Journal of California and Great Basin Anthropology
Vol. 24, No. 1, pp. 41– 52 (2004)

Artifacts From a Submerged Prehistoric Site
On the Coos Bay Estuary, Southern Oregon Coast

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Artifacts recovered during channel dredging in the Coos Bay estuary include the first wooden fish clubs from an archaeological context on the Oregon coast. The clubs and other artifacts, shell debris, fire-cracked rock, and fish weir stakes recovered by the dredge point to the presence of a submerged archaeological site at the mouth of South Slough, a major arm of Coos Bay. The cultural deposits at 35CS135 may represent a submerged prehistoric component of an ethnographic village at the mouth of South Slough. Radiocarbon dates from the two wooden clubs suggest an age of about AD 1020-1450 for the inferred period of site occupation represented by the dredged cultural deposits. Although great earthquakes and accompanying tsunamis have episodically devastated the Oregon coast over the past 5000 years, the cultural deposits at 35CS135 were more likely submerged gradually by a slow rise in sea level than by sudden, earthquake-induced, coastal subsidence.

Although estuaries of the Southern Northwest Coast (the Pacific Coast of southern Washington, Oregon, and northern California) are known from ethnographic sources to have been a primary focus of Native American settlement and subsistence prior to Euroamerican settlement, knowledge of the material culture of coastal Indian groups is sparse because few archeological sites on estuary shores have been well studied and dated (Lyman 1991:41-48). Many sites have been submerged or eroded during the sudden coseismic and gradual interseismic rise of relative sea level of the past 5000 years (Hutchinson 1992; Nelson 1992; Nelson et al. 1996a). In the historic period, intensive development typical of privately-owned land fringing estuaries has disturbed or destroyed many sites that escaped natural destruction.

South Slough, an 8-km-long arm of the 50 km^2 Coos Bay estuary in southern Oregon (Fig. 1), has been less affected by shoreline development than much of the rest of Coos Bay and many other large estuaries on the Pacific Coast (Caldera 1995; Tveskov 2000). Of the 11 archeological sites reported in South Slough, which include shell middens and fish weir remains, none has been thoroughly studied (Stubbs 1973; Byram 1998; Tveskov 1995, 2000). Ethnographic sources suggest that the most intensive historic, and probably prehistoric, exploitation of estuarine resources in South Slough was near its mouth, about 3 km southeast of the bay's outlet channel (Fig. 1).

Unfortunately, extensive dredging, filling, and the construction of a marina, fish processing plant, and several generations of highway bridges have seriously disturbed shorelines on the south side of the bay near the mouth of the slough.

In this paper we report the recovery of artifacts dredged from 35CS135, a submerged prehistoric site on the east shore of the mouth of South Slough, across from the small community of Charleston, Oregon (Fig. 1). The artifacts include two wooden fish clubs—the first such implements to be recovered from an archeological context on the Oregon coast—that are remarkably similar to ethnographic specimens from northwest California. Since these artifacts were recovered by a dredge, specific knowledge of their stratigraphic context is lacking. Nevertheless, through the use of available archaeological, ethnographic, and geologic information we place this site within the context of the late prehistory of the Coos Bay area as well as the geological context provided by recent coastal studies, particularly those concerned with great earthquakes and tsunamis.

DISCOVERY OF 35CS135

In 1993 Leroy Hansen of North Bend, Oregon, brought five artifacts to the attention of the senior author that he had recovered while operating a dredge in Coos Bay in 1975. In addition to the artifacts, Mr. Hansen reported that shells, burned rock, large-diameter elk horn stubs, and alder stakes were recovered from the dredge's strainer box (3 inch-diameter mesh). The alder stakes were described as 8-10 cm in diameter, sharpened with a dull tool, and well preserved until exposed to air (Leroy Hansen, personal communication, 1993).

The finds were recovered along the east edge of the dredged channel at the entrance to South Slough (Fig. 1). Today at mean high tide, 2-3 m of water cover the soft muddy bottom where the dredge was working between a dock and line of pilings oriented north-south about 200 m north-northeast of the east end of the

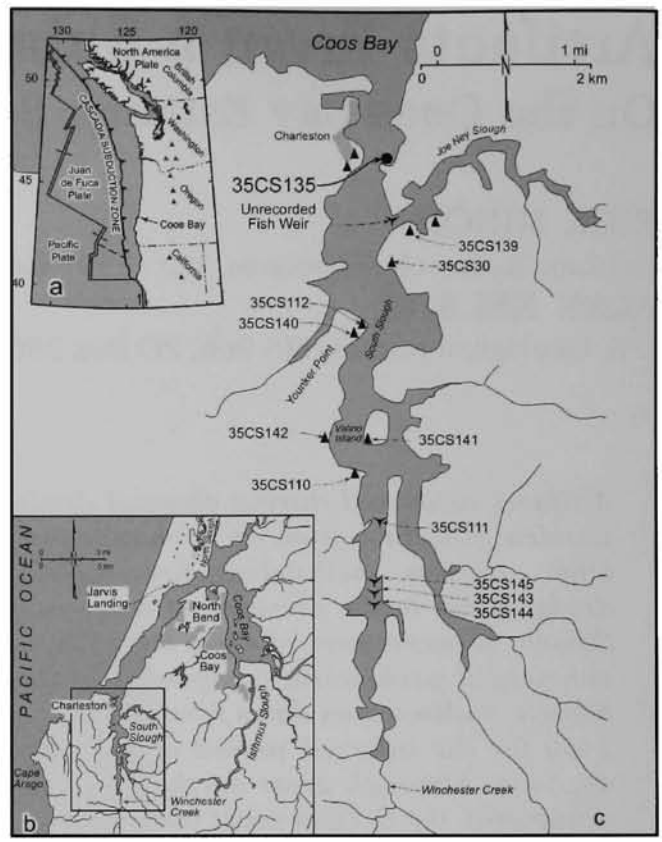

Figure 1. Location of (a) the Cascadia Subduction Zone, (b) South Slough near the mouth of the Coos Bay estuary, southern Oregonc coast, and (c) submerged prehistoric site 35CS135 and other archaeological sites on South Slough (adapted from Tveskov 1995). In a, the trace of the Cascadia Subduction Zone thrust fault (barbed line, barbs point downdip) is placed at the bathymetric boundary between the continental slope and abyssal plain; double lines are spreading ridges, solid lines are strike-slip faults, and dashed lines are political boundaries. In b, rectangle shows area of c; urban areas are shaded. In c, triangles mark dry sites and three prong symbols show weir sites.

Charleston bridge. A few tens of meters south of the site, a large area of placed fill extends westward from the original sandy tideflat at the east edge of the mouth of the slough. Mr. Hansen estimated that the materials were recovered from a depth of 4.3 m (14 feet) below low tide; the dredge eventually excavated to depths of 5.5 m (18 feet) to 6.1 m (20 feet) below low tide. Tides at the mouth of the slough have a mean range of 1.7 m and a diurnal range of 2.3 m (National Ocean Service 1987).

The presence of shells and burned rock

indicates that the artifacts recovered were not isolated finds, but were associated with an archaeological site a few meters below present sea level. The observation of alder stakes suggests that a wood stake weir was present as well. Mr. Hansen related that a wood stake weir upstream at the entrance to Joe Ney Slough had previously been destroyed by dredging. Hansen's account is consistent with an earlier archaeological study in the South Slough area, which noted that a weir at the entrance to Joe Ney Slough removed about 1965 or 1966 "was reportedly made of white cedar poles deeply buried in sediment, and was quite difficult to remove" (Stubbs 1973:15).

Attempts to relocate the site from which Hansen's dredge recovered the artifacts were made with augers during very low tides in 1994 and 1996 on the tide flat 10-30 m east of the site's reported location. The hand-operated bucket and gouge augers recovered about 70 cm of soft sandy mud overlying 120 cm of muddy sand with lenses of bivalve shells overlying, in turn, about 50 cm of interbedded coarse-sandy and fine-sandy mud. Maximum depth reached was about 2.6 m. The soft mud is probably dredge spoil, and the underlying deposits are typical of subtidal channel deposits in inlets like South Slough. Even during periods of fair weather, strong tidal currents at the mouth move much sand in and out of the slough.

Two types of evidence indicate that Mr. Hansen's estimate of 4.3 m for the depth of the recovered artifacts is too deep unless all cultural materials were reworked from a higher elevation. The gentle channel-ward slope of the sandy tidal flat east of the site suggests that an in-place site could not have been much more than 2 m below present sea level. The 1985 Coos Bay Nautical Chart (No. 18587) shows a water depth of about 2.0-2.5 m near the site, but this area was probably dredged prior to 1985. Moreover, recent studies of sea-level history in South Slough (Briggs 1994; Nelson 1996b; Nelson et al. 1998) and elsewhere on the Oregon coast (Nelson 1992; Hutchinson 1992; Darienzo and Peterson 1995; Kelsey et al. 2002) show that mean sea level has been no more than 1.5 m below present level for at least the past thousand years. Although the dredge was working at a depth of 4 m, cultural deposits at shallower depths along the edge of the dredge channel must have been incorporated into the sediment brought up by the dredge. Based on sea-level history and the geomorphology of the mouth of the slough, the elevation of the site is estimated to have been about 1-2 m below present sea level.

ARTIFACTS AND THEIR AGE

The most noteworthy of the five artifacts recovered during the dredging are two wooden clubs. Both clubs are similar in form, with relatively thin handles that taper to thick, heavy barrels that are flat on the ends. The larger of the two wooden clubs (Fig. 2a), made from the limb of a Douglas fir (*Pseudotsuga menziesii*) tree, measures 31.0 cm in length, 7.1 cm in maximum width, 5.3 cm in maximum thickness, 20.5 cm in maximum diameter, and weighs 745 g. Cut or adz marks are visible in several places, particularly on the handle, and other marks and abrasions are present elsewhere on the specimen.

The smaller of the two wooden club measures 31.5 cm in length, 5.0 cm in maximum width, 4.6 cm in maximum thickness, 15.2 cm in maximum diameter, and weighs 443.4 g (Fig. 2b). Also made from a limb, again most likely of Douglas fir, this club is in a more advanced state of decay than the other. Some delicate diagonal striations occur along one side near the top, while other areas show rot and worm damage.

The wooden clubs recovered from 35CS135 are the first implements of this kind to be recovered from an archaeological context on the Oregon coast. These clubs are virtually identical in appearance to fish clubs made and used by native peoples of northwest California (Kroeber and Barrett 1962:91). The two specimens from South Slough are closely comparable in size to two "salmon clubs" illustrated by Kroeber and Barrett (1962:Plate 18a-b). One of the illustrated clubs measured

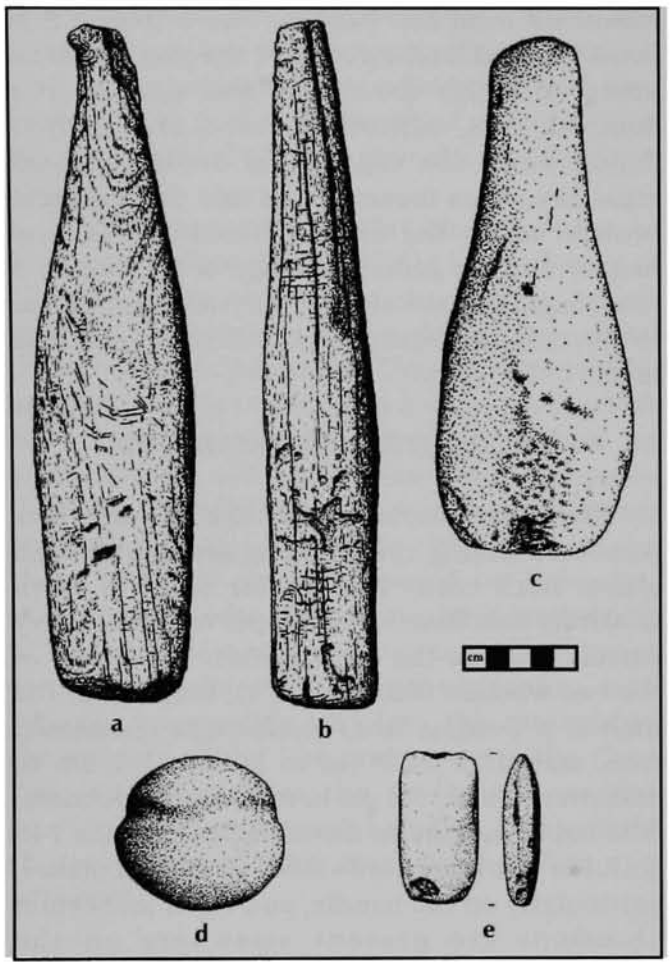

Fig. 2. Artifacts from submerged prehistoric site 35CS135: a-b, wooden clubs; c, stone club; d, netsinker; e, adz blade (all artifacts approximately 1/2 actual size; scale in centimeters).

31.5 cm in length, 7.7 cm in diameter, and weighed 450 g; the other measured 28.3 cm in length, 8.3 cm in diameter, and weighed 480 g (Kroeber and Barrett 1962:174). Fish clubs are listed among the culture elements of all Oregon coast native peoples with the exception of the Coos Indians, for whom information on this item of material culture was not obtained (Barnett 1937:164).

The other three artifacts recovered by Hansen's dredge include one stone club, one adz blade, and one girdled cobble netsinker. The stone club is schist with a nicely rounded handle and proximal tip and a flat distal end with use-wear from hammering on the broad end and sides (Fig. 2c). This specimen measures 23.5 cm in length, 8.9 cm in maximum width, 4.5 cm in thickness, and weighs 1.479 kg. The girdled cobble netsinker, made of sandstone, measures 7.5 cm in length, 6.9 cm in width, 6.8 cm in thickness, and weighs 432.67 g. The girdled area, which extends along the long axis of the cobble, ranges from 6.1 to 6.8 cm in width (Fig. 2d). The adz blade, also of schist, has a faceted cutting edge, squared sides, and a blunt back end (Fig. 3b). This specimen measures 6.8 cm in length, 3.5 cm in width, 1.6 cm in thickness, and weighs 81.1 g.

Two accelerator mass spectrometer radiocarbon dates on the wooden clubs provide an estimate of the age of the submerged cultural deposits at 35CS135. A sample of wood from the base of the larger club, which was subjected to acid/alkali/acid pretreatment, yielded a radiocarbon date of 550 ± 60 B.P. (Beta-79841) and a calibrated age of 1290-1450 cal yr AD (approximate solar years before AD 1950; methods of Stuiver et al. 1998). Cellulose extracted from a similar sample of wood from the smaller club produced a radiocarbon date of 890 ± 50 B.P. (Beta-91939) and a calibrated age of 1020-1250 cal yr AD. The apparent difference in the ages (40-430 years) adds uncertainty to estimates of the time of site occupation—the difference may indicate two periods of occupation or one long period. Thorough pretreatment of the wood samples prior to radiocarbon analysis rules out contamination by younger or older carbon as an explanation for the difference in ages. The site was probably occupied at least until the time of the younger age. The older club may have been fashioned from wood that was hundreds of years old, for example from an old tree or driftwood, or it may date an earlier phase of site occupation.

ARCHAEOLOGICAL CONTEXT

The late prehistory and ethnohistory of the Coos Indians, whose ethnographic territory extended from Coos Bay south along the Oregon coast to the Coquille River, has been studied by Tveskov (1995, 2000). The spatial

distribution of the seven shell middens and four wood stake fishing weirs recorded in the South Slough area during a survey for archaeological sites in 1994 "complements the overall distribution of sites in the Coos Bay estuary" (Tveskov 1995:72).

Ethnographic information indicates that the winter villages of the Coos Indians "were located on the 'inner' shore of Coos Bay from Charleston to the mouth of Coos River" (Tveskov 1995:72). Thus, shell middens near the mouth of South Slough, including 35CS135, presumably represent the former locations of winter villages. In contrast, shell middens farther up the margins of Coos Bay's major rivers and sloughs, including South Slough, more likely represent "warm weather camps" for collecting cockles and clams (Tveskov 1995:72). Marine shells collected from midden exposures at three shell middens on South Slough yielded relatively young radiocarbon ages of 430 ± 60 B.P. from 35CS110, 420 ± 60 B.P. from 35CS112, and 330 ± 60 B.P. from 35CS142 (Tveskov 1995:64-66). Subsequent excavations at 35CS142 recovered samples of marine shells from the top, middle, and bottom of the midden that yielded radiocarbon ages of 1080 ± 70 B.P., 940 ± 70 B.P., and 1450 ± 70 B.P., respectively (Tveskov 2000:293).

The four recorded wood stake fish weirs all occur in the upper portion of South Slough and all are composed of relatively small cut branches and split staves. Wood stakes from two weirs yielded young radiocarbon ages of 100 ± 60 B.P. from 35CS143 and 70 ± 60 B.P. from 35CS144 (Tveskov 1995:69). The young radiocarbon dates, as well as ethnographic and historical information, suggest that the weirs in upper South Slough were used in the historic period by individual Native Americans or families that had been cut off from their major seasonal fisheries by Euro-American settlement around Coos Bay (Tveskov 1995:72-73; 2000:464).

The weirs in upper South Slough contrast with the more substantial weirs reported at Joe Ney Slough and the Coos River (Tveskov 1995:72). Initially, Tveskov (1995:72; 2000:194) assumed that weirs in the lower estuary were employed in the mass harvest of salmon, as was the case with weirs elsewhere on the north Pacific coast. However, subsequent technological studies of wood stake weirs suggest that most weirs in Coos Bay, and other Oregon estuaries, were not intended primarily to take salmon, but instead were designed to harvest a wide range of estuarine fish species (Byram 1998:214-216; Tveskov 2000:196-197, 203).

The ethnographic literature seems to indicate that the more substantial weir sites in the lower Coos Bay estuary were situated near winter villages (or vice versa). The reported weir at the entrance to Joe Ney Slough fits this pattern, as the Indian Bay Site (35CS30), "one of the few remaining relatively intact estuarine villages sites in the Coos Bay area," is located nearby (Tveskov 1995:64). A weir at 35CS135, as suggested by the recovery of alder stakes during the dredging, may have been associated with a Coos Indian village mentioned in John P. Harrington's unpublished ethnographic fieldnotes. Lottie Evanoff, Harrington's principal Coos informant, mentioned that the east or northeast "end of the South Slough bridge has a big midden and must have been an Ind. v[illage] but [she] never got to hear the name of this v[illage]" (Harrington 1942:Reel 24, page 96). A village "on the east side of the mouth of South Slough on Coos Bay" was briefly referred to in an 1851 account by pioneer Loren L. Williams (Tveskov 2000:153-154).

The reported location of a "big midden" in Lottie Evanoff's account corresponds fairly closely with that of the submerged archaeological deposits discovered during the channel dredging. No evidence of this "big midden" is presently discernible. The site may have been destroyed when the original bridge was replaced or during later development along the shoreline at the mouth of South Slough. Assuming some connection, an ethnographic Coos Indian village at this location must represent a much

younger, as well as higher, extension of the submerged archaeological deposits in the channel.

PREHISTORIC EARTHQUAKES AND TSUNAMIS

Geologic investigations of the last decade have uncovered abundant stratigraphic evidence that the Southern Northwest Coast has experienced repeated great earthquakes (magnitude greater than 8) and accompanying tsunamis over at least the past 5000 years (Nelson et al. 1996b; Atwater and Hemphill-Haley, 1997; Clague 1997; Kelsey et al. 2002). The earthquakes are caused by sudden slip of the Juan de Fuca plate as it slides beneath the North American plate along the 1000 km-long thrust fault known as the Cascadia Subduction Zone. Based on analogies with the largest subduction-zone earthquakes of this century in Chile (1960, magnitude 9.5) and Alaska (1964, magnitude 9.2), elastic thinning of the North American plate or shallower faulting within it during each of many past earthquakes resulted in 0.5-1.0 m of permanent subsidence of parts of the Oregon coast. Abundant evidence of this sudden subsidence exists in the form of abruptly buried peaty soils of coastal marshes and swamps found in outcrops and cores of these sediments beneath intertidal lowlands—the sudden rise in sea level produced by subsidence quickly buried the soils with intertidal mud. Where there was a nearby source of sand, large tsunamis accompanying the earthquakes spread sheets of sand over the marshes and swamps higher and farther inland than even the largest historic storm surges (i.e., Clague et al. 2000; Kelsey et al. 2002). Stratigraphic evidence of sudden submergence and tsunami from coastal archeological sites (Woodward et al. 1990; Minor and Grant 1996; Cole et al. 1996; Hutchinson and McMillan 1997) and ethnographic sources (e.g., Kroeber 1976:460-465; McMillan and Hutchinson 2002) confirm that great earthquakes and tsunamis influenced patterns of prehistoric site occupation and abandonment along much of the Pacific coast of central North America.

In South Slough, Ota et al. (1995), Nelson (1996b), and Nelson et al. (1998) attributed the abrupt submergence and burial of at least three of ten peaty intertidal soils in a marsh along Winchester Creek at the south end of the slough (Fig. 1) to subduction-zone earthquakes about 300, 1700, and 2300 years ago. More recent research on similar buried soils at the Sixes River, 60 km to the south, supports the idea that most of the ten buried soils in South Slough were submerged during subduction-zone earthquakes (Kelsey et al. 2002). Studies of microfossils (foraminifera and diatoms) suggest that the slough subsided about 0.5-1.0 m during the greatest of the earthquakes. Widespread sand sheets indicating tsunami inundation of the slough have been found on only the buried soil corresponding with the youngest earthquake (Nelson et al. 1998), but stratigraphic studies in other tidal marshes to the north (Darienzo and Peterson 1995) and south (Kelsey et al. 1998; 2002) of Coos Bay and in coastal lakes (Nelson et al. 2000) suggest large tsunamis shortly followed most of the subduction-zone earthquakes. Maximum water levels during these tsunamis must have exceeded by at least several meters the 4-m (above sea level) level at Charleston of the tsunami generated by the 1964 earthquake in Alaska. Studies by Japanese seismologists and historians suggest that the tsunami generated by the earthquake about 300 years ago struck the Oregon coast in the early evening of 26 January AD 1700 (Satake et al. 1996).

The ethnographic literature of the Coos Indians supports the idea that large earthquakes occurred in the Coos Bay area in the recent past. John Waters, one of John P. Harrington's informants, related that "my grandmother told when years ago there was a big earthquake that caused cracks in the ground" (Harrington 1942:Reel 23, p. 770). Annie Miner Peterson, one of Melville Jacobs' informants, related a story entitled "Salmon did ill to boys" in which a tidal wave and flood killed "nearly all the people" living at one campsite (Jacobs 1939:52-53). Peterson also related a story entitled "The water got high" in which "the ocean became

higher, and the water rose", prompting "the people who had canoes got into them there, all the people dashed towards their canoes, and those people who were still running afoot were all caught by the water (and drowned)" (Jacobs 1939:58-59). Peterson asserted that all of the Coos knew and told these stories (Jacobs 1939:52, 58). Harrington's informant Lottie Evanoff, a generation younger, made several references to a flood emanating from the ocean that were probably derived from these stories (Harrington 1942:Reel 23, p. 951, 954; Reel 24, p. 124, 560-561). One of the stories mentioned the town of Glasgow, about 12 m above the northeastern part of Coos Bay:

"The water was just rising slowly when the flood came but when the flood subsided, then it went fast and that was when lots of Indians got drowned... When you run in the woods in that time, person fleeing the flood just got wild and stayed in the woods. Glasgow floated, never got wet, and bear and deer and all Indians congregated there."

Was the submerged archaeological site at the mouth of South Slough inundated during the tsunami of AD 1700? The distribution of tsunami-deposited sand about 300 years old in the fringing marshes of Crown Point and the Hayward Creek inlet (Nelson et al. 1998) show that the entire mouth of the slough must have been inundated by a very large tsunami. However, the estimated 1-2 m elevation for the cultural deposits and the AD 1020-1450 ages of the fish clubs indicate that even if the slough subsided a full meter during the earthquake of AD 1700 the site was already being regularly flooded by tides long before the earthquake. Buried marsh soils and other evidence of earlier earthquakes in this and other Oregon estuaries probably antedate the fish clubs by at least a few hundred years. Thus, a large subduction-zone earthquake is not a likely explanation for the abandonment of the site. However, the AD 1700 tsunami may well have eroded and redistributed cultural deposits as it surged into the mouth of the slough. Such mixing of artifacts of different ages is another possible explanation for the difference in the ages of the two wooden fish clubs.

While earthquakes and tsunamis are likely to have had the most dramatic effects on the recent geologic history of South Slough, more ubiquitous coastal processes probably account for the abandonment and burial of the submerged cultural deposits at 35CS135 and perhaps their later erosion. Relative sea level has been rising along this part of the Oregon coast at a net rate of 1.4 m/1000 yr for the past 4000 years (Nelson et al. 1996a; Nelson et al. 1998). Although the rise was punctuated by jerks of subsidence, the estimated elevation of the site and the fact that its age does not correspond with the ages of past earthquakes suggest that it was gradually submerged by the long-term rise of relative sea level rather than suddenly flooded following a great earthquake.

Strong currents produced during migration or breaching of bars at the mouth of Coos Bay, particularly during major storms or river floods, also may have eroded the submerged cultural deposits at 35CS135. Before construction of the north jetty in 1929, the location of the mouth of Coos Bay fluctuated seasonally over a distance of several thousand feet (Beaulieu and Hughes 1975:121). Ethnographic accounts indicate that the mouth of Coos Bay formerly was some distance to the north of the present channel near a place called Jarvis Landing (Harrington 1942:Reel 23, p. 974). Another of Harrington's informants, Alec Evanoff, stated that:

When a boy I have heard myself Marshfield Tom and other older Inds. say that Coos Bay used to have its mouth through where Jarvis' Landing is now, where it is only ¼.-m[ile] across, absolutely flat, where one can walk across from Jarvis' Landing to the ocean Beach, absolutely flat the whole way, only 20 mins walk–at present (Harrington 1942:Reel 23, p. 942).

Jarvis Landing, the home of Fred Jarvis who offered stage service between Coos Bay and the Siuslaw River, was located approximately 9 km north of the entrance to South Slough (Fig. 1). A shift of this distance in the position of the mouth of Coos Bay would have had a major effect on the strength and orientation of tidal

currents at the mouth of South Slough (Nelson et al. 1998). Such a change would have resulted in much erosion and redeposition of sediment in this area, likely reworking any cultural materials that had recently been submerged at 35CS135.

CONCLUSIONS

The recovery of artifacts, shell debris, fire-cracked rock, and fish weir stakes during dredging operations in 1975 points to the presence of a submerged archaeological site at the mouth of South Slough, an arm of the Coos Bay estuary. The cultural deposits at 35CS135 probably represent a submerged prehistoric component of an ethnographic village at the mouth of South Slough. As the first implements of this kind to be recovered from an archaeological context on the Oregon coast, the wooden fish clubs recovered from this site represent a previously undocumented aspect of the material culture of the late prehistoric ancestors of the Coos Indians.

Recent geologic research has documented evidence of repeated great earthquakes and accompanying tsunamis along the Cascadia Subduction Zone over at least the last 5000 years. Evidence of earthquake-induced subsidence associated with the most recent great earthquake in AD 1700 has been found in the stratigraphic record at a number of late prehistoric settlements along the Pacific Coast of Oregon and Washington (Cole et al. 1996; Hutchinson and McMillan 1997; Minor and Grant 1996). In the wake of these studies, there may be some tendency among archaeologists to interpret any occurrence of submerged cultural deposits in coastal settings as somehow earthquake-related (Losey et al. 2000:128-129).

In the case of 35CS135 at Coos Bay, however, earthquake-induced subsidence was not necessarily the primary cause of the submergence of the cultural deposits. As much or more of the submergence was probably the result of the gradual rise in sea level along the Oregon coast over the last few thousand years. Changes in tidal currents resulting from the migration and breaching of bars at the mouth of Coos Bay and the migration of the bay's mouth may have contributed to erosion and reworking of sediments near the submerged prehistoric site.

The shores of estuaries along the Southern Northwest Coast were once lined with archaeological sites containing the remains of Native American settlements inhabited in the prehistoric past. Recent geologic research indicates that much of the coastal margin in this region has been submerged as a result of eustatic (sea level rise) and tectonic (earthquake-induced subsidence) processes. This account of a submerged prehistoric site on Coos Bay illustrates the potential for the discovery of evidence of prehistoric occupation, notably including artifacts made from perishable materials, along the submerged margins of estuaries on the Southern Northwest Coast.

ACKNOWLEDGEMENTS

We are greatly indebted to LeRoy Hansen for bringing the artifacts recovered during dredging at the mouth of South Slough to our attention and for agreeing to their curation at the Oregon State Museum of Anthropology at the University of Oregon (Accession No. 983). Identification of the wood from which the two fish clubs were made was carried out by Nancy A. Stenholm of Botana Labs, Seattle. Funds in support of fieldwork, wood identification, and radiocarbon dating in connection with this research were provided by Heritage Research Associates, Inc. Nelson's coastal research was supported by the National Earthquake Hazards Reduction Program of the U.S. Geological Survey. We thank Ian Hutchinson and Gary Huckleberry for helpful reviews of a previous draft of this paper.

REFERENCES

Atwater, Brian F., and Eileen Hemphill-Haley
1997 Recurrence intervals for great earthquakes of the past 3500 years at north-

eastern Willapa Bay, Washington. U.S. Geological Survey Professional Paper 1576.

Barnett, H.G.
1937 Culture Element Distributions: VII, Oregon Coast. University of California Anthropological Records 1(3). Berkeley.

Beaulieu, John D. and Paul W. Hughes
1975 Environmental Geology of Western Coos and Douglas Counties, Oregon. Oregon Department of Geology and Mineral Industries Bulletin No. 87. Portland, Oregon.

Briggs, Greg G.
1994 Coastal Crossing of the Elastic Strain Zero-Isobase, Cascadia Margin, South-Central Oregon Coast. Unpublished M.S. thesis, Department of Geology, Portland State University, Portland.

Byram, Scott
1998 Fishing Weirs in Oregon Coast Estuaries. In Hidden Dimensions: The Cultural Significance of Wetland Archaeology, edited by Kathryn Bernick, pp. 199-219. UBC Press, Vancouver, British Columbia.

Caldera, Melody (editor)
1995 South Slough Adventures: Life on a Southern Oregon Estuary. Friends of South Slough, South Coast Printing Company. Coos Bay, Oregon.

Clague, John J.
1997 Evidence for Large Earthquakes at the Cascadia Subduction Zone. Reviews of Geophysics 35:439-460.

Clague, John J., Peter T. Bobrowsky, and Ian Hutchinson
2000 A Review of Geological Records of Large Tsunamis at Vancouver Island, British Columbia, and Implications for Hazard. Quaternary Science Reviews 19:849-863.

Cole, Steve C., Brian F. Atwater, Patrick T. McCutcheon, Julie K. Stein, and Eileen Hemphill-Haley
1996 Earthquake-Induced Burial of Archaeological Sites Along the Southern Washington Coast About A.D. 1700. Geoarchaeology 11:165-177.

Darienzo, Mark E. and Curt D. Peterson
1995 Magnitude and Frequency of Subduction-Zone Earthquakes Along the Northern Oregon Coast in the Past 3000 Years. Oregon Geology 57(1):3-12.

Harrington, John P.
1942 Coos Fieldnotes. John P. Harrington Papers, National Anthropological Archives, Smithsonian Institution, Washington, D.C.

Hutchinson, Ian
1992 Holocene Sea Level Changes in the Pacific Northwest: A Catalog of Radiocarbon Dates and an Atlas of Regional Sea Level Curves. Occasional Paper No. 1, Institute for Quaternary Research, Simon Fraser University, B.C., Canada

Hutchinson, Ian, and Alan D. McMillan
1997 Archaeological Evidence for Village Abandonment Associated with Late Holocene Earthquakes at the Northern Cascadia Subduction Zone. Quaternary Research 48: 79-87.

Jacobs, Melville
1938 Coos Narrative and Ethnologic Texts. University of Washington Publications in Anthropology 8(1). Seattle.

Kelsey, Harvey M., Robert C. Witter, and Eileen Hemphill-Haley

1998 Response of a Small Oregon Estuary to Coseismic Subsidence and Postseismic Uplift in the past 300 years. Geology 26:231-234.

2002 Plate-Boundary Earthquakes and Tsunamis of the Past 5500 yr, Sixes River Estuary, Southern Oregon. Geological Society of America Bulletin 114:298-314.

Kroeber, A.L. and S.A. Barrett

1962 Fishing Among the Indians of Northwest California. University of California Anthropological Records 21(1). Berkeley.

Kroeber, A.L.

1976 Yurok Myths. University of California Press. Berkeley,

Losey, Robert J., Jon M. Erlandson, and Madonna L. Moss

2000 Assessing the Impacts of Cascadia Subduction Zone Earthquakes on the People and Landscapes of the Northwest Coast. In Changing Landscapes: Proceedings of the 3rd Annual Coquille Cultural Preservation Conference, 1999, edited by Robert J. Losey, pp. 124-142. Coquille Indian Tribe, North Bend, Oregon.

Lyman, R. Lee, Ann C. Bennett, Virginia M. Betz, and Linda A. Clark

1991 Prehistory of the Oregon Coast—The Effects of Excavation Strategies and Assemblege Size in Archaeological Inquiry. Academic Press, San Diego.

McMillan, Alan D. and Ian Hutchinson

2002 When the Mountain Dwarfs Danced: Aboriginal Traditions of Paleoseismic Events Along the Cascadia Subduction Zone of Western North America. Ethnohistory 49:41-68.

Minor, Rick, and Wendy C. Grant

1996 Earthquake-Induced Subsidence and Burial of Late Holocene Archaeological Sites, Northern Oregon Coast. American Antiquity 61:772-781.

National Ocean Service

1987 Tide Tables, 1988–West Coast of North and South America. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Washington, D.C.

Nelson, Alan R.

1992 Holocene Tidal-Marsh Stratigraphy in South-Central Oregon—Evidence for Localized Sudden Submergence in the Cascadia Subduction Zone. In Quaternary Coasts of the United States: Marine and Lacustrine Systems, edited by C.H. Fletcher and J. F. Wehmiller, pp. 287-301. Society for Sedimentary Geology Special Publication 48. Tulsa, Oklahoma.

Nelson, A.R., I. Shennan, and A.J. Long

1996a Identifying Coseismic Subsidence in Tidal-Wetland Stratigraphic Sequences at the Cascadia Subduction Zone of Western North America. Journal of Geophysical Research B3(101):6115-6135.

Nelson, A.R., A.E. Jennings, and K. Kashima

1996b An Earthquake History Derived from Stratigraphic and Microfossil Evidence of Relative Sea-Level Change at Coos Bay, Southern Coastal Oregon. Geological Society of America Bulletin 108(2):141-154.

Nelson, Alan R., Yoko Ota, Masatomo Umitsu, Kaoru Kashima, and Yoshiaki Matsushima

1998 Seismic or Hydrodynamic Control of Rapid Late-Holocene Sea-Level Rise in Southern Coastal Oregon, USA? The Holocene 8:287-299.

Nelson, Alan R., Harvey M. Kelsey, Eileen Hemphill-Haley, and Robert C. Witter

2000 OxCal Analyses and Varve-Based Sedimentation Rates Constrain the Times of 14C-Dated Tsunamis in Southern Oregon. In Penrose Conference 2000: Great Cascadia earthquake tricentennial: Program Summary and Abstracts, edited by John J. Clague, Brian F. Atwater, Kelin Wang, Yumei Wang, Ivan Wong, pp. 87-88. Oregon Department of Geology and Mineral Industries Special Paper 33. Portland, Oregon.

Ota, Y., A.R. Nelson, M. Ymitsu, K. Kashima, and Y. Matsushima
1995 Interpreting an Earthquake History from the Stratigraphy of Late Holocene Intertidal Deposits in South Slough, Coos Bay, Oregon, USA [in Japanese with English abstract]. Journal of Geography [Japan] 104:94-106.

Satake, K., K. Shimazaki, Y. Tsuji, and K. Ueda
1996 Time and Size of a Giant Earthquake in Cascadia Inferred from Japanese Tsunami Records of January 1700. Nature 379:246249.

Stubbs, Ron D.
1973 Preliminary Report on Indian Bay Site, 35CS30. On file, Oregon State Historic Preservation Office, Salem.

Stuiver, Minze, Paula J. Reimer, Edouard Bard, J. Warren Beck, George S. Burr, Konrad A. Hughen, Bernd Kromer, Gerry McCormac, Johannes van der Plicht, Marco Spurk
1998 INTCAL98 Radiocarbon Age Calibration, 24,000-0 cal BP. Radiocarbon 40:1041-1084.

Tveskov, Mark A.
1995 Archaeological Survey of the South Slough of Coos Bay. Chapter 4 in An Evaluation, Survey, and Dating Program for Archaeological Sites on State Lands of the Northern Oregon Coast, by Madonna L. Moss and Jon M. Erlandson, pp. 58-73. On file, Oregon State Historic Preservation Office, Salem.

2000 The Coos and Coquille: A Northwest Coast Historical Anthropology. Unpublished Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene.

Woodward, John, James White, and Ronald Cummings
1990 Paleoseismicity and the Archaeological Record—Areas of Investigation on the Northern Oregon Coast. *Oregon Geology* 52:57-65.