	2±0.5		2±0.5		1±0.5
	2±0.5		2±0.5		0±0.5
	0±0.5		2±0.5		1±0.5
	2±0.5		0±0.5		1±0.5
	2±0.5		1±0.5		0±0.5
	2±0.5		2±0.5		1±0.5
	1±0.5		1±0.5		0±0.5
	1±0.5		2±0.5		1±0.5
	Mean=1.5		2±0.5		1±0.5
			1±0.5		1±0.5
			Mean=1.6		Mean=0.7
Siletz Bay	Yaquina Bay	Yaquina Bay	Alsea Bay	West Siuslaw	East Siuslaw
SB17,18,11,48	YB9	YB9,HF1,YB5,1	AB8,7,10,19	N. Fork* #208	Karnowsky
Composite	5 records	Composite	Composite	5 records	#214,215,216
18 records	0±0.5-1700 A	15 records	17 records	0±0.5-1700 A	Composite
0±0.5	1±0.5	0±0.5	0±0.5	0±0.5	12 records
1±0.5	1±0.5	1±0.5	0±0.5	0±0.5	1±0.5
1±0.5	0±0.5	1±0.5	1±0.5	0±0.5	1±0.5
0±0.5	1±0.5	0±0.5	0±0.5	0±0.5	1±0.5
1±0.5	Mean=0.6	1±0.5	1±0.5	Mean=0.0	0±0.5
1±0.5		0±0.5	0±0.5		1±0.5
0±0.5		1±0.5	0±0.5		0±0.5
1±0.5		0±0.5	1±0.5		0±0.5
0±0.5		1±0.5	0±0.5		0±0.5
1±0.5		1±0.5	0±0.5		1±0.5
1±0.5		1±0.5	1±0.5		1±0.5
0±0.5		1±0.5	1±0.5		0±0.5
1±0.5		1±0.5	1±0.5		1±0.5
0±0.5		1±0.5	0±0.5		Mean=0.6
1±0.5		1±0.5	0±0.5		
0±0.5		Mean=0.7	1±0.5		
1±0.5			1±0.5		
0±0.5			Mean=0.5		
Mean=0.5					

West Umpqua	East Umpqua	West Coos Bay	Central Coos B.	East Coos Bay	
Providence*	Oar#320,321,	North Sl.#476,	Haynes*#440,	Palouse#448,	
#326,328,	Otter#337,	N.Pony#470,	Kentuck*#450,	Kentuck#449,	
Butler*	Dean Creek	South Sl.#408	S. Pony*#421,	Millicoma#442,	
#311,312,313,	#322,323,332	Composite	Coalbank*	Daniels	
Scholfield	Composite	13 records	#456,478,	#407,465	
#301,302	16 records	1±0.5	Shingle*#460	Composite	
Composite	1±0.5	1±0.5	Composite	17 records	
26 records	0±0.5	0±0.5	22 records	1±0.5	
0±0.5	1±0.5	0±0.5	0±0.5	1±0.5	
0±0.5	0±0.5	1±0.5	0±0.5	0±0.5	
0±0.5	1±0.5	1±0.5	0±0.5	0±0.5	
0±0.5	1±0.5	0±0.5	0±0.5	1±0.5	
0±0.5	1±0.5	1±0.5	0±0.5	1±0.5	
0±0.5	1±0.5	1±0.5	0±0.5	0±0.5	
0±0.5	0±0.5	1±0.5	0±0.5	1±0.5	
0±0.5	0±0.5	1±0.5	0±0.5	0±0.5	
0±0.5	0±0.5	1±0.5	1±0.5	1±0.5	
0±0.5	0±0.5	1±0.5	0±0.5	0±0.5	
0±0.5	1±0.5	Mean=0.8	0±0.5	1±0.5	
0±0.5	1±0.5		0±0.5	1±0.5	
0±0.5	0±0.5		0±0.5	1±0.5	
0±0.5	0±0.5		0±0.5	0±0.5	
0±0.5	Mean=0.5		0±0.5	0±0.5	
0±0.5			1±0.5	0±0.5	
0±0.5			0±0.5	Mean=0.5	
1±0.5			0±0.5		
0±0.5			0±0.5		
0±0.5			0±0.5		
1±0.5			0±0.5		
0±0.5			0±0.5		
0±0.5			Mean=0.1		
0±0.5					
0±0.5					
0±0.5					
Mean=0.1					
Core site locations (UTM coordinates) are shown in Tables 2 and 6 and Appendix 1.					
* These sites showed no detectable evidence of episodic subsidence or paleotsunami deposits, so corresponding estimated numbers of events are based on section depth or basal radiocarbon age. All other sites contain event horizons that are identified on the basis of apparent changes in peat development or presence of paleotsunami deposits.					
1700 AD -- This event correlates to the last Cascadia earthquake ca. A.D. 1700.					
Data sources:					
Grays Harbor, Willapa Bay (Atwater, 1988), Netarts Bay (Darienzo, 1991), Yaquina Bay (Darienzo, 1991; Peterson and Priest, 1995), Alsea Bay (Peterson and Darienzo, 1996), Siuslaw, Umpqua, Coos Bay (Briggs, 1994).					

APPENDIX. Northern and central Oregon core data

Bay	Reference #-core #	UTM-N	UTM-E	Core-top elev. (m)	Subsurface paleomarsh depth (m)	No. of buried deposits	Basal sub-surface paleomarsh depth (m)	RCYBP	Beta lab no.
Blind Slough	13-#1	5116400	455800	FE	1.3	1	2.4	700 ± 60	Beta-56407
Blind Slough	13-#2	5116400	455900	FE	1.3	1	2.4		
John Day	11-#1 JD	5114040	442260	FE/HM	1.08	1	1.22		
John Day	11-#2 JD	5113820	442280	FE/HM	1.10	1	1.30		
John Day	11-#3 JD	5113860	442170	FE/HM	0.90	1	1.20		
John Day	11-#4 JD	5113900	442110	FE/HM	0.96	1	1.20		
Youngs	12-Warrenton	5117000	433500	FE	0.66	2	1.90		
Youngs	11-Wallooskee R.	5110250	438990	FE/HM	0.80	1	1.20		
Necanicum	1-#1	5092350	428880	1.63	0.55	6	3.70	480 ± 60	Beta-42112
Necanicum	1-#2	5092350	428940	1.49	0.47	6	2.80		
Necanicum	1-#3	5092350	428800	1.82	0.91	2	2.00		
Necanicum	1-#5	5092640	428900	1.65	0.33	6	2.20		
Necanicum	1-#6	5092640	428950	0.80	0.33	2	2.20		
Necanicum	1-#7	5093110	429120	1.30	0.52	3	2.78		
Necanicum	1-7A	5093110	429150	1.30	0.55	3	1.46		
Necanicum	1-#8	5095000	429360	1.30	0.20	1	1.24		
Necanicum	1-#9	5093840	429370	*1.3	0.62	1	1.10		
Necanicum	1-#10	5093710	428990	*1.3	0.48	1	0.70		
Necanicum	1-CB-1	5092400	428890	0.78	0.79	2	1.04		
Necanicum	1-CB-2	5092350	428920	0.78	0.74	1	1.03		
Necanicum	1-CB-3	5092410	428820	0.78	0.60	1	0.80		
Necanicum	1-CB-4	5092360	428820	1.82	1.00	2	1.46		
Necanicum	1-CB-5	5092350	428850	1.61	0.78	2	1.24		
Necanicum	1-CB-6	5092420	428860	1.74	0.58	2	1.20		
Necanicum	1-CB-7	5092640	428860	1.77	0.78	2	1.46		
Necanicum	1-CB-8	5095010	429220	1.38	0.70	1	0.88		
Cannon Beach	5-115-R	5083190	426000	1.70	0.64	6	3.56	380 ± 150	Beta-56402
Tillamook	7-Garibaldi-jy	5054640	429960	HM	0.45	5	4.25		
Tillamook	14-Bay City	5039810	431140	HM	0.55	1	0.95	250 ± 50	Beta-89165
Tillamook	14-Tillamook River	5031330	433330	HM	0.62	1	0.90	500 ± 40	Beta-97668
Tillamook	14-South Bay	5038270	426980	FE	0.43	2	0.93	1210 ± 60	Beta-97669
Netarts	1-N 5	5024240	424390	1.23	0.56	8	5.20		

Netarts	1-N 6	5024160	424320	1.40	0.50	7	4.84		
Netarts	1-N 7	5024340	425020	1.35	0.73	8	4.30		
Netarts	1-N 8	5024250	424550	1.40	0.56	4	2.78		
Netarts	1-N 9	5024770	424620	1.10	0.50	3	2.27		
Netarts	1-N 10	5023910	424530	1.40	0.75	10	6.40		
Netarts	1-N 11	5024240	424460	1.40	0.63	8	4.85	370 ± 60	Beta-24933
Netarts	1-N 12	5024460	424540	1.31	0.63	5	3.86		
Netarts	1-N 13	5024270	424740	1.34	0.59	7	3.58		
Nestucca	1-Hurliman 1	5006790	425930	*0.4	0.71	2	1.79		
Nestucca	1-Hurliman 2	5006790	425930	0.40	0.75	11	10.66	940 ± 90	Beta-43128
Nestucca	1-Hurliman 3	5006250	426980	*0.4	0.70	4	5.02		
Nestucca	1-Nestucca 1	5001200	426420	*1.0	0.76	2	2.94		
Nestucca	1-Nestucca 2	5000450	426970	*0.5	0.93	3	2.12		
Nestucca	1-little Nestucca 1	5001860	425800	*1.0	0.61	2	2.44		
Nestucca	1-little Nestucca 2	5001500	425990	*1.0	0.60	1	0.90		
Nestucca	1-little Nestucca 4	5000530	426950	0.03	0.32	5	6.03		
Nestucca	1-little Nestucca 5	5000400	426790	0.23	0.73	10	7.14	400 ± 60	Beta-43123
Nestucca	1-Nestucca Duck 1	5004220	425460	0.76	0.73	1	3.26		
Nestucca	1-Nestucca Duck 2	5004200	425320	1.04	0.75	1	1.80		
Nestucca	1-Nestucca Duck 3	5004200	425200	0.98	0.73	1	1.09		
Salmon River	11-#1SR	4987010	422270	HM	0.50	1	0.70		
Siletz	1-Salishan House, SB17	4971510	418700	1.18	0.43	6	3.30	270 ± 60	Beta-42089
Siletz	1-Salishan Spit, SB18	4971630	418800	1.28	0.19	5	3.80		
Siletz	1-Drift Creek	4973660	421120	*1.2	0.50	3	3.00		
Siletz	1-Siletz River	4971770	420730	1.15	0.63	1	2.50		
Siletz	1-Siletz Spit	4972090	418760	1.09	0.62	5	3.49		
Siletz	1-Siletz 2	4972360	418900	*1.2	0.62	1	1.4		
Siletz	1-Alder	4970860	420440	0.80	0.72	1	3.14		
Siletz	1-Millport Slough 1	4970820	421450	*1.6	0.44	1	3.80	480 ± 60	Beta-42085
Siletz	1-Millport Slough 2	4971140	421070	*1.4	1.17	2	2.80		
Siletz	1-Millport Slough 3	4971300	420710	*1.5	0.80	1	1.64		
Siletz	4-SB 1	4972374	418928	*1.7	0.46	1	0.91		
Siletz	4-SB 2	4972504	418991	*1.5	0.61	2	0.70		
Siletz	4-SB 3	4972404	418897	*1.7	0.45	1	0.55		
Siletz	4-SB 4	4972375	418955	*1.5	0.43	1	0.55		
Siletz	4-SB 5	4972316	418915	*1.7	0.46	2	0.80		
Siletz	4-SB 6	4972218	418808	*1.7	0.29	1	0.57		
Siletz	4-SB 7	4972153	418770	*1.7	0.40	1	0.85		

Siletz	4-SB 8	4972088	418733	*1.7	0.57	2	1.62		
Siletz	4-SB 9	4972077	481791	*1.5	0.48	2	1.23		
Siletz	4-SB 10	4972076	418852	*1.5	0.31	1	0.84		
Siletz	4-SB 11	4972064	418578	*1.7	0.50	4	2.43		
Siletz	4-SB 12	4972063	418730	*1.7	0.59	4	2.04		
Siletz	4-SB 13	4972039	418728	*1.7	0.50	4	1.66	40 $\pm$ 70	Beta-73252
Siletz	4-SB 14	4971919	418799	*1.7	0.35	2	0.69		
Siletz	4-SB 15	4971720	418753	*2.0	0.39	1	0.79		
Siletz	4-SB 16	4971537	418756	*1.5	0.40	1	0.61		
Siletz	4-SB 19	4971428	418802	*1.5	0.35	1	0.56		
Siletz	4-SB 20	4975382	420060	*2.5	0.59	1	0.79		
Siletz	4-SB 21	4975533	420098	*2.0	0.51	1	0.63		
Siletz	4-SB 22	4975538	420071	*2.5	0.59	1	0.88		
Siletz	4-SB 23	4975576	420128	*2.5	0.44	1	0.61	1130 $\pm$ 50	Beta-73253
Siletz	4-SB 24	4975679	420425	*1.7	0.85	1	0.97		
Siletz	4-SB 25	4975729	420440	*1.7	0.81	1	0.90	580 $\pm$ 60	Beta-73254
Siletz	4-SB 26	4975766	420460	*1.7	0.85	1	1.00		
Siletz	4-SB 27	4975766	420776	*1.7	0.47	1	0.79		
Siletz	4-SB 28	4975813	420861	*2.0	0.85	1	0.95		
Siletz	4-SB 29	4975550	421144	*1.7	0.95	1	1.00		
Siletz	4-SB 30	4975562	421149	*2.0	0.81	1	1.00		
Siletz	4-SB 31	4976140	422100	*2.2	0.92	1	1.00		
Siletz	4-SB 32	4974273	420168	*2.0	0.34	1	0.74	510 $\pm$ 60	Beta-73247
Siletz	4-SB 34	4973442	421057	*1.7	0.91	1	2.00		
Siletz	4-SB 35	4974008	421188	*2.0	0.89	1	1.00		
Siletz	4-SB 36	4974300	421252	*2.0	0.90	1	1.00		
Siletz	4-SB 37	4972603	420491	*1.5	0.62	2	0.99		
Siletz	4-SB 40	4970875	420414	*1.5	0.44	2	1.09		
Siletz	4-SB 42	4970942	420603	*1.7	0.80	1	0.91		
Siletz	4-SB 43	4971188	420873	*1.2	0.63	1	1.37		
Siletz	4-SB 44	4971133	420775	*1.2	1.00	2	1.49		
Siletz	4-SB 45	4971027	421205	*1.5	0.55	4	2.76		
Siletz	4-SB 46	4970910	421242	*1.5	0.79	1	1.05		
Siletz	4-SB 47	4970797	421514	*1.7	0.56	2	0.94		
Siletz	4-SB 48	4970977	421418	*1.5	0.42	4	3.45	480 $\pm$ 60	Beta-42085
Siletz	4-SB 49	4970665	421417	*1.2	0.75	1	0.87		
Siletz	4-SB 50	4970430	422302	*2.0	0.80	1	0.92		
Siletz	4-SB 51	4976140	422100	*2.0	0.40	2	1.14		

Yaquina	1-Hatfield 1	4940170	417370	1.74	0.73	2	1.07		
Yaquina	1-Hatfield 2	4940170	417370	1.45	0.36	3	0.87		
Yaquina	1-Hatfield 3	4940170	417370	1.51	0.85	1	0.90	1270 ± 70	Beta-41992
Yaquina	1-Oysterville 1	4935660	420000	*1.2	0.35	2	1.51		
Yaquina	1-Oysterville 2	4935540	420290	*1.2	0.76	1	1.82		
Yaquina	1-Oysterville 4	4934600	420540	1.37	0.80	1	1.70		
Yaquina	1-Oysterville 5	4934100	421640	1.38	0.90	1	2.67		
Yaquina	1-Blind 1	4936080	424020	*1.0	0.42	2	1.38		
Yaquina	1-Toledo 1	4938580	427010	*1.0	0.52	2	1.74		
Yaquina	1-Toledo 2	4938520	426980	*1.0	0.52	3	1.77		
Yaquina	1-Conser 1	4938380	427150	1.06	0.42	2	2.39		
Yaquina	1-Conser 2	4938320	427190	0.82	0.42	3	1.80		
Yaquina	1-Slack 1	4938010	427760	0.43	0.60	9	5.44		
Yaquina	1-Slack 2	4938060	427730	0.37	0.82	3	2.82		
Yaquina	1-Slack 3	4938130	427750	0.31	0.90	3	4.70		
Yaquina	1-Slack 5	4938220	428040	0.41	0.40	3	2.20		
Yaquina	1-Slack-CB-A	4938510	428230	*1.4	0.72	2	1.20		
Yaquina	1-Slack-CB-B	4938340	428260	1.40	0.74	1	0.85	550 ± 70	Beta-38862
Yaquina	1-Poole Slough CB-1	4935860	419810	*1.2	0.75	1	1.28		
Yaquina	1-Poole Slough CB-2	4935950	419910	*1.2	1.12	1	1.40		
Yaquina	1-Poole Slough CB-3	4935400	420040	*1.3	0.72	1	1.10		
Yaquina	1-Poole Slough CB-4	3934400	420440	*1.4	0.74	1	0.80		
Yaquina	3-YB 13	4940430	417310	*1.7	0.73	1	0.98		
Yaquina	3-YB 1	4940160	418030	*1.7	0.45	1	0.80		
Yaquina	3-YB 2	4938080	418150	*1.7	0.46	2	0.84		
Yaquina	3-YB 3	4938130	418140	*1.7	0.58	1	0.74		
Yaquina	3-YB 4	4938700	419330	*1.0	0.31	2	0.55		
Yaquina	3-YB 9	4941540	420420	*1.8	0.36	4	2.00		
Yaquina	3-YB 5	4938160	419160	*1.0	0.35	3	1.00		
Yaquina	3-YB 6	4938680	419240	*1.7	0.39	2	1.00		
Yaquina	3-YB 7	4936320	418910	*1.0	0.40	1	0.79		
Yaquina	3-YB 10	4938150	419920	*1.0	0.31	3	0.98		
Yaquina	3-YB 11	4937560	419720	*1.7	0.49	5	2.00		
Yaquina	3-YB 12	4936340	420020	*1.0	0.46	2	2.00		
Yaquina	3-YB 14	4935930	422950	*1.0	0.39	1	0.73		
Yaquina	6-Ollala 1	4942610	427000	LM	0.38	3	2.10		
Alsea	1-AB2	4919280	417410	1.34	0.35	1	1.38		
Alsea	1-AB4	4918850	418220	1.89	0.45	3	1.56		

Alsea	1-AB5	4918720	419340	1.65	0.45	4	4.60		
Alsea	1-AB6	4918430	420330	1.63	0.40	5	4.10		
Alsea	1-AB7	4918460	417170	1.64	0.40	6	6.87		
Alsea	1-AB8	4918800	419180	1.50	0.42	7	6.53		
Alsea	1-AB9	4918900	419200	1.54	0.34	8	5.92	480 ± 60	Beta-39181
Alsea	1-AB10	4918300	419160	1.57	0.46	6	2.20		
Alsea	1-AB11	4918690	419740	1.39	0.45	7	6.02		
Alsea	1-AB12	4918320	420540	1.50	0.54	4	3.52		
Alsea	1-AB13	4918200	421260	1.44	0.56	3	3.80		
Alsea	1-AB15	4919380	418140	1.63	0.71	5	4.30		
Alsea	1-AB16	4918780	419300	1.43	0.53	5	3.58		
Alsea	1-AB17	4918200	419060	1.67	0.33	2	1.50		
Alsea	1-AB18	4918770	417560	1.32	0.65	2	1.86		
Alsea	1-AB19	4919050	419220	1.50	0.40	5	4.50		
Alsea	1-AB20	4920200	418300	1.50	0.27	3	1.43		
Alsea	1-AB21	4920330	418580	*1.5	0.43	3	2.90		
Siuslaw	2-201	4871190	416190	HM	1.50	1	6.00		
Siuslaw	2-202	4870420	418810	0.72	0.70	3	3.50		
Siuslaw	2-203	4873730	424050	HM	0.75	2	1.60		
Siuslaw	2-206	4869260	414810	HM	NA	0	1.64		
Siuslaw	2-207	4866870	415160	HM	1.86	1	2.54		
Siuslaw	2-208	4870980	413640	HM	0.94	2	4.00		
Siuslaw	2-209	4871960	414320	HM	2.30	2	4.00		
Siuslaw	2-210	4870320	418760	*.7	1.00	3	3.56		
Siuslaw	2-211	4870320	418810	*.7	2.20	1	2.70		
Siuslaw	2-212	4870580	418840	*.7	2.54	2	4.00		
Siuslaw	2-213	4870490	418800	0.72	NA	1	2.30		
Siuslaw	2-214	4872530	420380	1.89	0.63	2	5.00		
Siuslaw	2-215	4872400	420470	HM	1.17	3	5.00		
Siuslaw	2-216	4872550	420340	1.89	0.64	3	2.24	540 ± 70	Beta-58116
Siuslaw	2-217	4873090	427810	HM	0.92	2	1.87		
Siuslaw	2-218	4873940	431730	*1.1	1.62	4	3.57		
Siuslaw	2-219	4873900	431940	*1.1	0.73	3	3.13		
Siuslaw	2-220	4873930	431940	0.80	0.40	3	2.50		
Siuslaw	2-221	4868610	415620	1.10	NA	0	5.00		
Siuslaw	2-222	4868570	415590	1.10	NA	0	3.26		
Siuslaw	2-223	4868740	415770	HM	2.70	2	4.00		
Umpqua	2-301	4836550	412500	HM	0.81	5	4.16	400 ± 60	Beta-67455

Umpqua	2-302	4836550	412500	HM	0.89	1	5.00		
Umpqua	2-303	4837200	413650	*1.5	NA	0	2.00		
Umpqua	2-304	4842750	408700	NA	0.84	1	2.00		
Umpqua	2-305	4842720	408460	1.48	NA	0	2.00		
Umpqua	2-306	4842660	408560	1.48	1.00	1	1.08		
Umpqua	2-307	4842660	408640	*1.5	NA	0	3.00		
Umpqua	2-308	4842760	409900	HM	0.64	1	0.73		
Umpqua	2-309	4841120	410540	HM	NA	0	2.00		
Umpqua	2-310	4843310	410150	1.16	NA	0	3.00		
Umpqua	2-311	4839690	413760	HM	NA	0	3.00		
Umpqua	2-312	4839630	413850	HM	NA	0	4.00		
Umpqua	2-313	4839540	414530	HM	NA	0	2.86		
Umpqua	2-314	4837660	412930	2.46	NA	0	4.00		
Umpqua	2-315	4837510	423860	HM	1.40	3	4.00		
Umpqua	2-316	4838370	421570	1.64	1.70	4	5.00		
Umpqua	2-317	4838410	421510	1.64	1.71	3	3.36		
Umpqua	2-318	4837470	423910	HM	NA	0	4.00		
Umpqua	2-319	4842760	408630	1.48	0.92	1	0.97		
Umpqua	2-320	4835960	414470	1.21	0.85	6	3.93		
Umpqua	2-321	4836530	414410	*1.2	2.05	3	5.00	1420 $\pm$ 80	Beta-67460
Umpqua	2-322	4837040	419290	HM	0.72	4	2.50		
Umpqua	2-323	4837380	418790	HM	0.71	3	1.74		
Umpqua	2-325	4843290	412890	HM	2.31	3	5.00		
Umpqua	2-327	4840370	409600	HM	0.42	1	1.86		
Umpqua	2-326	4840370	409540	HM	NA	0	4.40		
Umpqua	2-328	4840370	409540	HM	NA	0	2.62		
Umpqua	2-329	4843700	415880	HM	1.60	3	4.25		
Umpqua	2-330	4842760	408640	1.48	0.90	0	1.10		
Umpqua	2-331	4840080	410500	HM	0.65	1	1.74		
Umpqua	2-332	4837060	419230	HM	0.72	4	2.50	1270 $\pm$ 90	Beta-58122
Umpqua	2-333	4839640	413710	HM	0.30	1	1.24		
Umpqua	2-334	4839660	413660	HM	NA	0	1.87		
Umpqua	2-335	4842250	417440	0.76	2.50	2	6.00		
Umpqua	2-336	4842220	417350	0.59	NA	0	3.00		
Umpqua	2-337	4842260	417410	0.76	2.53	2	4.70	2150 $\pm$ 80	Beta-76458
Umpqua	2-338	4836000	405810	HM	1.43	3	3.55		
Umpqua	2-339	4836010	405760	HM	1.86	3	3.68	1040 $\pm$ 60	Beta-58125
Coos	2-401	4798230	388710	2.65	0.57	2	4.00		

Coos	2-402	4799650	393770	2.10	3.96	1	4.30		
Coos	2-403	4799670	393740	2.45	0.56	3	3.74		
Coos	2-404	4799630	393680	1.93	0.91	1	2.68		
Coos	2-405	4801240	414550	HM	0.86	1	3.52		
Coos	2-406	4802290	410520	1.87	1.80	1	3.81		
Coos	2-407	4801160	412160	*0.5	0.70	3	5.07		
Coos	2-408	4796660	393880	HM	0.77	6	5.61	650 $\pm$ 70	Beta-27675
Coos	2-409	4796670	393800	HM	0.76	5	3.59		
Coos	2-410	4802020	407850	HM	1.01	2	3.00		
Coos	2-411	4801410	408780	HM	0.94	1	1.60		
Coos	2-412	4796160	406560	HM	0.81	5	4.72		
Coos	2-413	4806580	400520	HM	NA	0	2.00		
Coos	2-414	4806580	400400	HM	NA	0	2.00		
Coos	2-415	4812970	400890	HM	0.65	2	1.90		
Coos	2-416	4813140	402570	HM	0.73	1	1.84		
Coos	2-417	4814870	405440	-0.80	1.19	1	1.82		
Coos	2-418	4814070	395490	HM	NA	0	2.00		
Coos	2-419	4805240	400200	HM	0.45	6	4.06		
Coos	2-420	4805230	400410	HM	0.77	3	2.92		
Coos	2-421	4804850	400020	HM	1.73	2	4.00		
Coos	2-422	4813250	402540	??-2.44	0.86	2	1.75		
Coos	2-423	4813470	402730	??-2.11	0.84	1	1.76		
Coos	2-424	4816700	408900	HM	1.20	2	2.34		
Coos	2-425	4816040	407590	HM	1.79	1	2.15		
Coos	2-426	4814870	406050	HM	0.90	3	4.00		
Coos	2-427	4814810	404760	??-1.18	1.44	2	2.78		
Coos	2-428	4815220	405090	-0.98	0.75	3	2.20		
Coos	2-431	4813070	400950	HM	NA	0	2.43		
Coos	2-432	4809240	405450	0.12	0.82	2	1.91		
Coos	2-433	4809620	405520	0.74	1.68	2	3.44		
Coos	2-434	4799600	393710	*1.9	NA	0	0.78		
Coos	2-435	4799670	393740	*1.9	0.50	1	1.44		
Coos	2-436	4799670	393740	*1.9	0.52	1	0.75		
Coos	2-437	4815150	405130	*-1.0	NA	0	1.76		
Coos	2-438	4814900	406020	HM	0.80	1	0.94		
Coos	2-439	4815130	406080	-0.64	0.69	3	4.00		
Coos	2-440	4812900	404500	HM	NA	0	3.00		
Coos	2-441	4806640	415410	HM	1.16	4	4.00		

Coos	2-442	4805570	413180	HM	0.94	3	5.00		
Coos	2-443	4804150	412270	HM	1.00	1	2.80		
Coos	2-444	4804190	412250	HM	0.81	2	5.00		
Coos	2-445	4799950	411810	HM	1.20	2	4.00		
Coos	2-446	4801000	411890	HM	0.96	3	4.06		
Coos	2-447	4800660	414740	HM	NA	0	4.00		
Coos	2-448	4815090	406160	-0.64	0.75	3	4.00	1800 ± 60	Beta-58137
Coos	2-449	4809360	405440	0.74	0.65	3	1.47	1000 ± 50	Beta-58134
Coos	2-450	4807880	403960	HM	NA	0	3.00		
Coos	2-451	4804400	399610	HM	NA	0	3.18		
Coos	2-455	4806470	400490	HM	0.43	1	1.00		
Coos	2-456	4800120	401980	HM	0.58	1	4.74		
Coos	2-457	4800070	402020	HM	0.50	1	1.84		
Coos	2-458	4800260	401840	HM	0.97	1	1.12		
Coos	2-460	4797000	401350	HM	3.40	1	4.75		
Coos	2-461	4802340	410510	1.87	1.46	1	2.27		
Coos	2-462	4798290	388590	2.65	0.68	8	5.80	540 ± 70	
Coos	2-463	4802540	403040	HM	NA	0	2.50		
Coos	2-465	4801170	412190	0.53	0.68	6	3.56	1970 ± 70	Beta-58128
Coos	2-466	4802540	410570	*1.9	0.58	5	3.46		
Coos	2-467	4802300	410460	1.87	1.46	4	3.88		
Coos	2-468	4802160	410450	*1.9	1.53	3	3.75		
Coos	2-469	4802340	410490	*1.9	1.52	3	4.01		
Coos	2-470	4805220	400140	HM	0.72	5	3.75	1020 ± 70	Beta-67437
Coos	2-471	4806700	400460	HM	1.40	4	3.80		
Coos	2-472	4806650	400440	HM	0.97	3	4.00		
Coos	2-473	4808550	406540	HM	1.70	1	2.13		
Coos	2-474	4815260	402230	HM	0.72	2	2.70		
Coos	2-475	4815730	402040	HM	0.68	3	3.00		
Coos	2-476	4815260	402230	HM	1.05	2	2.69	1780 ± 90	Beta-67441
Coos	2-477	4815620	402070	HM	0.40	3	2.36		
Coos	2-478	4797450	399670	HM	1.40	1	4.00	1740 ± 100	Beta-67443
Coos	8-SS1	4792020	392710	*0.0	0.59	2	1.29		
Coos	8-SS3	4792830	392920	*0.0	0.79	1	0.88		
Coos	8-SS4	4793590	393090	*0.0	0.49	1	0.64		
Coos	8-SS5	4794040	392490	*0.0	0.78	5	5.81		
Coos	8-Joe Ney Slough 6	4799120	394190	*0.0	0.83	1	0.94		
Coos	8-Joe Ney Slough 7	4798880	394330	*0.0	0.46	1	0.80		

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Coos	8-OC1	4793100	392930	*0.0	0.70	1	0.86		
Coos	8-SS9	4796610	393970	-0.95	0.79	5	4.94		
Coos	8-SS10	4796670	393800	-0.98	0.61	5	4.97		
Coos	8-SS11	4793210	395630	*0.0	0.76	7	5.50		
Coos	9-WC12	4792450	393150	*-0.9	0.45	9	5.47	380 $\pm$ 60	Beta-26289
Coos	8-SS12	4793110	395660	*0.0	0.60	2	1.42		
Coos	8-SS13	4795640	392600	*0.0	NA	0	2.00		
Coos	8-SS14	4795380	392410	*-0.9	NA	0	2.61		
Coos	8-SS15	4793510	395550	*0.0	2.52	4	5.54		
Coos	8-SS16	4793410	395600	*0.0	3.28	4	7.19		
Coquil-R	10-500	4777300	386170	HM/LM	0.60	2	2.52		
Coquil-R	10-501	4776470	386570	HM/LM	0.60	1	2.00		
Coquil-R	10-502	4778140	388150	HM/LM	NA	0	3.00		
Coquil-R	10-503	4779240	388700	HM/LM	1.00	1	2.00		
Coquil-R	10-504	4779340	388750	HM/LM	2.48	1	3.41		
Coquil-R	10-505	4780250	390440	HM/LM	NA	0	4.00		
Coquil-R	8-507	4774410	394500	LM	NA	0	1.80		
Coquil-R	10-508	4776370	386130	HM/LM	0.59	4	2.54		
Coquil-R	10-509	4776080	386120	HM/LM	0.65	2	2.63		
Coquil-R	10-510	4776020	386070	HM/LM	0.32	1	1.34		
Coquil-R	8-511	4780310	391090	HM/LM	0.58	3	1.90		
Coquil-R	8-512	4780810	391370	HM/LM	0.61	4	1.95		
Coquil-R	8-513	4778850	393920	HM/LM	NA	0	2.00		
Coquil-R	8-514	4780360	394660	HM/LM	NA	0	2.00		
Coquil-R	8-515	4780840	394610	HM/LM	NA	0	2.10		
Coquil-R	8-516	4783250	395820	LM	1.00	1	1.00		
Elk-R	8-#1	4793110	375680	HM/LM	0.78	3	1.68		
Elk-R	8-#2	4793100	375740	HM/LM	1.64	4	3.00		
Elk-R	8-#3	4793220	375780	HM/LM	0.36	3	4.03		
Elk-R	8-#4	4793510	375840	HM/LM	2.05	1	3.10		

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Notes:
Reference#-core#: First number indicates publication number (below); second number indicates author's core or cutbank designation.
UTM: UTM values are estimated from USGS 7.5 min field topo maps, UTM-E are in zone 10.
Datum for core top elevation is local mean tidal level (MTL) $\pm$ 0.10 m, except for data from Briggs (1994) and Galloway and others (1992) which are referenced to mean sea level (MSL).
*: Author's estimate of core top elevation $\pm$ 0.3 m.
??: Questionable elevations reported by author.
LM (low marsh), HM/LM (high marsh/low marsh), HM (high marsh), FE/HM (forest edge/high marsh), and FE (forest edge): author's estimate of elevation where core was taken.
Paleomarsh depth $\pm$ 0.01 m.
NA: Core with no evidence of buried wetland
RCYBP: Radiocarbon years before present; age of youngest buried wetland deposit
References
1. Darienzo (1991)
2. Briggs (1994)
3. Peterson and Priest (1995)
4. Peterson and others (1996)
5. Gallaway and others (1992)
6. Peterson and Darienzo (unpublished data)
7. Peterson and Darienzo (unpublished data)
8. Peterson and Darienzo (unpublished data)
9. Nelson (1992)
10. Briggs and Peterson (1993)
11. Peterson (unpublished data)
12. Peterson and others (1993)
13. Peterson and Madin (1997)
14. Barnett (1997)