Exxon Valdez Oil Spill
Restoration Project Final Report

Site Specific Archaeological Restoration at SEW-440 and SEW-488

Restoration Project 95007B
Final Report

Linda Finn Yarborough

United States Department of Agriculture
Forest Service
Chugach National Forest
3301 C St., Suite 300
Anchorage, Alaska 99503

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Study History: The project effort was initiated under Restoration Project 94007B. An annual progress report was issued in January, 1995 by Yarborough, L., under the title Restoration Project 94007, Archaeological Restoration at SEW-440 and SEW-488 Progress Report, January 1995. The project continued under Restoration Project 95007B, the subject of this annual report. A second progress report was prepared in September 1995 by Yarborough, L., under the title Restoration Project 94007, Archaeological Restoration at SEW-440 and SEW-488, Progress Report, September 1995. FY 95 was the last field season for this project. Data analysis and project report preparation took place in FY 96 and FY97. Papers were prepared for presentation and peer reviewed publication, and results were presented to the public in FY 97.

Abstract: Project 94007 provided for restoration of two archaeological sites damaged during the *Exxon Valdez* Oil Spill and its subsequent cleanup program. Test excavations were carried out at both SEW-440 and SEW-488 during 1994. Analysis and completion of excavations at SEW-488 took place in 1995. Analysis continued in 1996 and 1997. Each site was assessed in the field and mapped prior to testing. Data recovery work yielded both environmental and cultural information. Both sites appear to have been intermittently occupied, SEW-440 over a period of almost 2000 years, and SEW-488 for up to 3000 years. Artifact and zooarchaeological analyses resulted in information on prehistoric technology, subsistence, seasonality and site use. The data augment knowledge of cultural ecology and settlement patterns in the Prince William Sound area. Analysis of site stratigraphy, soils, pollen and tephra layers have yielded tectonic, geomorphological, palaeoenvironmental, and volcanic information. The project attained the restoration goals of recovery, analysis, and curation of artifacts, backfilling and surface stabilization, and determination of the nature of each site and the extent to which information has been compromised or destroyed.

Key Words: archaeology, Chugach, *Exxon Valdez*, fauna, geology, geomorphology, palaeo-environment, palynology, pollen, Prince William Sound, Sugpiaq, tephra, zooarchaeology.

Project Data: *Description of data* - Two primary sets of computerized data were compiled during the project, one for artifacts, and the other for fauna. Both include provenience, identification, and descriptive information. *Format* - Both data sets are in Microsoft Excel 5.0. *Custodian* - Contact Linda Finn Yarborough through the U.S.D.A. Chugach National Forest, 3301 C St., Suite 300, Anchorage, Alaska (work phone: (907) 271-2511; fax: (907) 271-3992). *Availability* - Because some of the information is sensitive in nature, the data sets will be made available to researchers on a case by case basis.

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LIST OF ACRONYMS AND ABBREVIATIONS

AD	*Anno Domini*
ADNR	Alaska Department of Natural Resources
AHRS	Alaska Heritage Resource Survey
AHPA	Alaska Historic Preservation Act
ANCSA	Alaska Native Claims Settlement Act
ARPA	Archaeological Resources Protection Act
BC	Before Christ
BIA	Bureau of Indian Affairs
BP	Before Present (1950 AD)
CERCLA	Comprehensive Environmental Response Compensation Liability Act
CFR	Code of Federal Regulations
CNF	Chugach National Forest
cm	centimeter
cmbd	centimeters below datum
cmbs	centimeters below surface
EVOS	*Exxon Valdez* Oil Spill
ft	feet
gr	gram
ITZ	intertidal zone
m	meter
ml	milliliter
mm	millimeter
MLLW	mean lower low water
NOAA	National Oceanic and Atmospheric Administration
NHPA	National Historic Preservation Act
OHA	Office of History and Archaeology
PWS	Prince William Sound
SCAT	Shoreline Cleanup Assessment Team
TAG	Technical Advisory Group
USDA	United States Department of Agriculture
USDAFS	United States Department of Agriculture Forest Service
USGS	United States Geological Survey

EXECUTIVE SUMMARY

Project 94007 provided for restoration of two archaeological sites, SEW-440 and SEW-488, in western Prince William Sound which were damaged during the *Exxon Valdez* Oil Spill (EVOS) and its subsequent cleanup program. The restoration measures were recommended by a multi-agency panel of experts in archaeology of the region, chaired by Martin McAllister (1992). Injury to SEW-440 was described as severe oiling, an increase in erosion of the prehistoric midden component as a result of foot traffic and high pressure water treatment during the cleanup response, displacement of archaeological resources during geological testing, and an un-backfilled excavation in the horizontal surface of the site (Jesperson and Griffin 1992; McAllister 1992). Injury to SEW-488 consisted of oiling, and displacement of archaeological resources during high pressure water treatment and unmonitored cleanup activities (Jesperson and Griffin 1992; McAllister 1992). Erosion along three portions of the site was evident in 1991 (Dekin *et al.* 1993).

This report documents implementation of the restoration measures proposed by the panel for SEW-440 and SEW-488, including a full field site damage assessment; recovery, analysis, and curation of artifacts; and an evaluation of the presence of intertidal zone (ITZ) oil. The report also presents environmental, historical and archaeological information relevant to understanding these sites in the context of other known cultural resources in Prince William Sound and the north Pacific.

SEW-440 and SEW-488 were discovered in 1989 during the EVOS cleanup program, and were visited and briefly evaluated by Exxon archaeologists. SEW-488 has an ITZ component which is on state land, while the uplands of both sites are administered by the United States Department of Agriculture, Forest Service (USDAFS). Subsequent to its discovery, the uplands of SEW-488 were selected as an amendment to a previously invalidated 14(h)1 selection under the Alaska Native Claims Settlement Act (ANCSA). As of the writing of this report, the land has not yet been conveyed out of government ownership. An archaeological team under contract to the USDAFS conducted minimal testing at SEW-488 in 1991 as part of a larger project to assess the results of the EVOS cleanup and Cultural Resource Program. Field work for the restoration project described in this report was conducted at both sites during the summer field season of 1994, and continued at SEW-488 during the summer of 1995. Analysis of data collected began in Fiscal Year (FY) 1995 and continued into FY 1997.

The majority of the cultural deposits at each site are prehistoric in nature. SEW-440 appears to have been occupied during the first half of the first millennium AD, and again in the middle of the second millennium AD A few pieces of dimensional lumber on the surface of the site provide evidence of twentieth century activity. Site depth varies from a few tens of centimeters to about a meter. The cultural remains consist for the most part of stone tools and animal bones, evidence of daily life and subsistence activities. Wood does not seem to be well preserved at the site.

The prehistoric deposits at SEW-488 represent occupations during the early first millennium B.C., the late first millennium AD, and the early to middle second millennium AD Historic artifacts indicate a short-term use of the site during the first half of the twentieth century. Cultural deposits range in depth from 50 cm or less in the ITZ, to 180 cm in the upland portion of the site. The prehistoric remains recovered include stone and copper tools, a wooden ulu handle and some pieces of cut wood, and some animal remains. Wood seems to be fairly

well preserved at SEW-488 in portions of the site which are saturated by ground water.

Because these sites were unknown and unevaluated prior to the oil spill, data recovery and analysis were necessary to understand the nature of the sites and the extent to which information contained in the sites has been compromised or destroyed as a result of oiling and EVOS cleanup activities. The restoration work indicates that there was relatively little damage to the uplands of SEW-440 as a result of EVOS activities in 1989. However, the ITZ still showed evidence of oil from the spill in 1994. The uplands of SEW-488 likewise do not appear to have been severely damaged by cleanup activities in 1989 and 1990. However, there is some evidence of disturbance of ITZ deposits at the site which may be related in part to EVOS cleanup activities. Those deposits which are likely to have been disturbed appear to be the older deposits at the site. Although this disturbance is somewhat offset by knowledge that remains of this early occupation are present in the upland portion of the site, future preservation of this deposit is important, as it is one of only three early Neoglacial period sites known from Prince William Sound. Although no formal determination of eligibility has been made for either site at present, both appear to be eligible for inclusion in the National Register of Historic Places under Criterion D, because of the information which they have yielded and which they contain regarding prehistoric Alaska Native culture.

CHAPTER 1: INTRODUCTION

Regulatory and Compliance Responsibilities

Both Federal and State cultural resource laws applied to the Exxon Valdez Oil Spill and resulting cleanup program. The oil spill itself was initially perceived as an "unauthorized disturbance to palaeontological, archaeological, or historical properties on state-administered lands" (Mobley *et al.* 1990), prohibited by the Alaska Historic Preservation Act (AHPA). The National Historic Preservation Act (NHPA) applied to the cleanup activity, which was determined to be an undertaking as defined in 36 CFR 800 (Protection of Historic and Cultural Properties). Through the Section 106 review process established by the NHPA, sites were inventoried, effects were determined, and mitigation was undertaken where necessary.

Numerous cultural resources were injured by oiling. Despite the efforts of the archaeologists employed in the *Exxon Valdez* Cultural Resource Program, and the constraints on treatment techniques devised in consultation with state and federal agencies to minimize site disturbance during cleanup efforts, some cultural resources were also injured by cleanup and treatment activities. The initial assessment of cultural resource damage resulted from a CERCLA-directed report by the Alaska OHA and the National Park Service which focused on "injury derived from Oil spill response and response-related vandalism" (Jesperson and Griffin 1992:1). This report describes the successful attempt of the USDAFS, Chugach National Forest, to comply with direction for mitigation at two archaeological sites on Forest administered lands which were identified as having been injured during the 1989 *Exxon Valdez* Oil Spill and its subsequent cleanup program.

Archaeological sites SEW-440 and SEW-488 were among those identified as having sustained substantial injury during the oil spill and cleanup process. SEW-440 is on Eleanor Island, while SEW-488 is on Knight Island (Figure 1). Both sites were severely oiled in 1989. In addition, SEW-440 suffered an increase in erosion of the prehistoric midden component as a result of foot traffic and high pressure water treatment during the cleanup response, displacement of archaeological resources during geological testing, and an un-backfilled excavation in the horizontal surface of the site (Jesperson and Griffin 1992; McAllister 1992). Injury to SEW-488 consisted of oiling and displacement of archaeological resources during high pressure water treatment and unmonitored cleanup activities (Jesperson and Griffin 1992; McAllister 1992). Erosion along three portions of the site was evident in 1991 (Dekin *et al.* 1993).

Funds for restoration work were originally sought from the *Exxon Valdez* Oil Spill Trustee Council in 1993 and were granted for FY94. Project 94007 provided for restoration of the two sites as recommended by a multi-agency panel of experts in archaeology of the region, chaired by Martin McAllister (1992). The project was designed to effect the proposed restoration measures for each of these two sites. These included a full field site damage assessment, and recovery, analysis, and curation of artifacts for both SEW-440 and SEW-488, with additional backfilling and surface stabilization at SEW-440. Both sites have been "treated as being eligible for inclusion in the National Register" (Mobley *et al.* 1990:230), although no formal determination of eligibility has been made for either site. In order to protect and preserve the remaining cultural deposits it is necessary to understand the nature of each site, and the extent to which the identified damage has compromised or destroyed information contained in the sites.

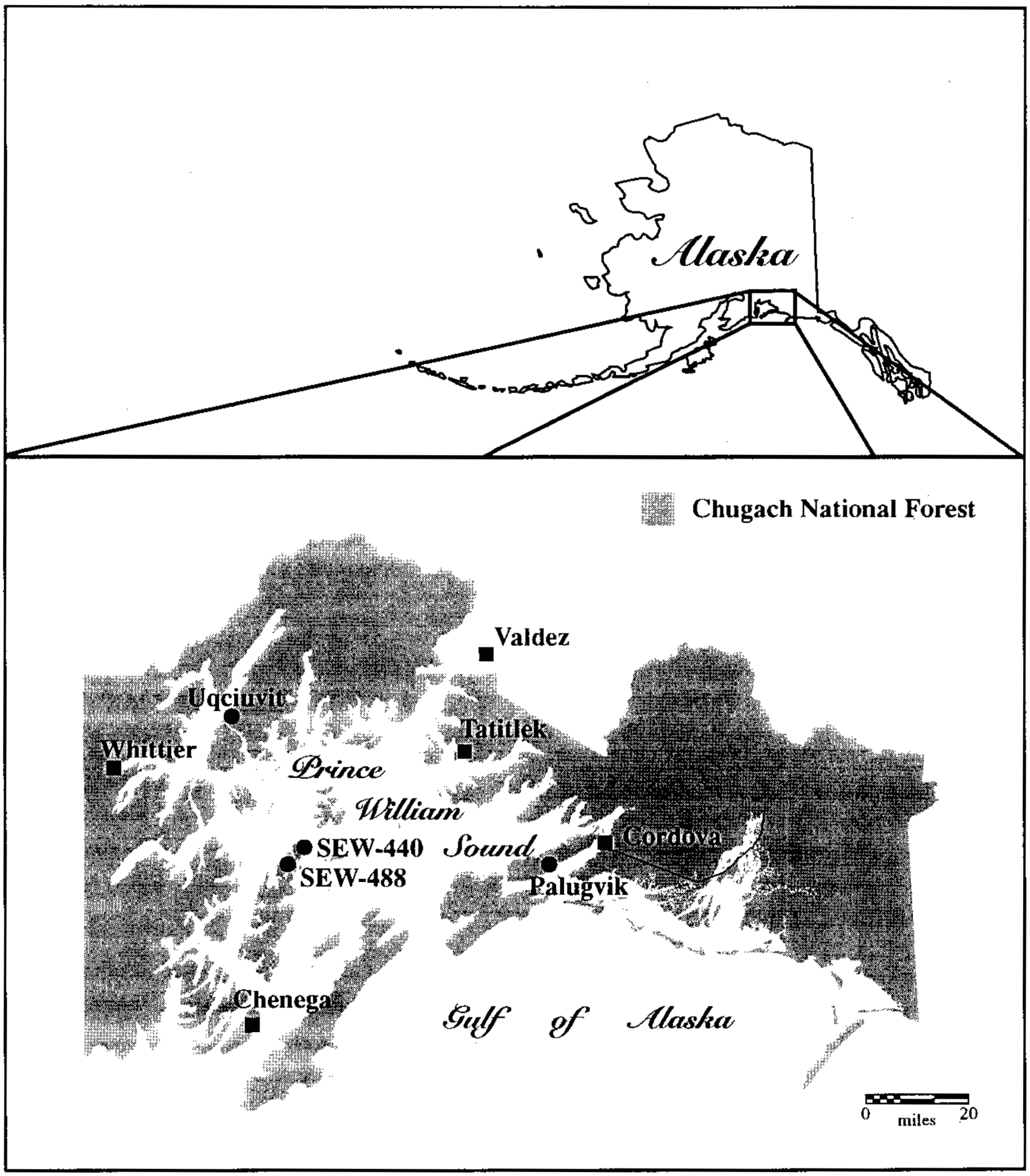


Figure 1. EVOS restoration project area.

Objectives

The major objectives of the project were to ameliorate and halt the deterioration and destruction of the sites, to protect and preserve the remaining cultural deposits, and to gain scientific and cultural knowledge which would add significantly to the understanding of the prehistory of Prince William Sound. Such knowledge includes site depths, boundaries, activities, cultural affiliation, and environment. This report presents in large part the results of the project.

Methodology

Prior to restoration work at each site, the current condition of each site was assessed. This included a pedestrian survey, photographic recordation for comparison with previous site photos, and written documentation of the site's condition. Each site was surveyed and gridded by a Chugach National Forest engineering survey crew. They subsequently prepared contour maps of each site. Test unit locations were chosen nonprobabilistically. In several instances at SEW-488, some units were excavated as contiguous blocks. The latter type of excavation was chosen to address relevant research questions and to recover "as much of the important information in the site as possible, given time and other constraints" (Advisory Council on Historic Preservation 1980:16). The sample fraction and size at each site was largely determined by the available field time and crew size. Data recovery was affected by pragmatic considerations, including "local conditions, the potential for unexpected discoveries, non-archaeological concerns, and other relevant factors (Advisory Council on Historic Preservation 1980:17).

The archaeological procedures used in the retrieval of data from tests at 49SEW-440 and SEW-488 were designed to retrieve a maximum of data from a small sample of each site. At SEW-440 the archaeological crew made small 25 cm^2 tests to determine the site boundaries. As the limits of SEW-488 were determined in 1991, no additional boundary tests were made at that site. The basic test units excavated at each site were 1 m^2. Deposits were manually troweled in 10 cm or natural levels, and screened through 1/8 inch mesh hardware cloth. Water screening was employed during part of the testing at SEW-488 because of the soil consistency. The amount of fire-cracked rock in each unit was weighed by level. Charcoal and pollen samples were taken, and a soil sample was collected from each excavation level of each unit for later laboratory examination. Observations were made and recorded by each excavator throughout the work. At the conclusion of testing, all tests were backfilled and the vegetation was replaced whenever possible. Flagging was removed, although some survey monuments were left in place, and the area was generally made to look as undisturbed as possible.

Soil pH testing of bulk samples was done in the USDA State and Private Forestry laboratory in Anchorage. Samples taken from the middle ITZ of each site were provided to the OHA for hydrocarbon analysis in conjunction with EVOS monitoring project 007a. Flotation of 1 litre portions of the bulk samples was accomplished using a 55 gallon flotation unit with nesting sieves, in cooperation with the Anchorage District Office of the Bureau of Land Management. The faunal collections from the two sites were identified through comparison with the zooarchaeological collections at the University of Alaska, University of Wisconsin-Madison, and University of Victoria. Artifact analysis and report writing took place in Anchorage.

Michele Potkin, USFS 1995

Figure 2. Project area, from vicinity of wet meadow pollen tests.

CHAPTER 2: ENVIRONMENTAL SETTING: WESTERN PRINCE WILLIAM SOUND

Physiography and Geology

Prince William Sound, with roughly 4,800 km of shoreline, is comprised of an intricate system of bays and islands (Grant and Higgins 1910:15; N. Lethcoe 1987:1). Fjords are common in the northern and northwestern areas of the sound, in contrast to the eastern part which is characterized more by relatively flat, low islands and forelands (Grant and Higgins 1910:15-17). There are numerous coastal streams in the sound, although most head in glaciers and are short and swift (Wahrhaftig 1965:40; Alaska Department of Fish and Game 1978:11).

The restoration project area falls within the Pacific Border Ranges province of the Pacific Mountain System division. This province consists of the mountain ranges bordering the Pacific coast and, in places, a shelf between the mountains and the ocean (Wahrhaftig 1965:39). The project area is found within the Kenai Mountains portion of the Kenai Chugach Mountains section of this province.

The Kenai-Chugach Mountains are rugged, 900 to 4,000 m high mountains along the northern coast of the Gulf of Alaska. Passage Canal marks the divide between the Chugach Mountains, which roughly parallel Prince William Sound's northern shore, and the Kenai Mountains, which form the "backbone" of the Kenai Peninsula (N. Lethcoe 1987:56). Deep fjords and sounds mark the southern face of the mountains, and ridges extend southward as chains of islands (Wahrhaftig 1965:40). Prince William Sound, an irregular, 113 km wide embayment, lies within a maturely eroded part of the Kenai-Chugach Mountains (Orth 1967:778; Grant and Higgins 1910:14).

The Kenai-Chugach Mountains are comprised of rocks of both the Prince William and Chugach terranes. The shores of Prince William Sound are principally formed by rocks of the Prince William terrane, a wide outcrop belt that extends southwest from the Copper River and Prince William Sound, beneath the continental shelf off of Kodiak Island. The "basement" of the terrane is made up of the Orca Group, "an accreted late Paleocene and early through middle Eocene deep-sea-fan complex interbedded with oceanic volcanic rocks and minor pelagic sediment" (Plafker 1987:233). The Orca Group consists primarily of dark colored slates and graywackes, interbedded locally with greenstone. Greenstone (altered basalt) is abundant in the lower Orca layers (Grant and Higgins 1910:11; de Laguna 1956:5).

The Prince William terrane is separated from the Chugach terrane by the Contact Fault (Hoekzema 1985:47). An elongated belt extending roughly 1,700 km around the Gulf of Alaska, the Chugach terrane is made up principally of deformed sedimentary rocks. Deformation of the terrane resulted in the uplift of the Chugach Mountains and the St. Elias Range (Plafker 1987:235; Sample and Moore 1987:8).

There are at least two subterranes of the Chugach terrane. The dominant subterrane is composed of late Cretaceous volcaniclastic flysch and oceanic basalts. It is separated from the second subterrane, a late Jurassic to early Cretaceous melange, by the Eagle River thrust fault (Plafker 1987:234; Sample and Moore 1987:8; Mobley *et al.* 1990:15). Because it was originally described in the Port Valdez area, the portion of the flysch subterrane extending in "an arcuate-shaped band" from Chichagof Island to the southern margin of the Kenai Peninsula is designated the Valdez Group (Hoekzema 1985:45; Hoekzema *et al.* 1987:5; Winkler *et al.* 1984:9). This group is most commonly made up of "well indurated, rhythmically interbedded sandstone, siltstone, and argillite with minor pebble conglomerate" (Hoekzema *et al.* 1987:5).

Glacial History

The large ice fields and numerous valley glaciers found today in the Chugach and Kenai Mountains are remnants of a much larger late Pleistocene ice sheet. Ice flowing from the mountains coalesced in Prince William Sound to form a huge piedmont glacier which probably extended at least to Montague and Hinchinbrook Islands (Heusser 1983:337). Evidence of glaciation is found throughout the sound. Large deposits of till and glacial gravels are not common, however, since the district is characterized more by glacial erosion than glacial deposition (Grant and Higgins 1910:18).

Prince William Sound was apparently deglaciated later than other areas of south-central Alaska. Heavy snowfall during the late Pleistocene evidently maintained the glaciers here even as the ice wasted in neighboring regions. Deglaciation began sometime prior to 10,000 BP, although it was not until about 9000 BP that lower elevations were completely ice free (Heusser 1983:337, 353; 1985:153).

Studies of tidewater and land-terminating glaciers in the mountains of Kenai Peninsula indicate three major intervals of late Holocene glaciation: one that began about 3600 BP, a second that commenced about 1350 BP and the third from about 650-100 BP (Wiles and Calkin 1994:1). The latter corresponds to advances in other parts of the world, and is often termed the Little Ice Age. Similar periods of advance are indicated for western Prince William Sound. Glacial features in Harriman Fjord and College Fjord, radiocarbon dated to about 3200-2500 BP, and peat from Coghill Lake, dated to 3205 BP, relate to the first Neoglacial advance in that region. A date of 2360 BP from the proximal portion of a submerged moraine where Port Wells joins Barry Arm and College Fjord, is believed to measure the time just after the retreat of the glacier (Heusser 1983:351). A second simultaneous glacial expansion in both Prince William Sound and the Kenai mountains is suggested by a date of 1410 BP on peat on a moraine at Coghill Lake (Heusser 1983:351). Glacial features in Prince William Sound which correlate with the third Kenai mountains glacial episode include a partially submerged moraine in Blackstone Bay apparently created between 650 BP and 580 BP, and the moraine directly in front of Blackstone Glacier, estimated to be about 100 years old (Post 1980).

Within the general time frame of the Little Ice Age, differences in periods of advance have been noted for glaciers on the western and eastern sides of the Kenai Peninsula. Dendrochronological correlations show that those on the west expanded between 510 BP and 490 BP, from 300 BP to 240 BP, and from 120 BP to 90 BP while those on the east advanced from about 530 BP to 490 BP, between 310 BP and 280 BP, again about 200 BP, and from 70 BP to 40 BP (Wiles and Calkin 1994:299). Western expansions are suggested to correspond to intervals of cooler summers, while eastern advances are believed to have corresponded to periods of higher winter precipitation. The glaciers on the west side of the Kenai Mountains appear to have retreated as much as 200 years before those on the east side (Wiles and Calkin 1994:282). which may have been due to a rain shadow effect.

Holocene Tectonics and Geomorphology

The 1964 Alaska earthquake resulted in warping, horizontal displacement, and faulting over a large area of south central Alaska. Regional uplift and subsidence occurred across two roughly parallel zones along the continental margin (Plafker 1969:1). Areas along the coast of the Gulf of Alaska, including all but the extreme northwestern and northern parts of Prince William Sound, were uplifted an average of roughly 2 m. The maximum uplift, measured on the western side of Montague Island, was 11.6 m (Plafker 1969:24).

North and west of the zone of uplift, across a "broad asymmetrical downwarp" centered on the Kenai-Chugach and Kodiak Mountains, subsidence averaged approximately .75 m. The greatest downwarping, approximately 2.5 m, was recorded in Harriman Fjord in northwestern Prince William Sound (Mobley *et al.* 1990:19). Along the southwestern coast of the Kenai Peninsula, the maximum measured subsidence was roughly 2.3 m (Plafker 1969:1).

The tectonic movement associated with the 1964 Alaskan earthquake was only the latest in a long series of deformations in the region (Plafker 1969:1). Palaeoseismic data from the area indicate that there have been earthquakes on the order of the 1964 event every 650 to 850 years since about 3035 BP. However, seismic disturbances are common in this region. Records of the late nineteenth and twentieth century document 78 earthquakes within 200 km of Prince William Sound, and an earthquake in 1900 centered east of the sound which may have had a magnitude similar to the 1964 earthquake (Chaney 1995, U.S. Department of Commerce and the Interior 1981).

During the past several thousand years, the trend has been one of emergence of portions of the continental margin and concurrent submergence of the Chugach, Kenai, and Kodiak Mountains. In general, there is a correspondence between zones where there was a significant amount of uplift or subsidence during the 1964 earthquake and areas of net emergence or submergence during the late Holocene (Plafker 1969:62). The seismic cycle in the region is complex, however, and uplifted areas can subside as much or more between earthquakes as they are raised during events. In the Copper River Delta, for example, there has been a net long-term subsidence, even though the area has been uplifted as much as 2 m during earthquakes (George Plafker, personal communication, 1990).

Studies done after 1964 suggest that much of the coast affected by the Alaskan earthquake had also experienced a pronounced, short term tectonic submergence (Plafker 1969:60-61). Radiocarbon dates from samples of submerged terrestrial vegetation taken from Seward to Cape Suckling show that this submergence occurred gradually or in numerous small increments, and generally took place at a rate of approximately 52 cm per century during the last 930 years. The upper limit for the duration of this submergence is uncertain, but it could have begun as early as 1350 BP (Plafker 1969:62).

Since this short term, late Holocene submergence occurred in a region where the general trend of isostatic adjustment seem to have been upward, and during a time when the sea was at or near its present level, it was likely a result of tectonic movement (Plafker 1969:62). Most studies suggest that sea level either reached its present stand between about 2,000 and 6,000 years ago, or has been slowly and continuously rising for the past 7,000 years. However, other research indicates that the sea has fluctuated approximately 1 to 2 m above and below its current level since it reached this position 3,000 to 5,000 years ago (Plafker 1969:55).

A study by Stanley (1969) suggests that changes in shoreline processes and beach morphology caused by the 1964 earthquake were similar to those resulting from more gradual, long term, sea level changes. In areas of subsidence, beaches flattened in gradient and receded shoreward. Minor beach features were initially altered or destroyed, but soon began to reappear in their original forms. Frontal beach ridges migrated shoreward, and became wide and higher. Along uplifted shorelines, beaches "were stranded out of reach of the sea," although new beaches are slowly developing to match current sea levels (Stanley 1969:1).

Local Geomorphology

In a 1994 geomorphological study conducted to further understand the shoreline history of the project area, both northern Knight Island and Eleanor Island were found to have a similar morphogenesis (Chaney, this volume, Appendix B). Six periods of varying geological influences are recognized for the immediate areas of the sites. From the period of post-Pleistocene deglaciation to about 9000 BP, the tombolos on which the sites are located were uplifted through isostatic rebound, and underwent reworking of their glacial marine sediments through intertidal wave action. Between approximately 9000 BP and 6500 BP, uplift of the tombolo surfaces continued to at least 2.4 m above current elevation. At the end of this period there is evidence of deposition of a thin glacial-related sediment in the vicinity of SEW-488. This may have been a result of local submergence and ice-rafting, the advance of local glaciers, or deposition by a glacial sediment-bearing iceberg washed ashore by a storm or tsunami. Deposits from the subsequent 2000 years indicate that the area was uplifted at least 4.3 m above current elevation. A thin bed of sand deposited near SEW-488 between about 4500 and 4230 BP, indicates either marine influences to a minimum of 3.7 m above today's mean lower low water (MLLW) level, or deposition by a local stream channel. During the subsequent 2000 years, marine influences remained below the 2.7 m elevation MLLW, and possibly the 2.1 m level. This indicated uplift may be related to four postulated major earthquakes during this period, as noted above. An episode of long-term subsidence is indicated between about 2000 BP and AD 1964. Storm waves or tsunamis may have reached the upland surface of both tombolos on one or more occasions during this period. The uplift associated with the AD 1964 earthquake appears to be at least a momentary reversal in this trend.

Climate

During the past 10,000 years, the North Pacific region has experienced two gross climatic periods, as exemplified by palaeobotanical evidence (Heusser *et al.* 1985). The early Holocene was characterized by warm temperatures and low precipitation, while the late Holocene (after 5000 B.P) featured higher precipitation and lower temperatures. Increased storm activity during the late Holocene, combined with steadily decreasing temperatures, appears to be associated with the Neoglacial episodes described above (Heusser *et al.* 1985:486-487).

There have been suggestions that what appear to be palaeobotanical responses to temperature changes may in some cases be simply a response to changes in precipitation. Response to dry conditions may appear similar to that for warm conditions, whereas response to wet conditions may approximate cold (Bryson 1987). Likewise, the initiation of glacial advance may be more closely related to precipitation change than to temperature. In a study in progress, comparison of global data sets for glacial activity, temperature, and precipitation in the interval from about AD 1860 to 1960 shows a lowering of glacial firn lines on a world-wide basis, despite an overall increase in temperature. However during this time, a global increase in precipitation was recorded (R.A. Bryson personal communication 1993).

Equatorial and high latitude volcanic eruptions have also been discussed as triggers for climate change. Porter (1986:44) suggests that the average temperature during glacial advances following volcanic events may have been from 0.5 degrees to 1.2 degrees Celsius (C) lower than current temperatures. The data from the Little Ice Age indicate that temperatures during this most recent glacial advance were lower at least in the northern hemisphere than they were during the preceding Medieval Optimum, or than they are today. It appears that temperature decreases during Neoglacial events may have been a response to several factors, including upper atmosphere volcanic emissions content, an increase in cloud cover associated with precipitation, and increased albedo from expanding glaciers, rather than a variable to be considered as a cause of neoglaciation. Lower temperatures themselves observed during glaciation are not likely to have been the initiating factors for ice buildup.

Eighteenth and nineteenth century comments about climate, and in particular precipitation and temperature in Prince William Sound, corroborate for the northern Gulf of Alaska the records that were kept in other parts of the northern hemisphere during the Little Ice Age. Russian historian Tikhmenev (1978:417) noted:

> The shores of Chugach Bay present a cheerless picture. They and the high snow-capped mountains hovering above the shore are enveloped by eternal fog accompanied by a continuous sleet or drizzling rain. The ice in the ravines and crevices in the mountains never melts. There is bad weather here at least three quarters of the year. The thermometer does not rise above 12 [degrees C].

Ethnographic accounts indicate that the native inhabitants also found Prince William Sound's weather forbidding. "That the storms, wind, and rain were felt as hardships by the natives, in spite of their waterproof gut skin clothing and seaworthy skin boats, is shown by the number of magic rites and spells which they practiced in order to bring good weather" (de Laguna 1956:8).

The present-day climate in the Prince William Sound region is still generally cool, with July temperatures averaging 11.8 degrees C at Cordova and 11.6 degrees C at Valdez. The average temperature in January for these stations is -4.9 degrees C and -7.7 degrees C, respectively. Annual precipitation averages 158 cm at Valdez and 206 cm at Cordova (Heusser 1983:340). Precipitation is especially heavy during the winter due to the tendency of storms to stagnate over the Gulf of Alaska (Heusser 1983:340). Storms are less frequent during the summer, with June being the driest month. Late summer to early autumn is the wettest time of the year. A considerable amount of precipitation falls in the form of snow, which remains on the ground at sea level on average between October and April (Birket-Smith 1953:15).

Soils

Four of the original 10 Soil Orders have been identified in Prince William Sound: Inceptisols, Spodosols, Entisols, and Histosols (Rieger *et al.* 1979; Heucker *et al.* 1984). All these soils tend to be acidic, especially if they are covered by spruce forest. Andic qualities, or characteristics resulting from the presence of volcanic ash, are not currently recognized for any of these soils, which were identified prior to the inclusion of the Andisol Order in the U.S. Soil Taxonomy system. While there are no volcanos in Prince William Sound, they are present to the west, along the west side of Cook Inlet and on the Alaska Peninsula, and to the east in the Wrangell-St. Elias mountains and British Columbia. Recent palaeoseismic work revealed evidence in the sound of Holocene volcanic tephras, or thin layers of airborne volcanic ash discernible in the soil (Wilbur *et al.* 1991). Additional studies indicate that these tephras are from volcanic eruptions that occurred on at least four different occasions between about 5600 BP and the present. Likely sources for these tephras are Augustine Volcano in Cook Inlet, and Wrangell Volcano (Beget personal communication, 1996).

Vegetation

Vegetational changes in Southern Alaska correspond generally to climatic fluctuations during the Holocene. A pollen core from Hidden Lake, a moraine-dammed lake on the Kenai Peninsula, indicates that the pioneer vegetation on the Kenai Peninsula following deglaciation about 14,000 BP was actually a discontinuous mosaic of tundra communities, made up mostly of herbs, but also including a few shrubs and ferns. The earliest pollen records on both Kodiak and the lower Copper River, also from about 14,000 BP, record the presence of sedge tundra (Heusser *et al.* 1985:153). Dwarf birch shrub tundra began to develop by about 13,700 BP, indicating moister, warmer summers, and possibly deeper winter snows (Ager 1983:133, 139). At about 10,300 BP the vegetation on the Kenai Peninsula changed to willow-poplar scrub forest mixed with shrub tundra. Alder pollen increased dramatically in the record by about 9,000 BP. Between 10,000 and 9,000 BP, pioneer communities of moist sedge tundra moved in to recently deglaciated land in Prince William Sound, but were quickly followed by alder, which became the dominant vegetation. Spruce (*Picea glauca* and possibly *P. mariana)* invaded the Kenai Peninsula by about 8,000 BP, apparently by way of the interior rather than the coast. Along the eastern gulf border, vegetation development during the Hypsithermal followed a pattern of sedge-heath tundra to about 10,000 BP, followed by shrub tundra with invading alder, and culminating in alder fen by about 7,500 BP during a period of warmer and drier climate with more periods of sunshine than at present.

A wetter and cloudier climate in the northern Gulf of Alaska after 7,500 BP is indicated by the accumulation of sedge peat. Pollen records indicate that Sitka spruce also began to colonize the mountainous eastern gulf area at this time, although shrub tundra was probably still the dominant vegetation. This change to a cooler, moister climate roughly corresponds to the end of the Hypsithermal, and appears to indicate cooling with increased moisture. It is corroborated by sedimentation records spanning the past 7,800 years from a muskeg deposit on Baranof Island in southeast Alaska. While no distinct boundary is evident between the Hypsithermal and post-Hypsithermal time period from this area, pollen sequences indicate increased moisture availability and a probable closure of the forest canopy.

In the centuries following 3,800 BP, huge amounts of sedge peat were deposited, and western and mountain hemlock moved north along the coast. Decrease of alder and growth of sedge tundra in the northwestern sound at about 3,000 BP are believed to indicate that temperatures decreased and precipitation increased during the first Neoglacial episode (Holloway 1984:241). Sequences from the vicinity of Golden, in northwest Prince William Sound, show that from about 2,680 to 2,000 BP pollen from Western Hemlock and Sitka Spruce began to increase, along with an increase of Sphagnum species, signaling the end of the first neoglacial event (Heusser 1983:343-345). Conifer increase along the Gulf of Alaska coast in general seems to have been associated with storms moving northwestward into the sound area, bringing with them seeds from forest centers in southeast Alaska (Heusser 1983:351).

Today mature relatively open forests of Sitka spruce (*Picea sitchensis*) and mountain hemlock (*Tsuga mertensiana*), with some western hemlock (*T. heterophylla*) and Alaska yellow cedar (*Chamaecyparis nootkatensis*) are common in Prince William Sound, with the forest floor supporting a varied community of tall shrubs, herbs and mosses (Heusser 1983:338-339). Alder (*Alnus crispa*) can be found on the slopes of the inner fjords, growing in thickets that contain many of the shrubs found in the forest. Along the outer fjords and on the islands, stands of forest are interspersed with coastal tundra. Sedge tundra covers areas of poor drainage and grades into heath tundra on relatively drier ground and rock outcrops. Meadows are found on open slopes and alpine tundra occurs on slopes, ridges and summits above the tree line (Heusser 1983:339-340).

The slopes of the sound's inner fjords are almost entirely covered with alder thickets. These thickets also contain many of the shrubs found in the forest. Along the outer fjords and on the islands, stands of forest are interspersed with coastal tundra. Sedge tundra is found in poorly drained areas and grades into heath tundra on relatively drier ground and rock outcrops. Meadows cover open slopes, and alpine tundra occurs on slopes, ridges, and summits above the tree line (Heusser 1983:339-340).

Alpine communities are found between the tree line and snowfields. Drier slopes are generally covered with arctic willow, arctic wormwood, and low forms of grasses and sedges, interspersed with areas of moss pin, diapensia, and lichens. Alpine meadows, consisting of a lush growth of grasses and sedges, exist on well-drained soils watered by snowdrifts and glaciers (Alaska Planning Group 1975:75).

Fauna

The coastal environment is at the juncture of two major ecosystems–marine and terrestrial–each encompassing a wide variety of resources (Tables 1 and 2). These resources appear to have been consistently, if somewhat unevenly, available to the inhabitants of the sound for at least the past 4000 years, with the possible exception of the three neoglacial advances. During periods of glacial advance, ice covered many of the areas currently open for habitation, and sedge tundra predominated in the sound (Heusser 1983:343,347). Many resources used in the past four millennia are only seasonally available, such as anadromous fish, cetaceans, fur seal, hibernating terrestrial mammals, and migratory birds. Harbor seal, sea otter and a few sea lions are available year round, along with intertidal species and a few avians.

Climate and habitat are major variables in the availability of various resources, and often are perceived as changing slowly. However, sudden events such as earthquakes, tsunamis, and volcanic ashfalls, and changes in weather patterns can occasionally affect the presence, absence or population sizes of certain species. For example, coastal subsidence and emergence associated with the major earthquakes that have occurred approximately every 650 to 850 years in Prince William Sound (Plafker 1969), have undoubtedly affected shellfish populations, which are particularly sensitive to co-seismic turbidity and changes in water depth. Pacific littleneck clams reestablish beds within 10 years of such an event, but other species, such as smooth Washington clams, may take 20 years or more to regain a harvestable population (Paul and Feder 1976:17,21). In addition, changes in ocean depth can affect the availability of kelp beds, which are feeding areas for sea otters, and intertidal marshlands, which provide resources for migratory and resident birds. Changes in shorelines can affect haul-out areas for seals and sea lions.

Today, terrestrial mammals are relatively abundant on the mainland and islands of Prince William Sound and the outer Kenai coast. The species present, including mountain goat, bears, wolf, fox, wolverine, mink, weasel, marten, porcupine, marmot, beaver, squirrel, muskrat, and land otter, are typical of coastal western hemlock-Sitka spruce-mountain hemlock and Alpine tundra ecosystems. Among the marine mammals found in the region are sea otters, harbor seal, sea lions, and a variety of cetaceans (National Park Service 1988:33; Yarborough and

Table 1. Animal Resources commonly available in Prince William Sound.

Mammals

Terrestrial ecosystems: coastal western hemlock/Sitka spruce/ mountain hemlock, and Alpine tundra		Marine Ecosystems	
black bear	brown bear	sea otters	harbor seals
wolf	fox	sea lions	fur seals
wolverine	mountain goat	harbor and Dall porpoises	
mink	weasel	baleen and toothed whales	
marten	porcupine		
marmot	beaver		
squirrel	muskrat		
land otter			

Birds

Year round		Summer Residents		Winter Residents	
petrels	gulls	cormorants	auklets	grebes	puffins
grouse	ptarmigan	great blue herons	murrelets	murres	kittiwakes
bald eagle	gray jay	terns	geese	yellow-throated loons	
		swans	hawks		
		hummingbirds	plovers		
		snipes	songbird species		
		diving and surface-feeding ducks (scaups, shovelers and teals)[1]			

Fish

Anadromous		Marine		Freshwater	
herring	eulachon	halibut	flounder	trout	Dolly Varden.
salmon: king, red (sockeye), silver (coho), pink (humpback), dog (chum)		sole	snapper		
		sharks	greenling		
		sculpin	cod species		

Invertebrates

Intertidal Zone		Seasonally Intertidal		Deeper water	
Venus clams	cockles	whelks	tritons	Shrimp	crabs
mussels	limpets,			octopi	scaphopods
chitons	sea urchins			top shells	wentletraps
sea slugs	starfish				
sea cucumbers					

[1]Diving ducks such as scoters, eiders, buffleheads, old squaws and goldeneyes, and surface-feeding ducks such as widgeons, pintails and mallards may also spend the winter in the sound.

(Birket-Smith 1953; de Laguna 1956; and Dennis McAllister personal communication 1990)

Table 2. Plant Resources commonly available in south central Alaska.

Trees/Shrubs Without Berry-like Fruit	Plants With Berry-Like Fruit	Wild Vegetables	Medicinal Plants
White Spruce (*Picea glauca*)	Early Blueberry (*Vaccinium ovalifolium*)	Cow Parsnip (*Heracleum lanatum*)	Pineapple Weed (*Matricaria matricariodes*)
Black Spruce (*Picea mariana*)	Alpine Blueberry (*V. uliginosum spp. alpinum*)	Stinging Nettle (*Urtica lyallii*)	Common Wormwood (*Artimisia tilesii*)
Sitka Spruce (*Picea sitchensis*)	Bog Blueberry (*V. uliginosum* spp. *uliginosum*)	Beach Lovage (*Ligusticum scoticum*)	Northern Yarrow (*Achillea borealis*)
Kenai Birch (*Betula kenaica*)	Low Bush Cranberry (*V. vitis-idaea*)	Rice Lily (*Fritillaria camschatcensis*)	Hudson Bay Tea (*Ledum palustre*)
Balsam Cottonwood (*Populus balsamifera*)	Blackberry (*Empetrum nigrum*)	Sour Dock (*Rumex fenestratus* and *R. arcticus*)	
Mountain Alder (*Alnus crispa*)	High Bush Cranberry (*Viburnum edule*)	Wild Chive (*Allium schoenoprasum*)	
Willow (*Salix* spp.)	Cloudberry (*Rubus chamaemorus*)	Fireweed (*Epilobium angustifolium*)	
Yellow Cedar (*Chamaecyparis nootkatensis*)	Wild Raspberry (*R. idaeus*)	Spreading Wood Fern (*Dryopteris dilatata*)	
Western Red Cedar (*Thuja plicata*)	Trailing Raspberry (*R. pedatus*)	Lady Fern (*Athyrium filix-femina*)	
	Nagoonberry (*R. arcticus*)	Beach Pea (*Lathyrus maritiums*)	
	Northern Red Currant (*Ribes triste*)	Goosetongue (*Plantago maritima*)	
	Trailing Black Currant (*R. laxiflorum*)		
	Prickly Rose (*Rosa acicularis*)		
	Nootka Rose (*Rosa nutkana*)		
	Twisted Stalk (*Streptopus amplexifolius*)		
	Mountain Ash (*Sorbus* spp.)		
	Pacific Red Elder (*Sambucus racemosa*)		
	Devil's Club (*Oplopanax horridus*)		

Miscellaneous Other Plant Resources

Grasses (*Gramineae* sp.)
Lyme Grass (*Elymus arenarius*)
Club moss (*Lycopodium* spp.)
Other Mosses
Bull kelp (*Nereocystis leutkeana*)
Other Seaweeds
Artist's Fungus (*Ganoderma applanatum*)
Ganoderma and *Fomes* spp. fungi
Mushrooms (includes *Lactarius deliciosus*)

From Russell 1991

Yarborough 1991). Fur seals, occasional visitors to the area, may have been more plentiful prior to overhunting in the nineteenth and early twentieth centuries (Dennis McAllister, personal communication 1990).

Only a few species of birds are found year round in the project area. However, their numbers are augmented by the many migratory species which either summer or winter along the coast. In addition, close to 300 species have been recorded in the Pacific coastal flyway near the Copper River, many of which continue on through Prince William Sound en route to their nesting areas or wintering grounds (Isleib and Kessel 1992)

All five salmon species spawn in the streams or marshes of the sound. Runs of king, red, and silver salmon are small, although pink and chum salmon are common during the spawning season (Yarborough and Yarborough 1996). Other anadromous fish in the sound and its fresh water streams include trout and Dolly Varden. Herring are also seasonally available. Both bottom and mid-water fish are plentiful.

A wide variety of shellfish and invertebrates are found in the area, both in the intertidal zone and deeper water (National Park Service 1988:34; Yarborough and Yarborough 1996). Some, such as various clams, are present at relatively stable locations year-round, while others, such as whelks, tritons, crabs and shrimp, migrate seasonally between deeper and shallower water.

CHAPTER 3: CULTURAL AND HISTORICAL BACKGROUND

Ethnography

Coastal southcentral Alaska, an area encompassing the coast of the Alaska Peninsula, southern Cook Inlet, Kodiak Island, and Prince William Sound has been home since late prehistoric times to a group of people known culturally and linguistically as southern Yupik Eskimos. During the short course of written history in Alaska, they have been called Suqpiaq, Koniag and Chugach, Aleut, and most recently, Alutiiq. Historically, Prince William Sound and the adjacent islands were occupied by eight geographic groups of Chugach Eskimo (de Laguna 1956:27). The coast between the sound and Cook Inlet was inhabited by the Unegkurmiut, a mostly undocumented people who may have been a subgroup of the Chugach (Clark 1984b:199). They were certainly more closely tied to the Chugach, through dialect, social visits, and intermarriage, than to the Koniag of Kodiak Island (de Laguna 1956:34-35). At the time of contact with Europeans the Chugach may have constituted a stratified complex hunter-gatherer society. However, with acculturation and European domination, their subsistence and cultural orientation has shifted to what might be referred to as a more egalitarian "commercial" (Hayden 1981:346) hunter-gatherer focus.

The protohistoric Chugach lived on the periphery of two cultural areas. They represented the farthest southeast extension of Yupik Eskimos. However, their immediate neighbors were Athapaskans: the Tanaina, Eyak, Tlingit and Ahtena. Their geographic location put the Chugach in a pivotal position, receiving and sometimes passing on influences from both Athapaskans and Eskimos (M. Yarborough 1991). The many basic cultural traits shared by the people of Prince William Sound and other groups around the Gulf of Alaska are reflected in W. Workman's (1980:80) inclusion of the sound in his North Pacific Maritime co-tradition, and de Laguna's assertion that we are "dealing with a North Pacific province where the cultural lines...are much less sharply drawn than are the linguistic boundaries" (de Laguna *et al.* 1964:209).

The Eyak Indians were the only Athapaskans living slightly within Prince William Sound around the time of European contact. During the eighteenth century, they occupied the area between the Chugach of Prince William Sound and the Tlingit of Dry Bay. Their original homeland stretched from just east of Yakutat to Cape Suckling, and probably included the shores of Controller Bay. The Chugach, however, controlled the offshore islands.

There were four territorial groups of Eyak. The "Eyak proper" have occupied former Chugach territory in the Cordova-Copper River region since the early 1800s. Those Eyak living around Controller Bay, sometimes called the Chilkats, "...were becoming Tlingitized by 1850." The Yakatagas, Eyak who lived on the gulf coast between Capes Suckling and Yakataga, were also adopting the Tlingit language and culture in the mid 1800s. The fourth group of Eyak lived along the shores of Yakutat Bay (de Laguna 1990:189).

Archaeological Record

Research History

Frederica de Laguna (1956) conducted the first regional survey of Prince William Sound in the early 1930s. Other early work in the sound has included collections from burial caves by Jacobsen in the late nineteenth and Meany in the early twentieth centuries (de Laguna 1956:90-91). It was not until the 1970s and 1980s that this early work was augmented through limited survey and testing of sites by U.S. Forest Service archaeologists, identification and recording of sites by Bureau of Indian Affairs archaeologists, site inventory by Chugach Alaska Corporation, locational survey by the Exxon Cultural Resource Program (Haggarty *et al.* 1991), and several contract surveys (Jensen, 1990; Lobdell 1976; M. Yarborough 1992). In 1991, personnel from both the State University of New York (SUNY) at Binghamton and the Alaska Office of History and Archaeology (OHA) conducted independent field studies to assess the effects of oil contamination on selected sites along the northern Gulf of Alaska coast (Dekin *et al.* 1993; Reger *et al.* 1992). Six of the sites surveyed and tested by the SUNY Binghamton and OHA archaeologists were in the sound. In 1993, the Forest Service conducted test excavations at a rock shelter site on Eleanor Island. A request from Chugach Alaska Corporation that burials of repatriated human remains be accomplished within the site boundaries of five rock shelters and one open air site resulted in minor excavations at those sites in 1994 and 1996. A survey in 1994 by a Chugach National Forest crew to inventory cultural resources along the northern mainland coast between Long Bay and Unakwik Bay in northern Prince William Sound resulted in the location of several previously unknown sites. Two open air sites have been the subjects of extensive archaeological study: Palugvik, a site in the southeast part of the sound, partially excavated in 1933 and tested in 1996, and Uqciuvit, in the northwest part of sound, tested in 1988 (de Laguna 1956; Yarborough and Yarborough 1996; L. Yarborough 1996).

Prehistory of Prince William Sound

The cultural chronology in Prince William Sound is known primarily from the excavations at Palugvik and Uqciuvit. The earliest known occupation of the sound, termed the Uqciuvit phase, is dated to between about 4400 and 3300 years ago. Very little is known about the people of this pre-Neoglacial phase, except that they hunted sea mammals, used red ocher, and were familiar with slate grinding. They lived during a time of cool, moist, and sometimes severe weather (Heusser 1960), in a landscape that was dominated by sedge tundra (Heusser 1983:343, 347).

At least portions of the sound appear to have been abandoned during the Neoglacial interval. At Uqciuvit, there is a gap in the occupational sequence that corresponds almost exactly with the age –3200 to 2500 BP –of the first Neoglacial advance in northwestern Prince William Sound. Palugvik was apparently first occupied and Uqciuvit was reoccupied approximately 2250 to 2350 years ago by people of the Palugvik phase. This phase spans the period from about 400 BC to roughly AD 1100. De Laguna (1956) proposed that the prehistoric cultures of Prince William Sound should be divided into older (Palugvik 1-2) and younger (Palugvik 3-4) prehistoric stages, beginning about 2250 BP. Data from Uqciuvit suggest that these stages represent a phase, which should be divided into early and late periods corresponding to de Laguna's older and younger stages, spanning the period from about 400 BC to roughly AD 1100 (Yarborough and Yarborough 1996). The change from the early to late periods, reflected in the presence or absence of a few artifact types, shifts in the popularity of certain forms, and relative abundance of fire-cracked rock, occurred sometime after the middle of the first millennium AD.

The Chugach phase, as defined by data from Uqciuvit, encompasses the late prehistoric, protohistoric, and possibly early historic times. While this phase exhibits some technological continuity with what de Laguna called late Palugvik, certain tools–the slate end blade, quartz crystal graver, and native copper bipoint–are added to the assemblage. The Chugach phase is virtually lacking in slate "awls" (Yarborough and Yarborough 1996).The late prehistoric, protohistoric, and possibly early historic occupations of the sound belong to the Chugach phase.

Because de Laguna's (1956:275) early work lacked definitive evidence of continuous occupation from prehistoric to historic times, the question of the origins of the protohistoric Chugach was only answered relatively recently. Analysis of recently gathered data from Uqciuvit and Palugvik indicates that the early historic Chugach are most likely the direct descendants of Palugvik phase people who appeared in Prince William Sound at least 2400 years ago.

The Chugach, however, are both physically and linguistically related to the Koniag of Kodiak Island (Clark 1974a:172, 177).There are also close archeological ties between the late Palugvik phase and northern, nonceramic Koniag assemblages, although this is not to suggest that one was derived from the other.

Archeologically, although the Palugvik phase is related to the Kachemak tradition, Clark (1984a:140) is probably justified in excluding Prince William Sound from the tradition proper. The pervasive similarities both in stylistic details and more general cultural trends, and "the broad underlying interconnectedness that most of us sense in the Kachemak tradition...over a span of more than 1000 years" (W. Workman 1988:14) apparently did not exist between Prince William Sound and either Kachemak Bay or Kodiak. Instead, Prince William Sound seems to have been along the northeastern edge of a Kachemak cultural continuum that began on Kodiak Island. Similarities between the Chugach and Koniag are probably best explained by both diffusion and common ancestry.

Prehistoric Settlement patterns

Frederica de Laguna's (1956) early survey provided the first view of possible settlement patterns in Prince William Sound. The majority of the sites which she identified were thought to be from later prehistoric times, but excavations at Uqciuvit have shown that some of these sites may have unrecognized early components (Yarborough and Yarborough 1996). The Exxon Cultural Resource Program was basically an archaeological survey of the central and southwestern portion of the sound affected by the 1989 *Exxon Valdez* oil spill. During the course of this work, program archaeologists also located some sites with Uqciuvit phase components, and provided insight into the complicated nature of Prince William Sound settlement patterns, which have been affected by isostatic rebound, and tectonic subsidence and uplift (Haggarty *et al.* 1991). The majority of the known sites are coastal in nature, and in fairly sheltered locations. The lack of testing at most sites in the sound generally precludes statements about their seasonality or use.

Maritime/Terrestrial Adaptations: Resource Use

Although Prince William Sound has been occupied for at least 3800 years, subsistence information in the form of faunal collections from the only two excavated sites in the sound is limited due to sampling techniques and poor preservation. While the Uqciuvit phase extends from approximately 3800 to 3200 BP, only a few bird and mammal remains have been recovered from this time period (Yarborough and Yarborough in press). These, and a meagre artifact assemblage of a ground blade fragment, a few bits of ground slate, and some debitage, allow little more than the inference that inhabitants of the sound were probably marine oriented. During subsequent cultural periods, evidence of a definite marine subsistence orientation is present at both Uqciuvit and Palugvik. This subsistence pattern continued into the historic period. While information is available for the early (2530-1500 BP) and late (1500-900 BP) Palugvik phases, the most complete data are from the Chugach (900-250 BP) phase component at Uqciuvit, a village site in the Kangirtlurmiut area of the northwestern sound (de Laguna 1956, Yarborough and Yarborough 1996). Sea mammal bones are most abundant in the collection (79%) followed by fish (11%), terrestrial mammal (8%) and bird (2%) (figures computed from Yarborough and Yarborough 1996:tables 3-6). The sea mammal species represented include seals and sea lions (92%), porpoise (2%), cetacea sp. (whale and porpoise sp., 2 %).

It is possible that whales and fish are underrepresented by these data, and shellfish are over-represented. One whale provides much more food than one seal, yet because of the difficulty of dealing with prey of such large size, the carcass is not likely to be brought into the village, and few, if any, bones may find their way into refuse heaps. Conversely, when shells recovered are included with vertebrate fauna, their individual element numbers appear to be disproportionately large. However, when the amount of food represented by those shells is taken into consideration, the relatively smaller part which they probably played in the diet becomes more apparent. The possible underrepresentation of fish at larger village sites might be related to the use of temporary summer fish camps. People are reported to have traveled to camps where fish was harvested, split, and dried (Birket-Smith 1953:24). The splitting process involved removal of the vertebrae and head, which were thrown back into the water, or into a refuse heap. Consequently, although dried fish were brought back to the winter habitation, it is likely that few bones came with the finished product, to be subsequently discarded in more permanently occupied village sites.

Historically, Captains James Cook (Beaglehole 1967), Nathaniel Portlock (1789), and John Meares (1790), and naval Lieutenant Gavriil Davydov (1977:321) recorded that fish were the basic food source for the northern Pacific coast inhabitants. This has been dismissed by Hassen (1978:74) as a seasonal observation, as Cook and Portlock visited Prince William Sound in the summer. However, Meares wintered over in the sound in 1788-1789, observing the Chugach to some extent throughout the year, and Davydov spent the winter of 1802-1803 in Kodiak. Davydov (1977:232) reported that cod and halibut were the most important salt-water fish, but that these were not preserved in any way, being merely a "temporary source of food until the reappearance of the salmon." In addition, fish roe attached to kelp were considered a delicacy "of which they gather and eat great quantities" (Portlock 1789:239). Salmon heads were used as bait for snaring eagles (Birket-Smith 1953:39).

Davydov (1977:208-227) also reported Chugach sealing techniques, and noted their taking of black bear, lynx, sea otter, swans, and geese. He observed that the Koniag obtained sheep horn from the Chugach (Davydov 1977:213). Cook (Beaglehole 1967:344-346), 14 years earlier, noticed the use of seal for clothing, while Carl Merck (1980:111, 122), in 1790 mentioned the use of marmot and caribou for clothing by the Chugach. Although neither Cook nor Merck specify the use of these animals for food, it is likely that the meat of these species was eaten, in addition to their skins and bones/antler being used for various implements. Seal skins were also used as bags for holding tools, cradles for infants, drum heads, and knapsacks and boat covers (Birket-Smith 1953:64). Sea lion skins were also used to make boat covers, thongs, dog harnesses, and high topped boots, while sea lion whiskers often adorned Chugach spruce root conical basketry hats (Birket-Smith 1953:47-50, 66-67, 74, 79). Porpoise tendon was valued for sewing gut articles (Stratton and Chisum 1986:46). Birket-Smith (1953:50) recorded that whale baleen was used for the runners on the bottom of wooden sleds used to haul large trees. Bearskins were used for clothing, blankets and sleeping skins (Birket-Smith 1953:65).

The only domestic animal found in prehistoric sites in the sound is a small variety of dog which was traditionally bred by the Chugach for assistance in hunting small burrowing fur-bearers such as marmot, and for pulling or packing loads (de Laguna 1956:271-273). Both dog bones and bones gnawed by dogs were found in early and late layers at Palugvik (de Laguna 1956:51-52). There is some evidence from Kodiak that the Koniag and Late Kachemak tradition people both kept dogs as pets and also included them in their diet (Clark 1974a:44).

Models of Prehistoric Cultural Ecology

Currently available faunal analyses indicate that the prehistoric inhabitants of the northern Gulf of Alaska used both terrestrial and marine resources with an emphasis on the latter. This type of subsistence pattern has been categorized as a Modified Maritime adaptation (Fitzhugh 1975:344; McCartney 1988:33). When the faunal data is combined with information about settlement patterns, it appears that at least late prehistoric and protohistoric hunter-gatherer-fishers lived predominantly at residential bases from which task groups were sent to procure resources. Other sites were occupied on an intermittent basis by particular task groups. Ethnographic and recently obtained archaeological evidence suggests that the social complexity of the Sugpiaq of Prince William Sound was similar to the rudimentary class societies recorded for the Kodiak and Aleutian archipelagos at the time of European contact.

In attempting to account for the changes seen over time in faunal assemblages of various prehistoric north Pacific cultures, researchers have formulated several models over the years. One type, termed a maritime stability model, explains subsistence change while excluding population increases or either catastrophic or gradual environmental changes as possible variables (Yesner 1992:176). Schalk's (1981) model for the distribution of complex societies, which he characterized as a result of the "distributional structure of the environment", fits this particular category. Schalk hypothesized that these societies developed due to the "clumped" nature of resources in more northern regions, rather than as a result of increasing population size or circumscription, or general regional resource availability.

Subsistence intensification models, such as that proposed by Haggarty *et al.* (1991) for the northern Gulf of Alaska are based on assumptions of continually growing populations and increasing circumscription, with progressively more stress on subsistence resources over time. A preliminary caution for the application of this model in Prince William Sound is that current knowledge of archaeological sites in the region is quite likely skewed as a result of the amount and geographic restrictions of site survey that has been accomplished to date. The model assumes that the larger number of known late prehistoric sites, in contrast to fewer known early prehistoric sites, indicates population growth, rather than the possibility of archaeological survey bias.

Neither of these models considers environmental changes in the sound which are well documented for the past 5000 years. As noted above, during the second half of the Holocene three major neoglacial advances and retreats have affected precipitation, temperature, glaciation and sea ice. Prehistoric adjustments to changing climate have been well documented for inhabitants of the Arctic Ocean and Bering Sea coasts (Ackerman 1988) and recently suggested for the inhabitants of Prince William Sound as well (Yarborough and Yarborough 1996).

Environmental change models have not yet been developed for the sound. Those which have been proposed for the north Pacific were developed for the most part with very local databases, such as Kotani's (1980) and Yesner's (1982) respective explanations for changes in molluscan fauna at the Hot Springs site on the Alaska peninsula and the Chaluka site on southwest Umnak Island. Given the magnitude of late Holocene environmental changes in the sound, however, it is likely that a more realistic picture of human interaction with subsistence resources will emerge when climate change and resource availability data are considered as variables along with the possibilities of population change and potential human pressure on resources. The object of this restoration project is not to produce a new model for the region, but it is hoped that the data presented here will prove useful towards that end.

Russian Period

While several members of Vitus Bering's expedition landed on Kayak Island in 1741, they did not directly contact the individuals whose dwellings they found. The subsequent 37 years are often referred to as the protohistoric period, when the inhabitants of the sound had indirect contact with Europeans through Native trade routes. Captain James Cook's third voyage to North America in 1778, during which he explored Prince William Sound, marks the beginning of the historic period in this area (Beaglehole 1967:1418).

During the next decade, European exploratory and trade expeditions frequently traveled to the sound. In 1779, Captains Ignacio Arteaga and Juan Francisco de la Bodega y Quadra visited Kayak Island, and Prince William Sound (La Pérouse 1968:251-254; Gormly 1977:13-14). Commanders Eustrate Delarof, Dmitri Polutof, and Potap Zaikof undertook the first Russian trading expedition to the sound in 1783 (Bancroft 1970:187-189; de Laguna 1956:64). Captain James Strange (1982:24-25) and Alexander Walker (1982) spent a few weeks in Prince William Sound during in the fall of 1786. Each left a brief, detailed account of his stay. Also in 1786, John Meares (1790), captain of the *Nootka*, sailed eastward through the Aleutian Islands and Kodiak Archipelago to Cook Inlet and Prince William Sound. He spent the winter of 1786-1787 near Montague Island. Captains Nathaniel Portlock (1789) and George Dixon (1968), sailed to Alaska in 1786, but missed the southwestern entrance into Prince William Sound and were unable to make Cape Hinchinbrook. During the summer of 1787, they returned and spent roughly three months in the vicinity of Montague and Hinchinbrook Islands. While in the sound, they visited with Meares and those of his crew who had survived the winter.

There were three voyages to Prince William Sound in the spring of 1788. Captain James Colnett spent April and early May trading in the sound accompanied by surgeon and naturalist Archibald Menzies, who later returned to Alaska with Vancouver (Olson 1993:iii-iv). In May, two vessels under the command of Estéban José Martínez and Gonzalo López anchored in a harbor on the southern end of Montague Island. During the following 11 days they explored the area by small boat and traded with the local residents (Gormly 1977:15). Also in May, Russian navigators Ismailof and Bocharov sailed to the sound from Kodiak with instructions to "explore the American coasts and to establish the empress' rule over all the newly described places" (Tikhmenev 1978:24).

Three other expeditions visited the sound before the turn of the century. In the spring of 1790, Salvador Fidalgo explored northeastern Prince William Sound, "discovering" Columbia Glacier and naming Valdez Arm (Moore 1975:1). That same year, Captain Joseph Billings sailed eastward from Okhotsk on "a secret astronomical and geographical expedition" , travelling as far east as Prince William Sound (Baker 1906:61-62). Among the crew members were Lieutenant Gavrila Sarychev (1807), secretary and translator Martin Sauer (1802), and naturalist Carl Merck (1980) who all kept journals of the expedition. The following year Alejandro Malaspina, while on a scientific expedition around the world, sailed past Kayak Island and along the outer shore of Hinchinbrook Island, but did not actually enter the sound (Gormly 1977:29-30). The third expedition was that of Captain George Vancouver and Lieutenant William Broughton, who respectively commanded the Discovery and the Chatham, and explored portions of Prince William Sound in 1794. Lieutenant James Whidbey recorded coastal details during this expedition from a smaller boat (Vancouver 1967; Orth 1967:40).

The Russian fur trading companies initially represented the economic interests of the Russian government in Alaska, subsequently solidified in the chartered monopoly of the Shelikhov-Golikhov and eventual take-over of the company by the government. In 1793 the Lebedev-Lastochkin Company attempted, but failed, to force Chugach Eskimo to hunt for them out of Fort Constantine (Bancroft 1970:190). The Shelikhov-Golikhov Company subsequently took over Fort Constantine, with greater trading success. The Chugach village of Nuchek grew up near the post fairly quickly and the post was soon moved to the village location (Ketz 1981).

Eighteenth century explorers commented on the low population of Prince William Sound in the early historic period. Meares (1790:xlvii) reported seeing only about 500-600 Natives during his winter at Snug Corner Cove, while Vancouver (1967:197) in 1794 wrote "the population of this large sound is very inconsiderable when compared with its extent..." The highest census figure given for the sound during the Russian period was 1,563 (782 males, 781 females) recorded by Wrangell in 1825. Most other census numbers and explorer's estimates are "strikingly and consistently" low, on the order of 300 to 600 despite "apparently abundant food resources" (de Laguna 1956:255-256).

Population decline in the nineteenth century in Prince William Sound was in part a result of disease. Smallpox epidemics occurred in 1808, 1818, and 1837-39, and then again in 1862 (Tikhmenev 1978:161,198, 371). Although vaccines were rushed to Alaska by ship, each outbreak of the disease had an impact on the population. Measles in 1848 and influenza and typhus in 1855 also took their toll (Tikhmenev 1978:372). Other diseases such as syphilis, colic, festering sores, cancer, eye ailments in the spring, and scurvy affected the colony's population, although Tikhmenev noted that scurvy was most prevalent among Russians new to Alaska. As the population declined during the early historic period, the inhabited settlements in the sound decreased to Tatitlek, Chenega, Nuchek and Kiniklik.

American Period

Hutchinson, Kohl and Company acquired the assets of the Russian American Company when Alaska was transferred to the United States in 1867. Reorganized one year later as the Alaska Commercial Company (ACC), the firm reopened the post at Nuchek in the early 1870s and established new stores at Chenega, Kiniklik, and Tatitlek (Ketz 1978:6; Haggarty *et al.* 1991:105). The American period fur trade reached its peak in the mid 1880s. However, because of a region-wide decline in the number of sea otters, the trade collapsed in 1898. In 1911, the federal government established a total ban on sea otter hunting (Ketz 1978:6-8).

Mining possibilities lured many Europeans and Americans to Prince William Sound in the late nineteenth century. Valdez was settled in the late 1800s by miners and people in related services. The sudden increase in inhabitants of Prince William Sound from under 300 people in

1900 to over 2,000 people in 1910 reflects the establishment of Cordova. Built in 1906 as a railroad town principally to export copper from the Wrangell Mountains, Cordova incorporated the one Eyak Indian settlement remaining at that time (Stratton 1989:15, 28) and by 1910, had a population of 1,152 (Stratton 1989:29). Chugach Eskimos attracted by employment and local services also settled in the town. Between 1900 and 1920, Ellamar, near Tatitlek, was the site of the second largest copper mine in Prince William Sound. Following the closing of the mine, the facilities were converted to a cannery which operated until 1947.

Although logging occurred prior to the twentieth century to satisfy housing and technological needs, the demands of the copper mines induced swift growh in this industry during the early 1900s. The pace of timber sales in the Chugach National Forest, which was created in 1907 (Rakestraw 1981:44), increased during World War I, such that by the 1920s, when handlogging was largely replaced by cable logging, most of the timber accessible from the shore had been cut at least once. Logs were cut for the mills by contractors, many of whom were Native (Haggarty *et al.* 1991:109-111).

The commercial fishing industry in the Gulf of Alaska grew from small salteries in the 1880s to large canneries supplied by fishtraps in the early 1900s (Haggarty *et al.* 1991:105). The fishing industry also influenced regional settlement patterns. Some villages were established near canneries almost overnight, while others were either abandoned or at least depopulated during fishing season. The mouth of the Copper River was the focus of commercial fishing in the Prince William Sound region during the late nineteenth and early twentieth centuries. Four canneries opened in the area in 1889, two on Wingham Island and two at the western end of Eyak Lake (Krauss 1982:14). Six new facilities were established between 1910 and 1920. However, after World War I, overfishing and low prices resulted in many closures, and by 1924 there were only seven canneries operating in the region (Hassen 1978:151-153)

During the late nineteenth and early 20th centuries, Chinese workers provided much of the cannery labor. After the Chinese Exclusion Act of 1904, they were replaced by Japanese, Filipinos, Mexicans, and Puerto Ricans. Although few Chugach Natives actually worked in the canneries, they did fish for the canneries, with commercial fishing providing the principal source of cash income by the 1930s. Regarding the seasonal nature of the settlements associated with fishing, Birket-Smith (1953:24) noted:

> "On May 1st, after school teaching has been discontinued, the inhabitants [of Chenega] except some of the women and children together with most of the dogs move to Port Wells where they live in (white man's) tents with wooden floors, which are left from one season to another. Here they fish salmon for the canneries until August 2d, when the season closes".

The Chugach also operated salteries, which required little capital and could be easily moved from one location to another (Hassen 1978:156)

The advent of the second World War brought numerous changes to Prince William Sound and its residents. Most notable was the building of Whittier, and the tunnel and railway linking it to Anchorage, by the U.S. military resulting in increased marine traffic through the sound to the new port. When the public was allowed ownership of portions of Whittier and access became available via the Alaska Railroad, this port became a point from which the population of Anchorage and the Kenai Peninsula could more easily reach the sound for commercial purposes and recreation.

CHAPTER 4: RESTORATION PROJECT AT SEW-440

Injury to SEW-440

The *Exxon Valdez* Oil Spill resulted in oiling of the intertidal zone of SEW-440. After assessment, the Exxon archaeology program recommendations for cleanup were to deny access to the uplands, to have no fires or equipment on the upper beach, to use no high volume/high pressure techniques, and to have an archaeologist monitor the cleanup operations (Yarborough 1989). However, these constraints were not followed during the cleanup process. Small fires were made on the south end of the beach, burning pallets brought by the cleanup crew. High pressure water hoses were used in the beach cleanup, resulting in documented beach erosion. The cleanup crew's bear patrol frequently walked up and down the face of the midden, and there was a large amount of foot traffic in the upper beach area (Phippen 1989). During a 1992 TAG visit, disturbance in the form of "a large trench shaped as an 'L' with excavated material mounded inside 'L' " (Wilkinson 1992) was noted in the intertidal zone. The hole was refilled after bioremediation treatment with Customblen. In addition, "extensive pits were dug to determine the extent and level of oiling" and then bioremediated (Madden 1992).

Field Investigations Prior to Restoration

SEW-440 was discovered by archaeologist Michael Yarborough in April 1989 following the *Exxon Valdez* Oil Spill. He noted the midden remains eroding along a 12 m portion of the edge of the pre-1964 shoreline, culturally modified trees in the vicinity, and dimensional lumber on the site surface (Yarborough 1989). No tests were made either by Yarborough or by archaeologists who subsequently visited the site in June and monitored cleanup work in August 1989 (Bowers and Gallison 1989, Phippen 1989). During a monitoring visit to the site in May 1990, 26 culturally modified trees were noted in the uplands, and several artifacts were found in the intertidal zone: a stone lamp, a greenstone adze blade, a cobble with possible flake scars from utilization and a possible boulder spall tool. The lamp was collected (Eldridge 1990). The site was sketch mapped during an archaeological visit a few days later (Ludwig and Reanier 1990). A post-cleanup assessment in September 1990 resulted in discovery of an additional stone adze in the upper intertidal zone (Bowers and Gallison 1990).

Site Description and Stratigraphy

SEW-440 is located on a small tombolo, covered with an open spruce-hemlock forest, with an understory composed of moss, grasses, ferns, willow, devil's club, blueberry, alder, and labrador tea. Skunk cabbage is growing in a moist area southwest of the site.

Prior to the 1994 restoration work, cultural material was known to be present in the vicinity of the southwest side of the tombolo. However, the extent of the site to the northwest was unknown. Prior to opening larger test squares, 33 shovel tests, each approximately 25 cm^2, were systematically excavated, beginning near the northwestern shore and on the headland northeast of the site and working towards the known part of the site. Eight shovel tests contained cultural material, and defined the site in an "L"-shape (Figure 3). Cultural deposits occur on the tombolo just below the headland between the northwest and southeast shores, with the main site area extending south along the southeast shore of the tombolo.

The stratigraphy of the 25 cm^2 tests conveyed a sense of the natural deposition in the area. A mat of mossy vegetation typified the top 7 cm across the tombolo. Outside the site, the

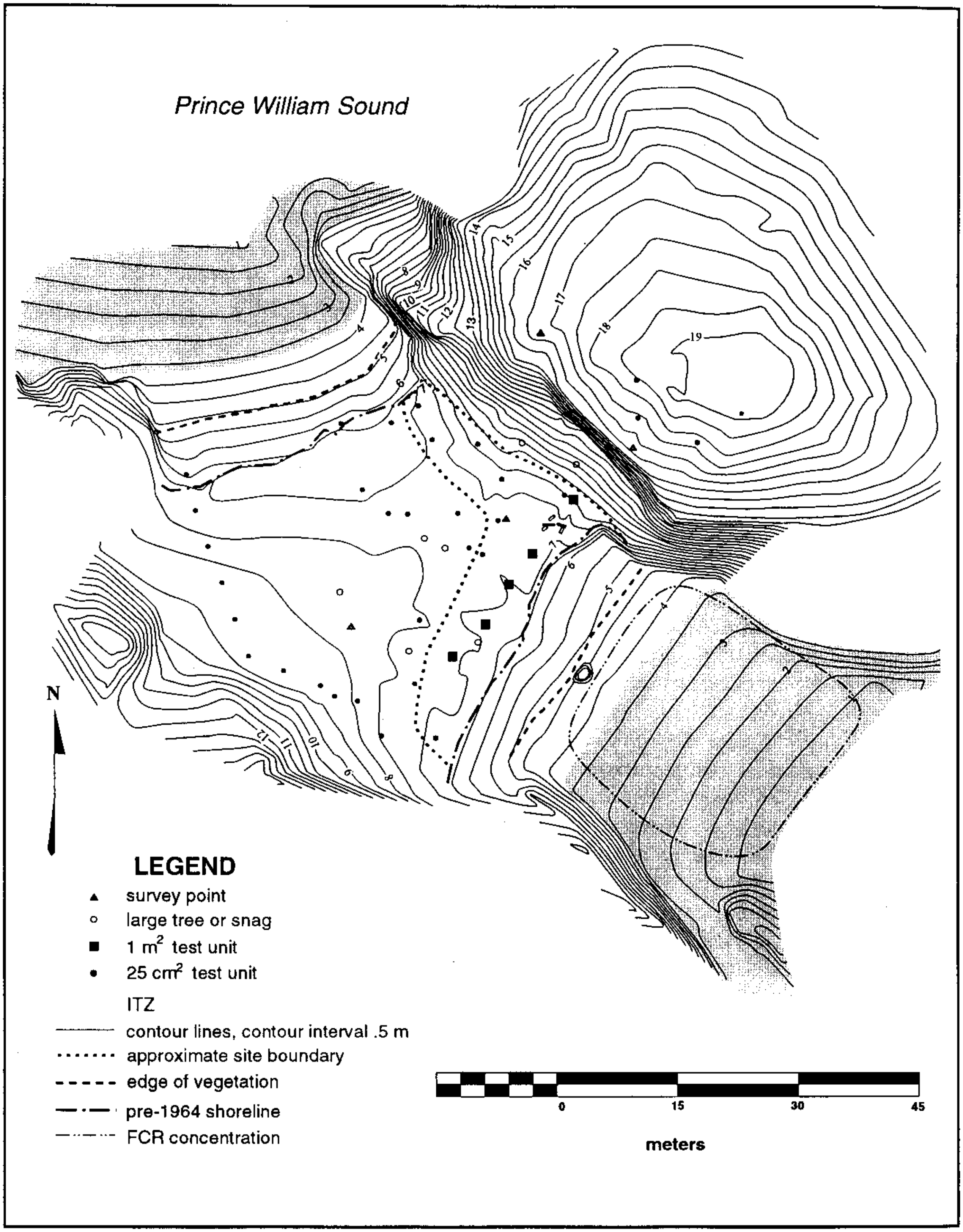


Figure 3. SEW-440.

deposits of the next 30-36 cm were generally reddish gray-brown (5YR5/3) to dark brown (10YR2/2) to black (2l5YR2/1) soil, often above very dense brown or reddish brown organic soil or peat, the latter being particularly noticeable on the southwest part of the tombolo. Near the southern edge of the site, not far from the southeastern shoreline, the dark organic soil was interrupted at depths varying from 36 to 50 cm below the surface with a layer of small cobbles or large pebbles, which appear to be beach gravels. Gravel also occurred near the northwestern shore, varying from a concentrated 30-50 cm deep deposit directly below the vegetation mat, to occurrences up to 25 cm thick within the organic deposits. Tephra was present at 22-28 cm below the surface in at least one test in the northeastern part of the area outside the site. Tests along the western edge of the site contained only a few pieces of fire-cracked rock or some charcoal.

Five 1 m^2 units were opened in the site, from just below the headland to the southern portion of the site. All backdirt was sieved through 1/8 inch mesh screens. The exposed cultural deposits ranged in depth from 60 cm to over 1 m. In four of the squares, cultural strata were sandwiched between natural deposits gravel, sand, peat, and decomposing grasses. The cultural strata were continuous in the unit N25E33, with stratigraphic changes evidenced by variations in the frequency of charcoal, gravel, and fire-cracked rock.

The strata observed represent both historic and prehistoric occupations. The main activity areas of SEW-440 are best exemplified by units N25E33, N21E30 and N16E27, while units N32E38 and N12E33, with less evidence of human activities, represent the edges of the site.

All of the units at the site were covered with a vegetation mat up to 10 cm thick. A brown deteriorating forest duff also occurred beneath the vegetation mat in all the excavation units. This varied in color from dark reddish brown (5YR2.5/2) in unit N32E38 in the northeast portion of the site to very dark brown (7.5YR2.5/2) in units N25E33 and N21E30, brown (7.5YR4/3) in unit N16E27, and dark reddish brown (5YR3/3) in unit N12E33 in the southwest portion of the site.

The strata below the forest duff in N25E33 were fairly level, and were generally characterized by the presence of charcoal, gravel, and fire-cracked rock (Figure 4). Directly below the duff was a 7-8 cm thick level of black-brown charred soil (10YR2/1) composed of large amounts of charcoal and fire-cracked rock, gravel, and some deteriorated forest organics. A sample of the charcoal yielded a radiocarbon date of 280$\pm$60 BP, calibrated to AD 1470-1680 (Beta 78756) (Table 3). The layer below had the same color (10YR2/1) and texture, but did not have as high a charcoal content. This lower layer varied from 10 to 25 cm in thickness. Yellowish areas of discolored soil were present between 40 and 50 cmbd, one of which is visible in the east and south wall profiles as a thin (up to 4 cm) lens of dark yellowish brown (10YR3/4) compressed powdery silt. Other patches of yellowish brown soil were characterized as light red (2.5YR7/6) and dark yellowish brown (10YR4/6), and lighter and drier in texture than the surrounding soil. The next distinguishable layer was also black-brown (10YR2/2), but was characterized by dense gravel, noticeably less charcoal, a smaller amount of fire-cracked rock, some mussel shell and sea mammal bone, and few artifacts. It varied in depth from about 15 cm in the north part of the square to about 10 cm in the southern part of the square, although its upper boundary was less distinct in the southern profile. Beginning at about 70 cmbd, strong brown (7.5YR4/6) soil and fibrous material were evident over much of the square, mixed with a sticky black (10YR2/1) mud and a small amount of gravel. At about 78-80 cmbd, deteriorating wood was present throughout the unit, mixed with a damp, black (10YR2/1) hard mud. A char-

Table 3 Analysis results for radiocarbon samples from 49SEW-440

49SEW440 catalog #	Beta #	unit	cmbd	conventional C14 age	calibration 2∑ 95% probability	C14/calibration curve intercept
1.c.2	78756	N25E33	21	280±60	AD 1470-1680	AD 1650
4.c.6	78760	N21E30	50-60*	380±60	AD 1425-1655	AD 1485
3.c.5	78759	N32E38	66-90†	400±50	AD 1425-1640	AD 1470
2.c.4	97208	N16E27	37	530±60	AD 1305-1460	AD 1420
1.c.6	97210	N25E33	79	990±80	AD 890-1225	AD 1025
4.c.4	97209	N21E30	58	1030±100	AD 790-1225	AD 1010
2.c.9	78758	N16E27	52	1820±60	AD 75-380	AD 225

*picked from fish bone layer
†sample from just above sloping bedrock

coal sample from 79 cmbd yielded a radiocarbon date of 990±BP, calibrated to AD 890-1225 (Beta-97210). Between 80 and 90 cmbd, the brown-black mud continued with no evidence of artifacts or fauna.

The surface of unit N21E30 sloped to the southwest, as did most of the subsurface deposits (Figure 5). An 8-10 cm, brown-black (10YR2/1), artifact bearing layer occurred beneath the forest duff. As in the second layer below the forest duff in N25E33, the texture was organic silt with a large amount of fire-cracked rock and gravel. Beneath this layer was a 2-4 cm thick, lighter color (dark brown, 7.5YR3/3), fine silty/sandy matrix which continued across much of the square. This may be a tephra, although its analysis is not yet complete. Directly below the sandy layer is a black (10YR2/1) organic layer characterized by fire-cracked rock, gravel, and a large number of fish bones. This 2-10 cm thick layer directly overlay a 4-14 cm thick layer of matted fish bone with gravel, fire-cracked rock and dense fine roots. The soil matrix of this layer was black (10YR2/1), although the lighter brown (7.5YR4/6) color of the densely matted fish bone gave the layer a reddish brown appearance. A charcoal sample taken from this layer yielded a radiocarbon date of 380±60, calibrated to AD 1425-1655 (Beta 78760). Both the layer with fish and the matted fish bone layer sloped markedly to the southwest. Below these layers was another black (10YR2/1) layer similar to the one above the matted fish bone layer, but containing more charcoal. A discontinuous lens of gravel, fish bone, mussel shell and dense rootlets bisected this 8-30 cm thick black layer in the northeastern part of the square. The next lower stratum was very dark brown in color (10YR2/2), and is best characterized as decomposed organic material with charcoal chunks and large pieces of fire-cracked rock in its upper 8 cm. Analysis of a charcoal sample from the upper part of this layer, at 58 cmbd, yielded a date of 1030±100, calibrated to AD 790-1225 (Beta-97209). These cultural materials may have been pressed down into this stratum from the layer above, as in other respects its texture was distinct, its color quickly graded to a very dark reddish gray (7.5YR2.5/1), and no additional cultural material was apparent with increasing depth. A thin tephra, varying in depth from 70 to 74 cmbd, with the appearance of a layer of sand only a few grains thick, bisected this layer. This is likely to be the same tephra found in N16E27, discussed below. Both the tephra and the upper boundary of this layer were relatively horizontal, in contrast to the upper

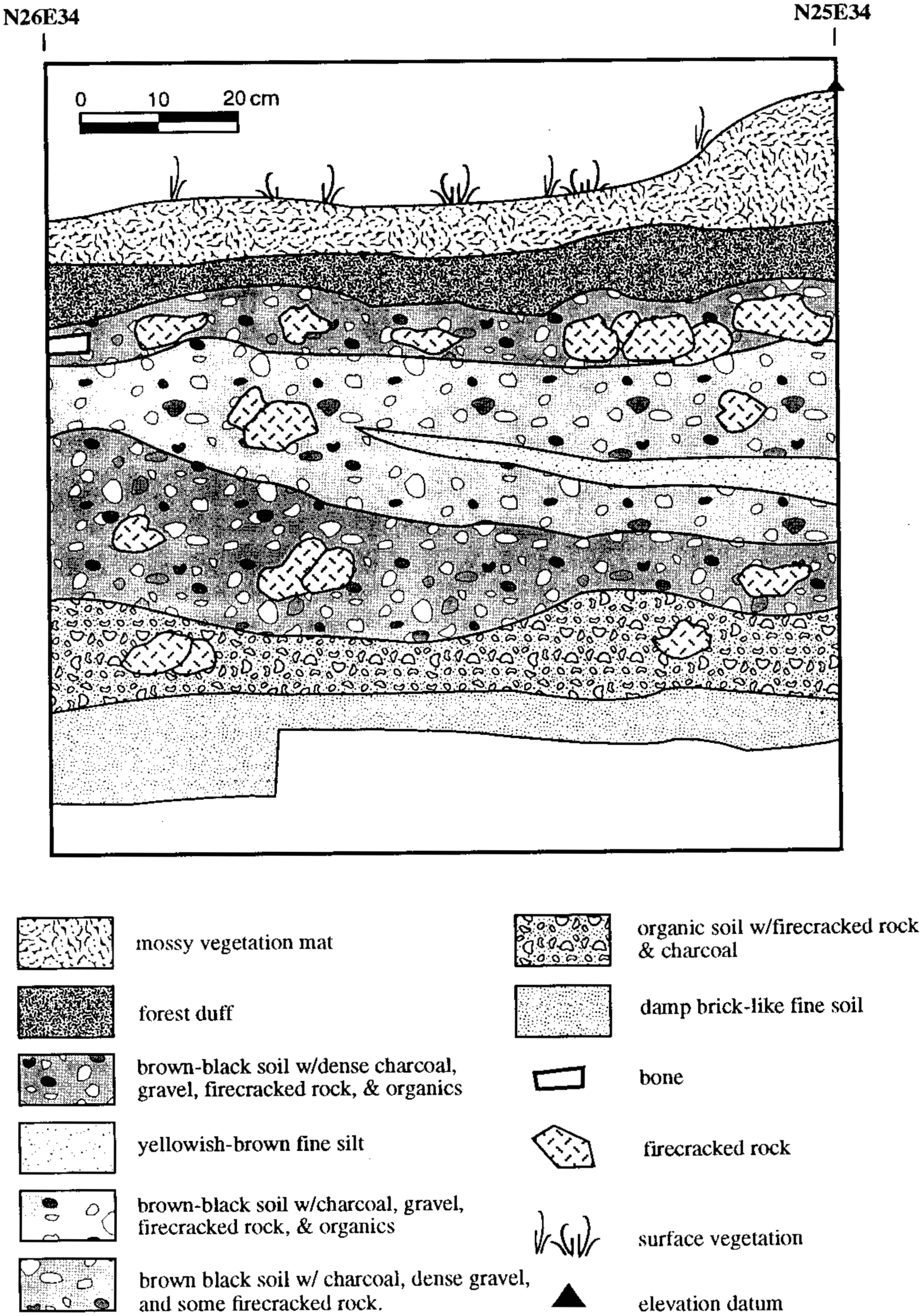


Figure 4. East wall, unit N25E33, SEW-440.

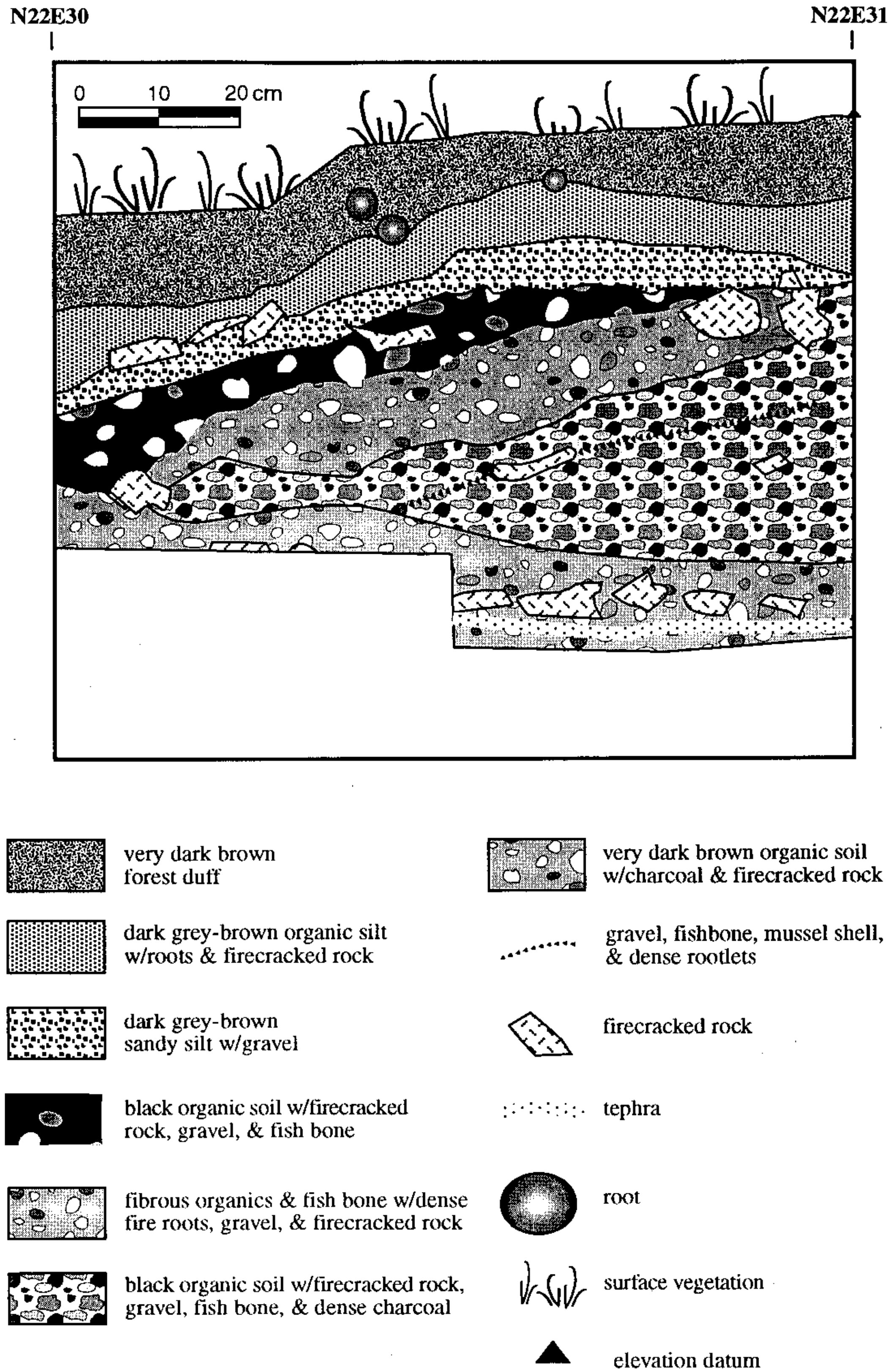


Figure 5. North wall, unit N21E30, SEW-440.

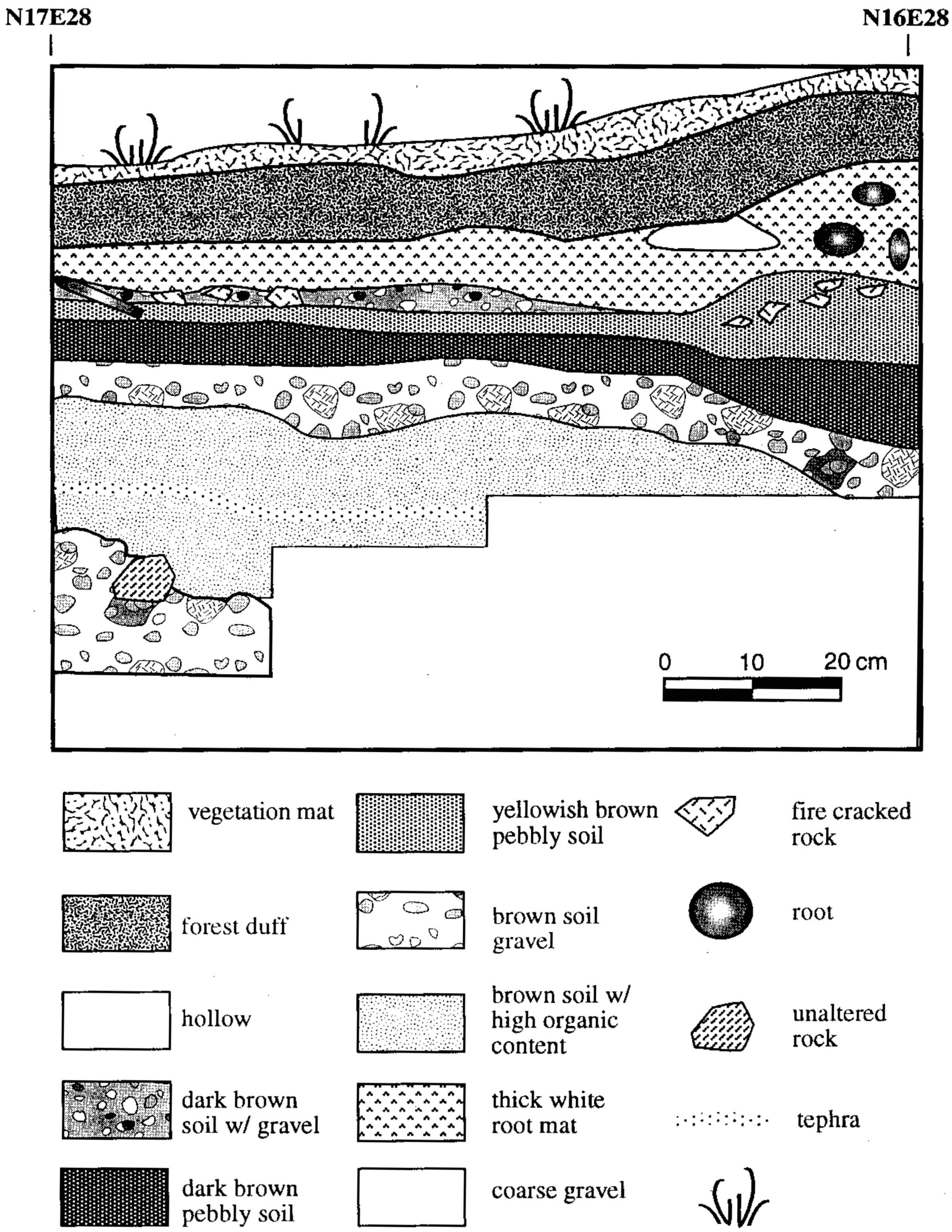


Figure 6. East wall, unit N16E27, SEW-440.

cultural strata.

The root system of a large spruce near the southeast corner of N16E27 caused the ground surface and duff layer below to slope to the north and east. It also created a boundary of hollow cavities, thick roots, and a mat of tiny white roots between the forest duff layer and the mottled dark brown-black (10YR2/1) layer below (Figure 6). This 2-4 cm thick layer, containing fire-cracked rock and charcoal, was found primarily in the northern 3/4 of the unit. Directly beneath it, and continuing across the unit, was a dark brown (7.5YR3/2), 2-7 cm thick, stratum of soil with virtually no gravel or fire-cracked rock, except in the southeast corner of the unit. Continuing down, a 2-10 cm thick dark brown-black (10YR2/2) layer was present throughout the unit. This layer was thickest in the southern part of the square, where its upper part of the stratum was slightly lighter in color (dark brown 10YR3/3), grading into the darker brown below. A radiocarbon date of 530±60 BP, calibrated to AD 1305-1460 (Beta-97208) was obtained on charcoal from this layer at a depth of 39 cmbd. This layer overlay an artifact-bearing strata of unsorted beach gravel with charcoal and fire-cracked rock. The gravels ranged in size from pea gravel to small cobbles, and in color from black-brown (10YR2/2) in the upper few centimeters of the southern portion of the deposit to dark brown (10YR3/2) throughout the rest of the unit. The date obtained from a piece of charcoal recovered from the upper darker part of the gravel layer is 1820±60 BP, calibrated to AD 75-380 (Beta-78758). Beneath the gravel was a peaty organic layer, which graded from reddish-black (2.5YR2.5/1) to dark reddish-brown (5YR3/2). This stratum was bisected at about 60 cmbd by a tephra only a few mm thick. Immediately above this tephra was a thin (1 cm) fibrous organic layer. Because of the tephra's appearance, and its presence in an apparently non-cultural layer of organic soil, it is likely that this corresponds to a layer noted at a depth of about 65 cmbd in N21E30. A second thin "sand" layer occurred about 10 cm below the identified tephra near the bottom of the organic layer in N16E27. It, too, may be a volcanic ash, however it has not yet been examined and analyzed. Beneath the organic layer is a compact layer of pea-sized gravels in a sandy matrix, which also appears to be non-cultural in nature. It sloped steeply from the east wall towards the middle of the unit.

The strata evident within N32E38 were markedly different from those of the three units described above. The surface of the unit sloped perceptibly from northeast to southwest (Figure 7). Although no radiocarbon dates are available for the upper humus layer, black-tail deer bones are present directly beneath the vegetation mat. As this species was introduced into the sound in the mid-twentieth century, the presence of these bones in this stratum indicates the historic nature of this deposit. The 5 cm thick, dark reddish brown (5YR2.5/2), humus layer beneath the vegetation mat was underlain by a humus layer characterized by dense organics which graded from dark reddish brown (5YR2.5/2) at its upper boundary to reddish black (2.5YR2.5/1) a few centimeters below. This lower humus was characterized by a large amount of fire-cracked rock, along with dense concentrations of decaying organic material, roots, rootlets, and charcoal. A thin 2-5 cm layer of dark yellowish-brown (3.10YR3/4) silt with pockets of dark grayish-brown (N2.5) powdery soil and bits of charcoal lay beneath the reddish black humus layer throughout the western part of the unit. A layer characterized by black (N2.5) sandy silt, a large amount of fire-cracked rock, charcoal and unsorted gravels was present between about 48 and 55 cmbd in the east part of the unit, and between 52 and 68 cmbd in the west. This overlay another dark reddish brown (5YR2.5/2) sandy silt with high concentrations of charcoal and less fire-cracked rock. A charcoal sample from the latter layer yielded a date of 400±BP, calibrated to AD 1425-

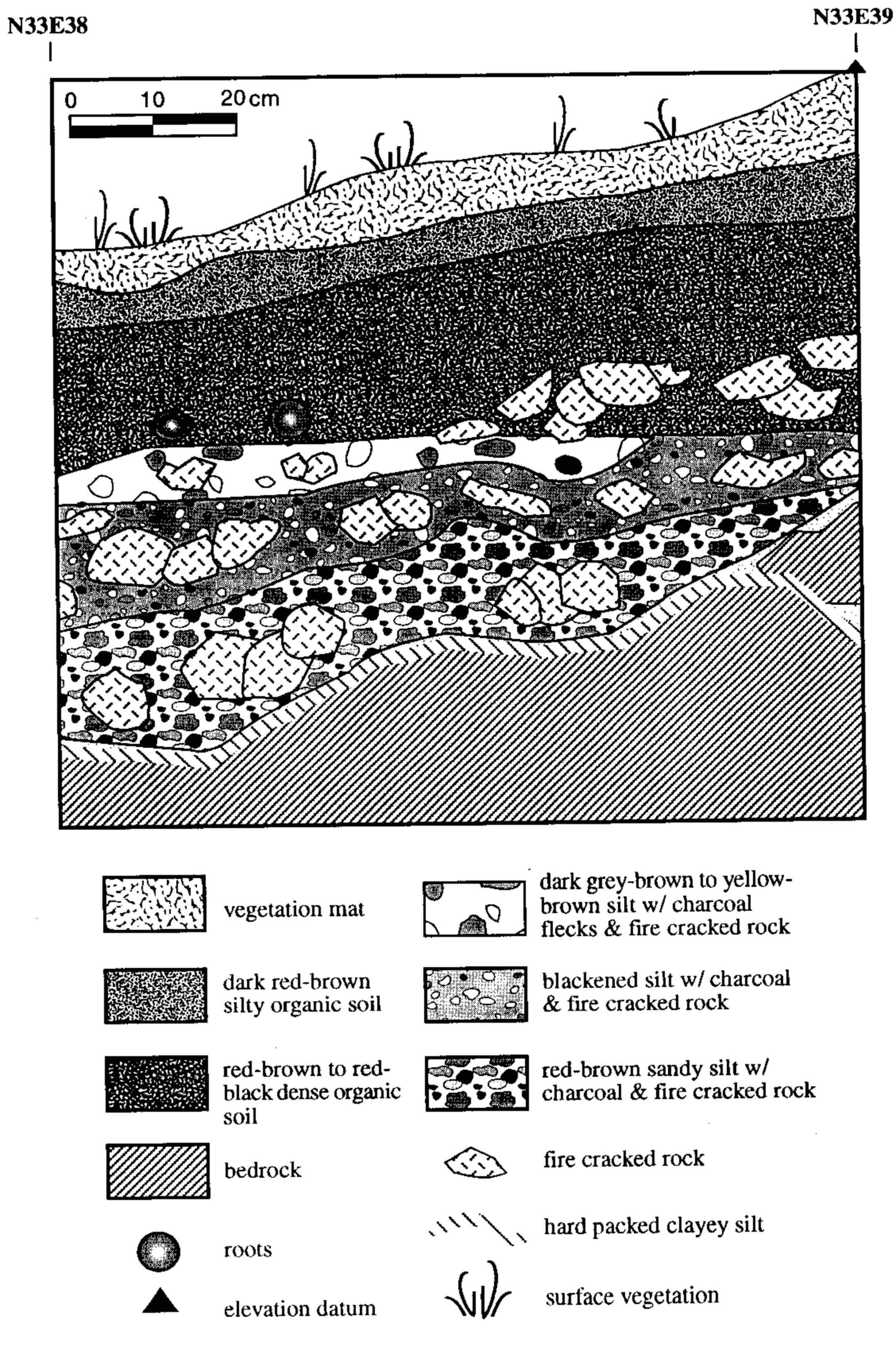


Figure 7. North wall, N32E38, SEW-440.

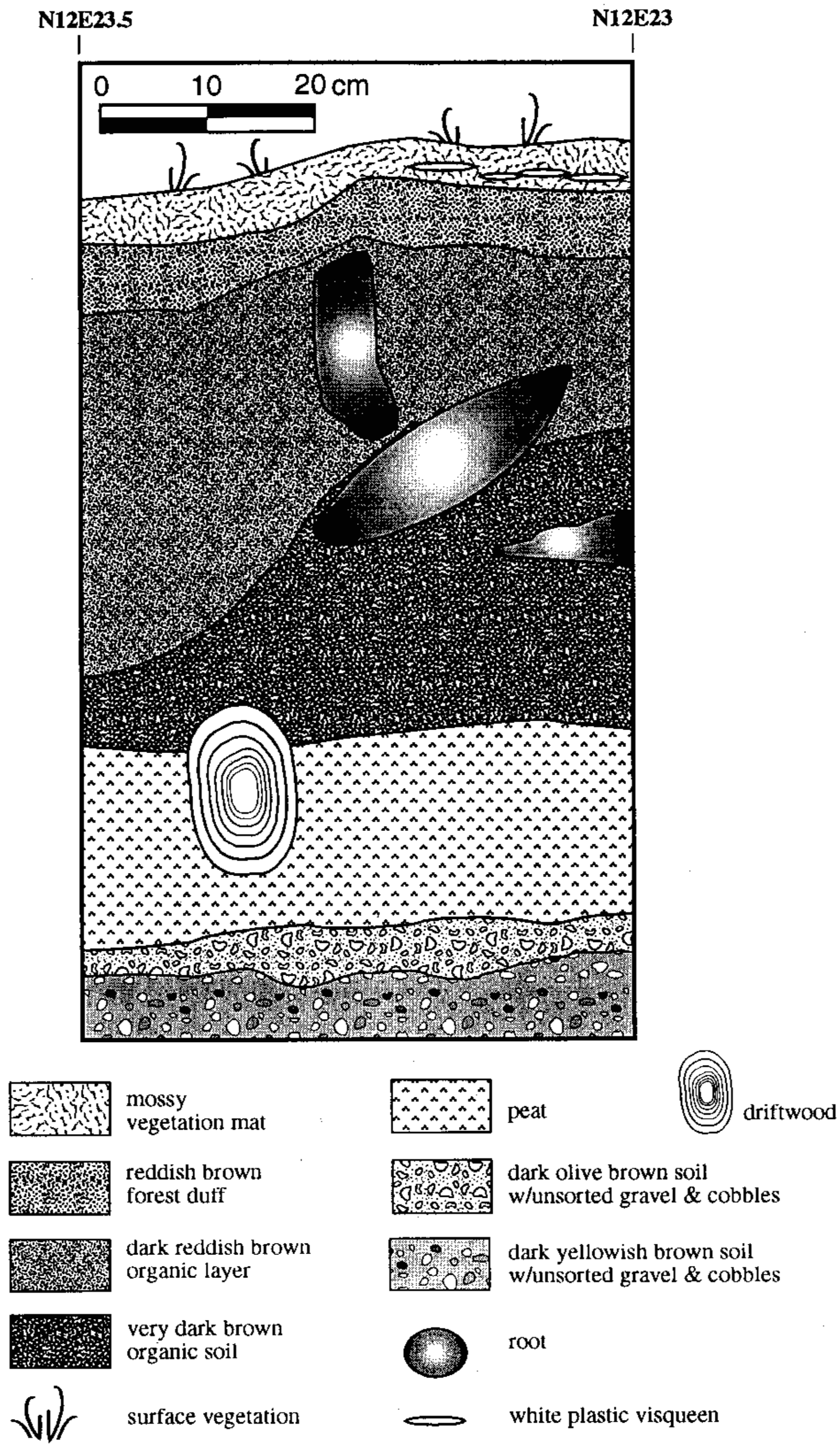


Figure 8. South wall, unit N12E23, SEW-440.

1640 (Beta 78759). This sandy silt was underlain by a 1 cm thick lens of very dark gray (5YR3/1) hard packed clayey silt directly above bedrock. Bedrock was present at about 60 cmbd in the eastern part of the square, and about 85 cmbd in the western part of the square.

The vegetation mat and underlying forest duff comprised the top 10-12 cm of unit N12E23, in the southwestern part of the site (Figure 8). Pieces of thin white plastic between the vegetation mat and the forest duff attested to the recent deposition of these layers. A 15-30 cm thick, dark reddish brown (5YR2.5/2) layer, characterized by decayed organics, underlay the forest duff. It contained a few pieces of fire-cracked rock and a few artifacts. This graded into a similar but very dark brown (7.5YR2.5/2) soil throughout the unit, which continued with some fire-cracked rock, a few pebbles, and a few artifacts to about 79 cmbd. A very thin slightly lighter soil, (dark brown 7.5YR3/3) associated with fibrous organics was present between the organic soil and the peat layer below. This may correlate to the fibrous layer associated with tephra in unit N16E27. Below the organic soil was a distinct dark brown (7.5YR3/3) peat layer almost 20 cm thick. A large piece of driftwood was present in the peat, which overlay unsorted gravel ranging in size from small pebbles to cobbles in a dark olive brown (2.5YR3/3) soil. This gravel overlay another similar unsorted gravel layer with a dark yellowish brown (10YR3/4-6) matrix.

Features

A possible post hole, approximately 7 cm in diameter, was discovered in the southeast quarter of N25E33. This feature appeared at about 42 cmbd and continued down to about 50 cmbd, vertically transecting the yellow compact powdery silt visible in the south and east walls. Filled with loose soil, it seemed more characteristic of a small post than of a non-cultural intrusion such as a rodent hole. It is within 8 cm of a concentration of fire-cracked rock in the southeast corner.

In unit N21E30, at the base of the 8-10 cm brown-black artifact bearing layer beneath the forest duff, there was a small depression containing pieces of fire-cracked rock. This depression was roughly 40 cm diameter at the top, 25-30 cm diameter at the bottom, and about 7-10 cm deep. Although the depression contained the same type of soil as the rest of the layer, the presence of fire-cracked rock suggests that it may have been a small cooking area.

Fire-Cracked Rock

Over 570 kg of fire-cracked rock were removed during excavations at SEW-440. Total amounts from any one square varied from less than 1 kg in N12E23 at the southwest edge of the site to over 213 kg in N32E38 at the northeast corner of the site. A marked spatial difference is apparent between squares with over 100 kg of fire-cracked rock, and those with less than 20 kg. The three test squares containing over 100 kg are in the northeastern portion of the site, while the two with less than 20 kg are in the southwest part of the site.

There are also stratigraphic differences in amounts of fire-cracked rock within each unit which appear to be diachronically related. The early Palugvik strata in the three middle test units yielded amounts of fire-cracked rock ranging from too small to weigh accurately with field scales, up to 8.3 kg per 10 cm level. This minor amount of fire-cracked rock is followed by a jump of as much as 30 kg per 10 cm level in later strata in these units. In each of the three northeastern units, the highest concentration of fire-cracked rock occurred in a stratum approximately 20 cm thick and at depths ranging from 30 to 60 cmbs. In each case, this concentration appears to be associated with dates of about AD 1470 to AD 1650. There is a gradual increase in the occurrence of fire-cracked rock in the early part of this period, with density ranging from 31 to almost 70 kg per 10 cm level at the peak of deposition, followed by a gradual decrease at the end of the late prehistoric period.

The distribution of fire-cracked rock is also related to activity and disposal patterns. During the late prehistoric period, the highest density of fire-cracked rock, 69.4 kg per 10 cm level, occurs in unit N32E38 at the base of a 10 m cliff which marks the eastern edge of the site. The calibrated radiocarbon date of AD 1425-1640 above the bedrock at the base of this deposit gives an indication of when use of this area of the site began. Slightly lower amounts of fire-cracked rock, varying from 31 to 53 kg per 10 cm level, were removed from the late prehistoric levels of the two squares to the southwest, N25E33 and N21E30. The unit at the cliff base contained little of cultural interest besides fire-cracked rock. It may be that this area was used as either the location for a sweat bath, or the disposal area for rocks which had been used for this purpose.

The stratigraphic distribution of fire-cracked rock at SEW-440 is similar to the distribution at Palugvik and Uqciuvit. Fire-cracked rock is relatively rare in the earlier levels at Palugvik and abundant in later prehistoric deposits (de Laguna 1956:49, 266). De Laguna (1956:60) suggests that an abundance of burned rock in a site indicates "approximate contemporaneity" with late Palugvik. This is certainly true at Uqciuvit, where fire-cracked rock occurs in large amounts in the more recent, late prehistoric, deposits and and is rare to absent in early Palugvik phase strata (Yarborough and Yarborough 1996). Similar archaeological evidence is present from coastal sites southeast, west and southwest of Prince William Sound. In Cook Inlet, fire-cracked rock is scarce in older sites in Kachemak Bay (de Laguna 1975:162). Both historic sources and archeological reports indicate that fire-cracked rock resulted from the use of steam or vapor baths on the Kodiak archipelago and Alaska Peninsula (Clark 1974a:140; 1974b:6), and "...there is little doubt that...fired stone was the by-product of steam-sweating." (Heizer 1956:23). "Massive quantities" of fired rock found in Late Kachemak layers at Crag Point (KOD-044) and KAR-31 indicate that the presence of burned rubble in sites is not strictly a Koniag phase phenomenon but begins at about the end of the the first millennium AD (Jordan and Knecht 1988:273). However massive amounts of fire-cracked rock associated with sweat baths are characteristic of late Koniag sites, and coincide with the onset of the Little Ice Age (Knecht 1995). To the southeast, a similar pattern of increased amounts of fire-cracked rock in late prehistoric layers is seen at Old Town (YAK-007) on Knight Island in Yakutat Bay (de Laguna *et al.* 1964:40).

Tephra

Two tephra samples were collected from SEW-440. One occurred in the southwestern part of the site at depths varying from 64-68 cmbd. This tephra was only a few millimeters thick. The date on a piece of charcoal above it is 1820$\pm$60 BP, calibrated to AD 75-380 (Beta 78758). This date is only slightly later than the date of 1885 BP for the White River north lobe ash identified elsewhere in Prince William Sound. However, the chemical composition of the ash appears to be more similar to the Valdez ash which has been identified in other sites in the sound and dated as occurring between 1000 and 500 BP. Both the Valdez ash and the White River north lobe ash are believed to have originated in the Wrangell Mountains (Begét *et al.* in press), and it is likely that this tephra has a similar geographic origin.

The other tephra sample was collected from a 25x25 cm test in the northern edge of the site. It does not have a radiocarbon date directly associated with it, although it appears to coincide stratigraphically with a date of 280±60 BP, calibrated to AD 1470-1680, (Beta 78756) from a charcoal sample taken from test square N25E33 to the southeast. Both the date and the chemical composition of the tephra sample are comparable to samples of the Valdez ash from other parts of Prince William Sound.

Soils

Bulk soil samples taken from SEW-440 during the 1994 excavations were tested for pH. As expected, the upper layers of units N21E30, N25E33 and N32E38 were acidic, consistent with the Sitka spruce-western/mountain hemlock vegetation present at the site. Deeper layers within each site, however, became more neutral (Table 4). The soil in a test at the southwest edge of the site was an exception to this general condition. In this test, the pH below 78 cm depth was quite acidic and peat had formed at depths close to 1 m. The more neutral pH at greater depths in unit N25E33 appears to have contributed to the preservation of bivalve periostraca, the outer brown covering of the bivalve during life, while the valves themselves have disintegrated.

Table 4. Soil pH values, SEW-440.

Sample #	cmbs	pH
4.s.1	10	4.40
4.s.5	30-40	5.60
3.s.1	30-40	4.00
4.s.6	38-40	5.90
3.s.2	40-50	4.90
4.s.7	40-50	5.50
4.s.9	50-60	5.70
4.s.10	60-70	5.50
3.s.4	60-70	5.10
1.s.13	78	5.20
5.s.1	78-80	3.40
5.s.2	95-96	3.90

Site Chronology

SEW-440 appears to have been occupied during two distinct time periods during the past two millennia. This supposition relies on radiocarbon dates from the site (Table 3) and typological comparisons with artifacts from de Laguna's (1956) Prince William Sound work and the Uqciuvit excavations (Yarborough and Yarborough 1996). Occupations at SEW-440 are thus placed within the Palugvik and late prehistoric Chugach phases.

The earliest occupation evidenced in the restoration tests appears to have occurred during the early Palugvik phase, in the first half of the first millennium AD. This is based on the date of 1820±60 BP, calibrated to AD 75-380 (Beta 78758), on a charcoal sample from the lowest identified cultural level in unit N16E27. Characterized by gravel with charcoal and fire-cracked rock at 52 cmbd, the layer yielded artifacts–a slate awl, a reworked slate awl, a whetstone, two polishing stones and several slate and siltstone flake fragments–which are not diagnostic, but are found in early Palugvik collections. The time period indicated for this occupation of the site coincides with the postulated warm period prior to the second neoglacial advance in the sound.

The next period of habitation seems to have been initiated around the end of the late first millennium/early second millennium AD, during the late Palugvik phase. There are two radiocarbon dates for this occupation, one of 990±80 BP, calibrated to AD 890-1225 (Beta-97210), and a second of 1030±100 BP, calibrated to AD 790-1225 (Beta-97209) (Table 3). While both samples are associated with cultural material–utilized flakes and fire-cracked rocks, respectively–none of the artifacts are diagnostic.

It is unclear if there was much use of the site in subsequent centuries. Although 60 cm of artifact bearing deposits are present above the dated sample from 79 cmbd in N25E33, associated charcoal samples were not recovered from these layers. An argument for little to no use of the site for several hundred years is that there are only a few centimeters separating charcoal samples from two adjacent layers in unit N21E30, samples whose standard deviations do not overlap, and whose calibration curve intercepts are about 400 years apart.

Even if the site was not occupied around the beginning of the the second millennium, it is clear that the site was inhabited during the Chugach phase, in the middle and second half of the second millennium AD. Dates obtained on charcoal from the three northern units place this later use of the site between approximately AD 1305 and AD 1680. Two quartz crystal gravers recovered from N25E33 are diagnostic for this phase. While the other artifacts from these later strata are not diagnostic, they are not out of place in a late context. In unit N21E30, several distinct deposits of faunal material may represent individual and perhaps seasonal occupational events within this late prehistoric time period. The occupants of the site would have coped during this time period with the climatic rigors associated with the third neoglacial advance, or Little Ice Age.

Evidence of modern twentieth century use of the site is sparse but present. A piece of plastic was found in the living vegetation mat of each of units N12E23 and N16E27, and some rotting dimensional lumber was present on the surface northeast of unit N25E33. These few remains do not seem to indicate a substantial use of the site during the past century, although the lumber (not collected) may have been associated with a fox farming effort.

Artifacts

<u>Historic Plastic</u>

A tiny piece of clear plastic film, 8.6 mm long, 6.4 mm wide and 0.1 mm thick was recovered from near the surface of N16E27. This piece of film appears to be similar to plastic used in sandwich bags. This was the only historic artifact recovered from the site.

Adze (figure 9)

One cortical flake with a highly ground and polished edge appears to be from the bit of an adze. Step fractured from previous impact blows, it is 31.5 mm long, 17.2 mm wide, and 6.0 mm thick at its thickest point. It was recovered from 60 cmbd in unit N23E33 in the late prehistoric deposit.

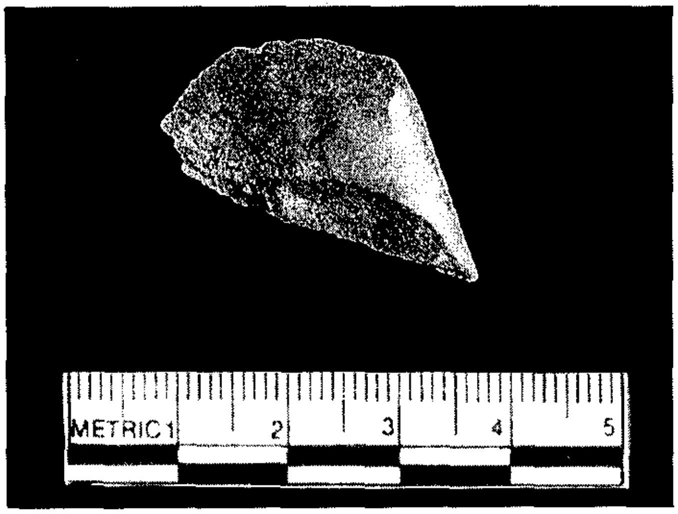


Figure 9. Adze flake (1.29).

Both splitting and planing adzes have been found at almost all the sites in the sound. Splitting adzes are generally defined as being taller than they are wide, while planing adzes are wider than tall and generally smaller than splitting adzes. Many of the splitting adzes are broken from use and, in some cases, these pieces have been reworked into planing adzes, axes, chisels, or hammers (de Laguna 1956:111,113; Yarborough and Yarborough 1996). This adze flake from SEW-440 does not appear to be reworked and is smaller than even the planing adzes from Uqciuvit and Palugvik. Therefore it is difficult to say from size alone which type of adze it represents. However, its removal is more likely to have resulted from a forceful blow, such as might occur during the use of a splitting adze.

Quartz crystal gravers (figure 10)

Two fragments of quartz crystal were recovered from unit N25E33. One opaque piece is 12.0 mm long, 5.8 mm wide, and 4.2 mm thick, while the other, a small, clear prismatic crystal, is 13.4 mm long, 8.1 mm wide and 4.7 mm thick from 51 and 58 cmbd.

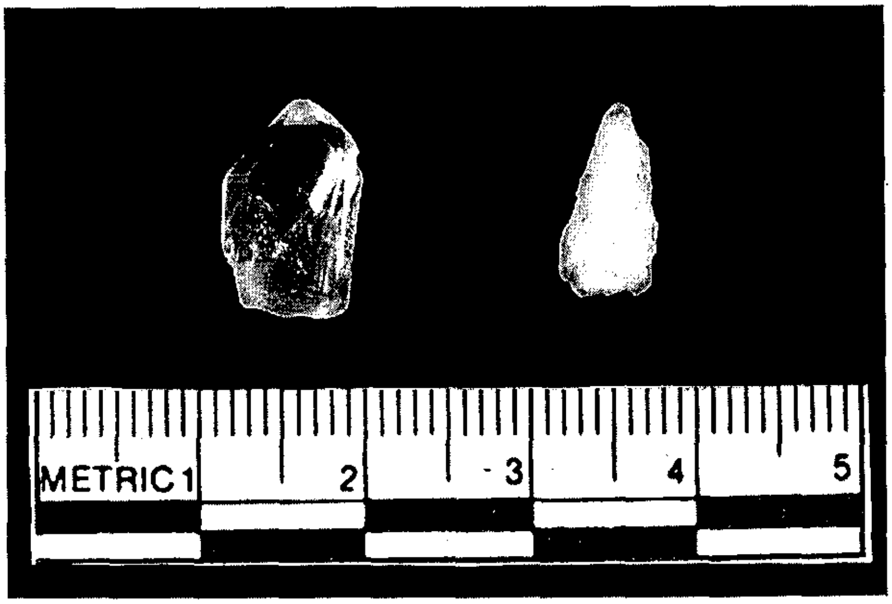


Figure 10. Quartz crystal gravers (1.15, 1.12).

No charcoal samples were recovered from this stratum, although charcoal from above the gravers yielded a date of 280±60 BP (calibrated to AD 1650) while a sample recovered below them returned a date of 990±80 BP (calibrated to AD 890-1225), placing these artifacts in the temporal vicinity of the first half of the second millennium AD. A quartz crystal graver found in a late prehistoric context at Uqciuvit in northwest Prince William Sound is very similar to the prismatic crystal discussed above (Yarborough and Yarborough 1996:142). Quartz crystals showing attrition at the pointed end or ends have been recovered from late prehistoric and early historic sites on Kodiak. These have been interpreted as drills or gravers, based on their wear patterns. Similar quartz crystals identified as engraving tools have been found in sites along the Bering Sea coast (Clark 1974a:95). East of the sound, hafted quartz crystals are reported to have been used on the Northwest Coast as cutting and carving tools (Stewart 1973:87).

Whetstones, abrading stones, grinding slabs, and polishing stones

Twenty six whetstones and whetstone fragments were recovered from the site. Four are from unit N25E33, three are from shovel tests, one is from N16E27, and 17 fragments are from unit N21E30. They range in size from pebbles to large fragments which may actually be portions of grinding slabs.

Three of the four whetstones from N25E33 are pebbles of igneous materials. One is subrectangular and 72.9 mm long, 26.6 mm wide, and 18.6 mm thick. It has a highly polished facet on one broad side which tapers to form an adze-like edge. There are transverse incisions adjacent to the facet. The second is a flattened ovoid pebble, 63.3 mm long, 25.9 mm wide, and 11.2 mm thick, whose smooth cortex is interrupted only by an abraded facet on one end. The third example is slender and rounded with a very smooth cortex. It is 77 mm long, 19.1 mm wide, and 13.2 mm thick. These three are all from what appears to be a late prehistoric layer. The fourth whetstone is a 77.6 mm long, 48.9 mm wide, and 12.6 mm thick slab of burned and broken igneous rock. One face is flat and polished, the sides of the slab are rounded, and the edge of the polished face is irregularly raised.

The 17 fragments from unit N21E30 may be broken portions of two large grinding slabs. Eight, made of the same igneous material, range in length from 9.9 to 31.3 mm, in width from 8.6 to 31.0 mm, and in thickness from 3.7 to 16.3 mm. One is a piece 22.75 mm long, 17.45 mm wide, and 5.1 mm thick,with a rounded ground cortex surface on one face. A second, 46.1 mm long, 31.0 mm wide, and 16.3 mm thick, has five broken faces and one face which is smooth and abraded. A third, 9.9 mm long, 8.65 mm wide, and 7.5 mm thick, is triangular in cross section and pyramidal in shape. One face is ground, with a smooth rounded edge. Five fragments do not exhibit any smooth surfaces, but simply appear to be angular pieces broken from the same slab.

The other nine whetstone fragments all appear to be the same igneous material. All are angular with at least one smoothed or polished surface, and five are reddened by heat, suggesting that the original slab cracked as a result of proximity to fire. Three are blocky, angular, chunks of rock. One, 12.6 mm long, 15.9 mm wide and 13.8 mm thick, has an irregularly flattened edge with a smoothed cortex. A second, 24.05 mm long, 17.05 mm wide, and 9.35 mm thick, is angular and fire-cracked with one very polished surface. The third, 81.3 mm long, 59.4 mm long and 37.1 mm thick, is also fire-cracked and exhibits part of a concave smoothed face. It also has one flattened smoothed face. Five are flat spalls from the grinding stone surface, each with a smooth polished surface. They vary in size, with dimensions as follows: 23.5-60.2 mm long, 14.1-30.7 mm wide, and 3.5-9.3 mm thick. A sixth spall, 28.5 mm long, 17.1 mm wide and 8.2 mm thick, is blocky with one very smooth concave face.

Three whetstones were recovered from shovel tests near the site boundary. One, from test 2D, is a slate slab edge fragment, 53.1 mm long, 17.9 mm wide, and 10.3 mm thick. The whetstone from test 9A is a blocky cobble, 66.8 mm long, 44.4 mm wide, and 38 mm thick, with one smooth face and a very grainy structure.

Two whetstones from the site are somewhat unusual in that they are grooved. The whetstone from test 4D is a triangular shaped, end fragment of fine gray sandstone which is transversely broken. It is 27.8 mm long, 22.9 mm wide, and 11.4 mm long. One face has a deep striated transverse rounded groove, while the opposite face and sides are quite smoothly ground. The one whetstone from unit N16E27 is tabular sandstone, with one broad face and an adjacent end which are grooved and broken. The other broad face is grooved as well. These two artifacts are similar to whetstones found at Uqciuvit (Yarborough and Yarborough 1996:88) used in the production of slate "awls", an artifact type discussed below. De Laguna (1956:124-125) recovered seven small grooved whetstones from Palugvik. She suggested these could have been used to shape or sharpen "small objects, such as shafts, awls, needles, etc..." The grooved whetstones from Palugvik or Uqciuvit do not seem to have any particular chronological significance, but are associated with both early and late Palugvik phase deposits. The grooved whetstone from test 4D is not associated with a date, but the grooved whetstone from unit N16E 27 is associated with the charcoal sample which dated to 1820±60 BP (calibrated to AD 75-380, Beta 78758) and falls within the early Palugvik phase.

An undated whetstone from unit N12E23 is made of a medium-coarse sandstone. This piece, which measures 77 mm long, 26.8 mm wide and 15.2 mm thick, has a flattened oval cross section, and a smoothed slightly concave face.

Grinding slabs are generally distinguished from whetstones by their larger size, generally being too large and unwieldy to be held during the abrading process. Three grinding slabs and a grinding slab fragment were recovered from SEW-440. One, recovered from the late prehistoric deposits of unit N21E30 is 177.0 mm long, 150.0 mm wide, and 34.8 mm thick. It is subrectangular in shape and oval in cross section, and made of an igneous material. Both faces and all of its edges are ground. A second slab, recovered from test 2D, is a subrectangular basalt cobble with a triangular cross section. One broad face is ground, and there are two large flake scars on one end, possibly from use of this implement as a hammerstone. The third, found in unit N12E23, is a massive irregular slab of igneous material 280.0 mm long, 110.0 mm wide, and 87.6 mm thick, with two shallow rounded notches 59.0 mm wide intersecting the smoothed face. There is also a smaller ground facet at the end of the smoothed face. A fragment of a large grinding slab was recovered from the late prehistoric deposits of unit N21E30. This fragment is 120.2 mm long, 63.9 mm wide, and 26.5 mm thick.

An angularly fractured, grainy textured andesite chunk, broken in two pieces which were recovered from unit N12E23, appears to have been used as a red ochre grinder. One piece is roughly rectangular in cross section and ground on two faces. The other is a triangular slab with irregular sides and one straight edge rounded from grinding. The first is 113.0 mm long, 66.1 mm wide and 37.5 mm thick, and the second is 109.7 mm long, 93.9 mm wide, and 39.4 mm thick. Both are stained with red ochre on several faces, and have pieces of red ochre caught in crevasses in the rock.

Polishing stones are generally distinguished from whetstones by their finer material and a higher degree of polish. Eight polishing stones were recovered from both early and late prehistoric deposits at the site. Two are small ovoid pebbles from late prehistoric deposits in units N21E30 and N25E33. One is 34.0 mm long, 27.85 mm wide and 22.05 mm thick; while the other is 12.4 mm long, 11.9 mm wide, and 6.5 mm thick. The former is polished on all surfaces, while the latter has a flattened, highly polished facet. Four of the polishing stones are cobbles of varying sizes, and one is a cobble fragment. The fragment, from unit N16E27, is triangular in shape and 65.5 mm long, 43.5 mm wide, and 35.2 mm thick. It has a highly polished flat facet. Two of the cobbles are also from this unit, from the early Palugvik phase deposit. One is elongated and rounded with a very polished facet running the length of one face, with small discontinuous striated facets on the opposite face. This piece is 103.6 mm long, 46.1 mm wide, and 45.6 mm thick. The other example is egg-shaped, with areas of polishing sheen on the broadest face. It is 108.4 mm long, 51.7 mm wide, and 43.4 mm high. Two of the larger ovoid polishing stones are from the late prehistoric deposits of N21E30. One is 67.6 mm long, 51.25 mm wide, and 23.9 mm wide, and polished on all sides. The second is 87.3 mm long, 65.1 mm wide, and 56.7 mm thick, with one broad curved polished surface.

A polishing stone which may also have been used as a hammerstone was recovered from the late prehistoric deposits in N25E33. It is a rounded oblong cobble which has been fractured transversely. The broken facet is ground very smooth and exhibits areas of polish.

De Laguna (1956:124) suggests that different size whetstones were used to sharpen artifacts of varying sizes: small knives and points were sharpened on small stones, while adzes were ground on large slabs. She categorized many as bars or slabs, despite variances among shapes. Whetstones have been found in a variety of sizes. Shapes recorded from the Palugvik and Uqciuvit collections include oval, oblong, subrectangular, rectangular, cuboid, trapezoidal, or roughly triangular, with similar variations in cross section (Yarborough and Yarborough 1996). De Laguna did not note polishing stones among the artifacts she collected, although polished stones and pebbles similar to those from SEW-440 were recovered at Uqciuvit.

Burnishers

Six slate cobble spalls from the late prehistoric deposits of unit N21E30 were used as burnishers. All are long, thin pieces, with one pointed end which is rounded and polished. One is the outer portion of a broken cobble with a triangular to rhomboid cross section. The cortex is still present on one surface, while the other faces are rough and broken. It is 58.15 mm long, 16.85 mm wide and 10.1 mm thick. The second, a flat spall 37.4 mm long, 13.4 mm wide and 4.4 mm thick, is reddened from heat. The third is roughly triangular in cross section, with an impact flake scar on the end opposite the burnished point. It is 101.0 mm long, 15.4 mm wide and 11.2 mm thick. The fourth, which measures 90.5 mm long, 22.2 mm wide and 8.3 m thick, is rather flat and bipointed. It also has impact flake scars opposite the burnished end. The fifth is a slender fragment which is 51.0 mm long, 9.9 mm wide, and 7.3 mm thick. The final example is 79.2 mm long, 19.2 mm wide, and 9.5 mm thick.

A similar implement, a bar-shaped beach pebble fragment with a blunt point rounded and polished from use, was recovered from Uqciuvit (Yarborough and Yarborough 1996:142). The SEW-440 burnishers are also comparable to dull "slate splinters" from late prehistoric Koniag sites on the Kodiak archipelago (Clark 1974a:97-98) which have been interpreted as creasing or embossing tools.

Split pebbles

Five split or fractured pebbles were recovered from the site: two from unit N25E33 and three from N21E30. All are apparently from late prehistoric deposits. One is a tabular graywacke fragment, 19.6 mm long, 13.2 mm wide, and 6.1 mm thick, with thick beveled polished edges. The other four are longitudinally fractured slate pebble fragments, varying from 13.4 to 36.1 mm in length, from 9.1 to 23.6 mm in width, and from 2.9 to 4.3 mm in thickness. These four do not show evidence of grinding or polish, but are from a context which implies a cultural origin.

The fractured and ground pebble is similar to, although smaller than, burnishing stones reported from Kiavak 418 on Kodiak. The latter are somewhat asymmetrical, and "bear touches of abrasion on one edge or all about the perimeter". They are suggested to "have been used to burnish wood" (Clark 1974a:94). De Laguna reported rubbing stones from a site near Angoon, which are "from rather flat pebbles or from sections split from pebbles...ground flat (dull), and one end is either rounded or bluntly pointed" (de Laguna 1960:106) , although she noted that the Angoon burnishers are symmetrical. The other fractured pebbles from SEW-440 may be pieces left from making burnishers.

Polished Pebble

A single highly polished pebble, with no evidence of battering or grinding, was recovered from unit N21E30. The pebble has a triangular cross section and is 21.7 mm long, 12.25 mm wide, and 12.0 mm thick. While this piece may have been used to polish some organic material, it may also be an example of a gastrolith, albeit rather large.

Notched Stone

A small tabular piece of notched slate was recovered from the late prehistoric deposits of unit N21E30. It is 45.5 mm long, 29.88 mm wide, and 5.7 mm thick, with rounded edges. It is basically rectangular in shape, although one long side angles in slightly at one end. There is a single concave notch on the long side opposite the taper. The short end opposite the tapered end is broken. This is not a notched stone in the classical sense, since it is not made from a beach pebble and there is only one notch.

Unfinished Point (Figure 11)

Two fragments of what appears to be a slate blade blank or an unfinished point was recovered from unit N25E33. The distal fragment is pointed at one end and transversely fractured at the other. While portions of its faces are ground smooth, the beveled ground edges are sawed facets. This piece is 19.2 mm long, 10.6 mm wide, and 3.5 mm thick. The proximal portion of the artifact also exhibits beveled sawn edges and discontinuously ground faces. It is 29.8 mm long, 13.1 mm wide, and 3.8 mm thick.

De Laguna (1956:154-155) noted several unfinished blades or points among those from Palugvik and Palutat. One unfinished point was recovered from Uqciuvit (Yarborough and Yarborough 1996). The SEW-440 example may have been discarded because of the transverse break.

Awls (Figure 11)

A portion of a slate "awl" was recovered from 49 cmbd in unit N16E27. This tapered fragment, from the distal end of the projectile, has edge facets which are wider than the faces and which exhibit deep diagonal striations. The edges are rounded and each end is impact

Figure 11. Slate awl midsection (2.16), slate awl splinter (2.12), unfinished point (tip–1.13; distal portion–1.17).

fractured. The piece is 60.0 mm long, 9.7 mm wide, and 5.9 mm thick. Two specimens which may be fragments of slate "awls" were also recovered, one also from unit N16E27, and the other from N21E30. The former is a bipointed slate fragment with a broad ground edge. It is 32.5 mm long, 5.0 mm wide, and 3.5 mm thick. The latter is a slender spall with a rounded ground edge which measures 44.8 mm by 4.9 mm wide, by 2.1 mm.

Slate "awls" were given their rather confusing appellation by de Laguna (1956:159). She concluded, based on the lack of tip wear, evidence of hafting, and the material from which they were made, that they were actually a type of projectile point, which was "probably intended to break off in the wound". The breakage patterns of the 127 "awls" and "awl" fragments that she collected, those recovered at Uqciuvit, and the specimens from SEW-440 all support this conclusion.

Ethnoarchaeological experimentation by this author with recently manufactured slate "awls" indicated that replicas of these implements do not shatter upon impact with soft tissue, and that they could be used repeatedly without breakage. However, the modern replicas did sustain impact fractures similar to the archaeological specimens when hard material such as bone was encountered.

Ground stone Fragments

Fourteen fragments from throughout the site are broken and discarded pieces of unidentifiable ground stone implements. Ten are from unit N21E30 and five of these are pieces of the same slate implement. Of the five, all from the bottom of the late prehistoric layer, only one piece, 57.1 mm long, 45.5 mm wide and 7.9 mm thick, is actually ground on one face. The other four are angular and crumbling, and vary in length from 24.8 to 71.1 mm, in width from 11.9 to 46.4 mm, and in thickness from 1.6 to 9.25 mm. Another ground stone fragment, 34.0 mm long, 21.0 mm wide and 4.4 mm thick, is flat and triangular shaped, with broken edges. Both of its large flat faces are ground smooth. The seventh ground stone piece from N21E30 is a flat, triangular, slaty siltstone fragment which is lightly ground on one face. The eighth piece, from an upper portion of the late prehistoric deposit, is roughly triangular, It has a triangular cross section and a raised ridge on one side. It measures 28.35 mm by 27.15 mm by 9.25 mm. It has been ground on one side of the ridge and has a small flaked notch near the "apex" of the triangle. The ninth piece from the unit is also from an upper deposit. It is 38.95 mm long, 28.35 mm wide, and 8.25 mm thick, and is roughly triangular in shape. It is lightly ground on one face. The last ground fragment from the unit is a ground and utilized graywacke cobble fragment, which is 28.8 mm long, 25.0 mm wide, and 5.1 mm thick. It is a flattened, sub-round spall with a broad smooth cortex portion. There is polish at the edge of both the cortex and the adjacent face, and use retouch around its margins.

Three ground stone fragments were recovered from unit N16E27. One of the two pieces from the upper part of the deposit is a flat bipointed piece of slate which has been ground to a smooth, slight longitudinal concavity on one face. It is 75.0 mm long, 26.8 mm wide and 7.0 mm thick. The other is a flat rectangular slate flake, 42.8 mm long, 20.3 mm wide and 4.5 mm thick, with a smooth ground facet on a portion of one broad face. The third piece, from slightly lower in the late prehistoric deposit, is an irregular thin slab, roughly pentangular in shape, which is 59.1 mm long, 50.9 mm wide, and 7.1 mm thick. A straight edge on one side has been ground and rounded, and is 37.2 mm long and 5.7 mm thick.

One ground cobble flake was recovered from unit N25E33. This broad piece is 28.5 mm long, 20.7 mm wide and 3.4 mm thick. It has cortex on one face, and has been slightly ground on the other.

Blanks/Preforms

A sawed slate piece recovered from 56 cmbd in unit N16E27 may be a discarded preform. This slender tapering bar, 95.8 mm long, 13.1 mm wide, and 11.3 mm thick, was formed by two intersecting saw cuts. The beveled faces formed during the sawing process have distinct parallel striations, which terminate in a narrow shelf where the bar was "snapped" from its parent material.

Utilized Pebbles, Cobbles, and Flakes

Eight artifacts are either flakes, or fragments of pebbles or cobbles, which show evidence of having been utilized. Six are from the late prehistoric deposits of N21E30, one is from N16E27, and one is from N25E33. The utilized stones from N21E30 range in size from 45.5 to 80.7 mm in length, 16.7 mm to 46.3 mm in width and 4.7 to 7.6 mm in thickness. All are slate or slaty schist and exhibit evidence of use through flaking or rounding of edges. The utilized slate cobble fragment from N16E27 is 107.9 mm long, 58.5 mm wide, and 13.8 mm thick. It has an irregular curved edge which appears to be slightly dulled from use. The small slate flake from N25E33 is 49.8 mm long, 32.0 mm wide, and 6.1 mm thick. This piece has a broad beveled edge which appears to be slightly rounded from use.

Spalls, Flakes and Debitage

The majority of the lithic material collected from SEW-440 consists of broken and apparently unused pieces of slate, and crypto-crystalline and igneous rocks. These were collected during the course of excavation because they were located in cultural deposits, and because such material was not expected to occur naturally in the site. However, it is possible that not all of these pieces represent cultural activities. The 87 slate pieces range in length from

7.2 to 94.2 mm, in width from 4.7 to 81.4 mm, and in thickness from 0.6 to 27.7 mm. Eight of the pieces are basalt, granite or graywacke. They range from 11.15 to 34.65 mm long, 3.3 to 44.4 mm wide, and 1.3 to 9.55 mm thick. An additional eleven pieces are siliceous in nature, ranging in size from 6.2 to 49.5 mm long, 5.6 to 35.5 mm wide, and 2.1 to 11.8 mm thick.

Wood

A flat, roughly rectangular piece of wood with one transversely cut end was recovered from test 9A. The wood is 84.6 mm long and 13.35 mm thick. It tapers from 30.2 mm wide at one end to 12.5 mm wide at the other.

Red Ochre

Only one piece of dull red hematite was recovered from the site, from late prehistoric deposits in unit N32E38. This small, irregularly shaped piece of friable, grainy material is rounded from grinding. It measures 10.4 mm long, 9.5 mm wide and 4.8 mm thick. As noted above, a grinding stone with red ochre stains and small bits of red ochre in crevasses in the rock was recovered from an undated deposit in unit N12E23.

The use of red pigment appears to be common through time in Prince William Sound. Both iron oxide and pieces of hematite, and artifacts with red ochre "paint" on their surface were also common in early and late Palugvik phase deposits at Palugvik (de Laguna 1956:251). Seven pieces of red pigment stone were recovered from Uqciuvit (Yarborough and Yarborough 1996:158).

Fire-Cracked Rock

Most of the fire-cracked rocks encountered during the course of excavation were weighed and discarded (see **Fire-Cracked Rock**, above). However, six small pieces were inadvertently collected. They range from 11.0 to 94.5 mm in length, 6.4 to 71.0 mm in width, and 4.25 to 8.3 mm in thickness. Three appear to be pieces of igneous cobbles, one is a flake of orthoquartzite, one is a piece of slate, and another is a thin spall of sandstone. All are reddened from exposure to heat. It is possible that some of the other unused spalls and flakes (see below) from the site may have resulted from heat damage, although only these six exhibited evidence of such alteration.

Mineral specimens

Several small rocks were collected during screening of cultural deposits. One is a tiny fleck of mica, 7.5 mm long, 5.7 mm wide and 0.3 mm thick. Another is a 16.5 mm long, 13.7 mm wide and 7.4 mm thick piece of quartz. The third is a piece of red jasper with quartz inclusions. It is 25.1 mm long, 20.8 mm wide, and 7.4 mm thick. They may represent raw materials which were collected and subsequently discarded or, in the case of the mica, pieces of debitage.

Fauna

Faunal remains occurred in three of the five units at SEW-440. Although not all were identifiable to species, almost 750 bones were identifiable to class or lower taxa (Figure 12). These specimens were identified using the comparative zooarchaeological collections at the University of Alaska-Anchorage and University of Victoria, British Columbia.

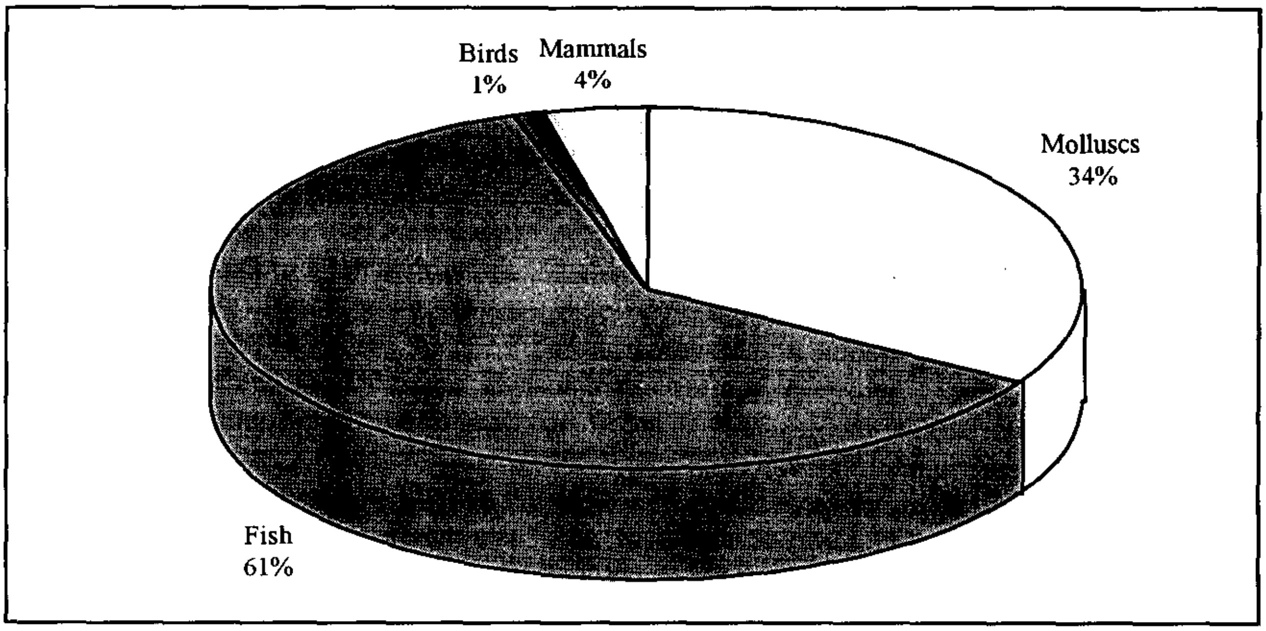


Figure 12. Fauna represented at SEW-440.

The historic period is minimally represented artifactually at SEW-440 and the faunal collection reflects this lack of intensive human use. Three black-tail deer (*Odocoileus hemionus sitkensis*) longbone portions and two associated large mammal longbone fragments which are also likely to be black-tailed deer were recovered in the uppermost portion of unit N32E38. Black-tail deer were not present in the sound prior to 1917 AD, when they were transplanted successfully from the Sitka area during a project sponsored by the state of Alaska (Burris and McKnight 1973:6). These are the only historic period bones recovered from the site, although they were not associated with any cultural materials and probably were deposited naturally.

Prehistoric faunal remains were much more numerous, but were only recovered from two of the five 1 m^2 units: N25E33 and N21E30. Of particular note is a layer several centimeters thick consisting of mostly fish bone in unit N21E30 (Figure 5). The lower portion of this layer, which may represent a single, perhaps seasonal, depositional event, has been dated to 380±60 BP (calibrated AD 1425-1655, Beta 78760).

Fish

The most numerous vertebrates in the collection are fish. Close to 400 identified specimens represent the cod family (*Gadidae*), and almost 200 of these were more specifically identifiable to Pacific or gray cod (*Gadus macrocephalus*) (Figure 13). It is possible that at least some of the cod family elements may be pollock (*Theragra chalcogramma*). The rest of the fish include over 180 rockfish (*Scorpaenidae*), 23 salmon (*Salmonidae*), and 11 sculpins (*Cottidae*), of which two were distinguishable as Irish lord (*Hemilepidotus* sp.) specimens. With the exception of two fish teeth and some unidentifiable fish fragments from unit N25E33, all of the fish bones collected are from unit N21E30. A few fragments identifiable only as fish were recovered between 20 and 40 cmbd. Those fish remains which were identifiable came from the thick fish bone layer between 40 and 60 cmbd (Figure 5).

Salmon have been a historically important resource for the inhabitants of Prince William

Sound (Haggarty *et al.* 1991, de Laguna 1956, Stratton 1989, Stratton and Chisum 1986). However, they are only represented in this collection by 23 small vertebrae which may all be from the same fish. The size of the vertebrae suggests pink salmon (*Oncorhynchus gorbuscha*). While there are several salmon streams on Eleanor Island today, none are particularly close to SEW-440, so the circumstances under which these bones are present in the assemblage are unclear. It is possible that the bones represent a salmon caught during the course of taking other species in open water.

The cod in the collection are generally large, and appear to be in the 13-22 kg range (Figure 14). The elements represented are mostly cranial, lateral facial, and appendicular bones. Only 84 complete vertebrae and 58 vertebral fragments are present in the collection, as opposed to 227 head bones. Cod are most often found near the ocean bottom, at depths ranging from 12-549 m. However, they are generally found at shallower depths in the spring, and deeper in the fall (Eschmeyer *et al.* 1983:97).

Rockfish (family *Scorpaenidae*) bones present include 27 cranial, lateral facial, and appendicular bones, 11 complete vertebrae, and 7 incomplete vertebrae. At least five individual fish are represented by these remains: three large, a medium, and a small rockfish. However, skeletal elements of individual Scorpaenidae species are not as distinctive as those in some other fish families. A definite species identification is generally not possible, and has not been attempted here. However, suggestions may be made as to which species may be represented by different bones, based on size, and knowledge of habitat and human fishing technology, Species within the range of size of the large bones include Rougheye rockfish (*Sebastes aleutianus*), Bocaccio (*Sebastes paucispinis*), and Yelloweye rockfish (*Sebastes ruberrimus*). These fish can attain lengths of 91 cm or larger. However, it is unlikely that the large bones represent Rougheye rockfish, as this species is found on the ocean bottom at depths of 183-732 m. Bocaccio and Yelloweye are found at shallower depths–27-320 m and 46-549 m, respectively–and might be more easily obtained. It is possible that the medium and small rockfish may be younger examples of these large species. On the other hand, they may actually represent such medium-sized species as Pacific Ocean perch (*Sebastes alutus*), Redbanded

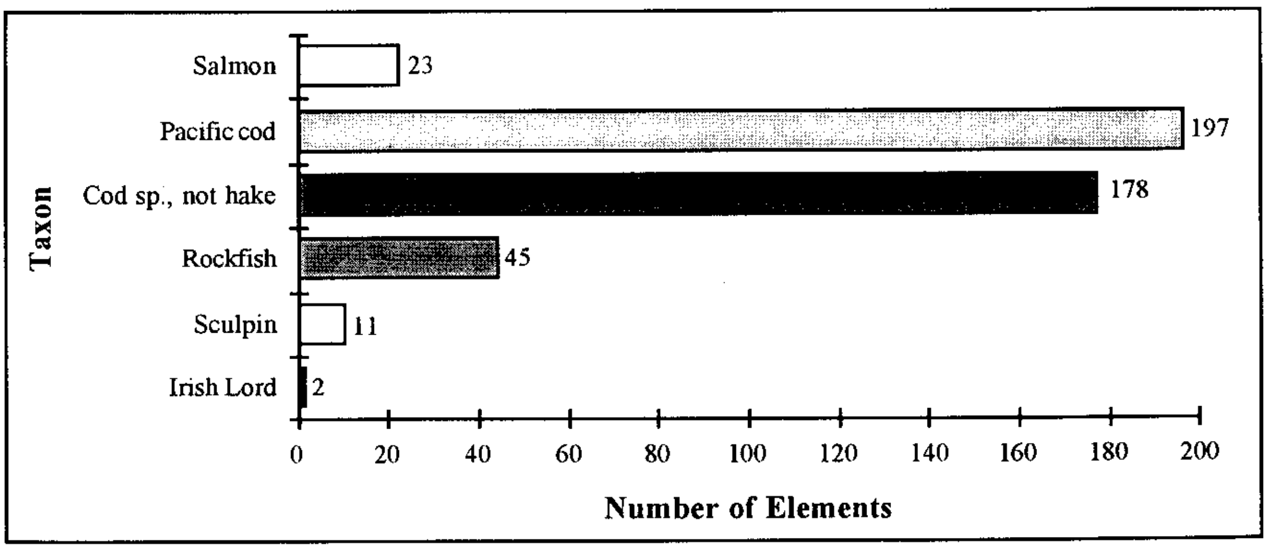


Figure 13. Fish identified from SEW-440.

rockfish (*Sebastes babcocki*), Silvergray rockfish (*Sebastes brevispinis*), Copper rockfish (*Sebastes caurinus*), Darkblotched rockfish (*Sebastes crameri*), Yellowtail rockfish (*Sebastes flavidus*), Quillback rockfish (*Sebastes maliger*), Black rockfish (*Sebastes melanops*), Blue rockfish (*Sebastes mystinus*), Redstripe rockfish (*Sebastes proriger*), or Shortspine Thornyhead (*Sebastolobus alascanus*); and small rockfish such as Dusky rockfish (*Sebastes ciliatus*), Greenstriped rockfish (*Sebastes elongatus*), Rosethorn rockfish (*Sebastes helvomaculatus*), Northern rockfish (*Sebastes polyspinis*), Harlequin rockfish (*Sebastes variegarus*), Sharpchin rockfish (*Sebastes zacentrus*), or Longspine Thornyhead (*Sebastolobus altivelis*).

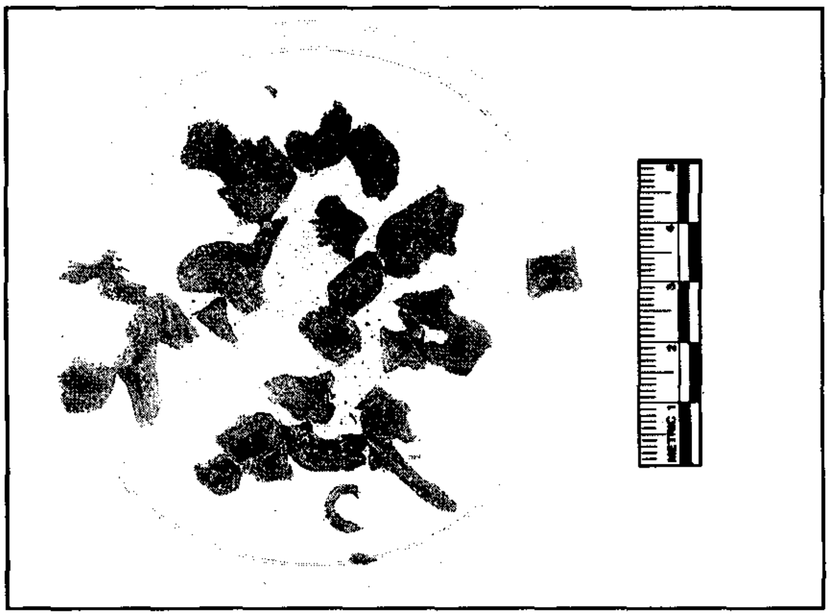


Figure 14. Cod fragments from SEW-440.

Two of the 11 sculpin (family *Cottidae*) bones recovered represent at least one Irish Lord (*Hemilepidotus* sp.), based on distinctive supraorbital and supraoccipital bones. The other nine bones may be from the same or different species. Several sculpin bones are of a size to possibly be Yellow Irish Lord (*Hemilepidotus jordani*) or Big Mouth Sculpin (*Hemilepidotus bolini*). The former grow as large as 41 cm and are found from the subtidal zone to 110 m, while the latter can grow to be 69 cm and generally occur offshore at depths of 122-216 m. The *Hemilepidotus* species have a large head in relation to body size, but are generally considered to be palatable.

Birket-Smith (1953:23) recorded that cod were traditionally caught in early summer. During the early 1930s, however, they were fished year round, as were halibut and red snapper or YellowEye rockfish (Birket-Smith 1953:40). Salmon runs could begin as early as the beginning of May.

Looking at the fish bones as a whole, head and appendicular elements are more numerous than vertebral pieces for all species except salmon. They constitute 61% (n=227) of the cod, 60% (n=27) of the rockfish, and 85% (n=11) of the sculpins. As a result, it appears that fish processing was a primary subsistence activity at this site.

Mammals

Despite the variety of sea and terrestrial mammals that range in the general vicinity of the site, mammal remains comprise a small portion of this faunal collection. Only Steller sea lion (*Eumetopias jubata*) and domesticated dog (*Canis familiaris*) bones were identified (Figure 15). Fourteen unidentifiable mammal fragments were recovered from unit N25E33. Of these, six fragments from the upper prehistoric layer were calcined. One unidentifiable fragment of mammal bone was also found in unit N21E30.

Sea lion bones were recovered from both the upper and lower prehistoric layers of unit N25E33. A badly eroded humerus, unfused portions of a thoracic vertebra from an immature sea lion, and a portion of a crumbling right humerus were recovered. These appear to represent two adults and one immature individual. An eroded and crumbling portion of a sea lion right scapula was also recovered from unit N21E30, near the bottom of the fish bone mat.

Sea lions are the largest pinnipeds in Prince William Sound. Adult males generally range from 3 to 4 m in length and weigh up to 820 kg. Females are smaller, attaining a length of 2.1 to 2.7 m and weighing as much as 373 kg (Hall and Kelson 1959:975; Kenyon and Scheffer 1953:8). The average newborn pup, born in late May or early June, weighs about 14.2 kg and measures about 98 cm long. They grow rapidly, more than doubling their weight within a two month period (Scheffer 1945:391). Steller sea lions inhabit the Pacific coast from California to the Bering Sea, with the greatest concentrations around the Aleutian Islands (Kenyon and Rice 1961:2332). Although they generally migrate southward in the winter and north in the summer, at least a few are likely to be present in Prince William Sound year round.

Sea lions tend to congregate at hauling grounds and rookeries, although individuals have been observed far from these areas. They prefer wave-beaten rocks and islets, and steeper more remote haul-out areas than seals (Kenyon and Scheffer 1953:9). The hauling grounds on northeast Perry Island, Point Eleanor, and southeast Glacier Island, not far from SEW-440, are used primarily in the winter and only by 30 to 100 animals. In comparison, thousands of animals congregate at haul-outs on Hinchinbrook Island in eastern Prince William Sound (Lloyd Lowerie, personal communication 1990). Because their main diet consists of molluscs, squid, herring, and rock fish (Mathisen *et al.* 1962:474-475), sea lions are dispersed throughout the sound and do not generally follow salmon runs.

The ethnographic record indicates that sea lions were hunted by the Chugach in the fall, winter, and spring, although those killed in the autumn provided more meat than those taken at other times (Birket-Smith 1953:27). Sea lions were reportedly not hunted in the summer when they had a strong odor. Because of the physical danger involved in hunting these large mammals, sea lions were generally taken as they slept in open water by a group of men in several kayaks.

The skins of young sea lions were sometimes used to cover kayaks, and the bottom of *aniaqs*, or large open boats. The belly portion of the skin was used to make a type of rope, dog

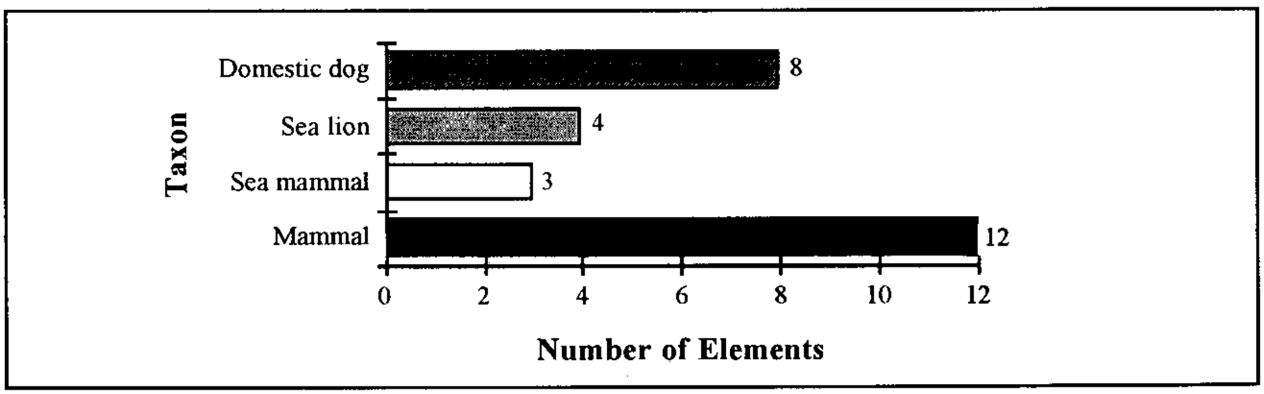


Figure 15. Prehistoric Mammals identified from SEW-440.

harnesses, and high topped boots. Throat portions were used for boots as well (Birket-Smith 1953:47-50, 67, 74, 79). Sea lion whiskers were a traditional adornment for Chugach spruce root conical basketry hats (Birket-Smith 1953:66).

Eight articulated domestic dog vertebrae, two thoracic and 6 lumbar, were found in unit N21E30, among fish bones. They represent a medium sized adult individual. There is no evidence of butchering on the bones. Bones from small to medium sized dogs, and bones gnawed by dogs, were found throughout the early and late midden layers at Palugvik (de Laguna 1956:51-52). Chewed bones were also recovered from late Palugvik and Chugach strata at Uqciuvit (Yarborough and Yarborough 1996). There is some evidence from Kodiak that the Koniag and Late Kachemak tradition people both kept dogs as pets, and included them in their diet (Clark 1974a:44). The remains of "Eskimo" dogs and smaller "Plains Indian type" dogs were recovered from Kachemak Bay culture sites on the Kenai Peninsula (de Laguna 1975:31-32). Historically, a small variety of dog was kept by the Chugach for hunting small fur-bearing mammals (de Laguna 1956:51). Prehistoric dogs may have been used for hunting as well.

Birds

Bird bones were only recovered from unit N21E30 in the southwestern part of the site. They were present in the portion of the deposit characterized by a large amount of fish bone. Three were identifiable to species, although several others, while not identifiable to species, are likely to be particular birds (Figure 16).

One left radius of a small adult cormorant was identified. Four species of cormorant have been recorded in Prince William Sound: double crested (*Phalacrocorax auritas*), Brandt's (*P. penicillatus*), pelagic (*P. pelagicus*), and red-faced (*P. urile*). This element is most likely representative of the pelagic cormorant. Tens of thousands of pelagic cormorants inhabit the sound, occurring individually and in groups of several hundreds, particularly near good feeding areas and roosting sites. Present year-round, they nest in numerous small colonies on rocky cliffs, and are often associated with black-legged kittiwakes (Isleib and Kessel 1992:48). Although the double-crested is also a common resident of the sound, the double-crested is large, 75-90 cm, and the pelagic is small, 64-76 cm (Peterson 1990:28), with very little overlap in size between species. The even larger (83-88 cm) Brandt's cormorant (Peterson 1990:28), a casual breeder in the Prince William Sound area (Isleib and Kessel 1992:47), is not likely to be represented by this element because of its size. Additionally, the only Brandt's cormorant breeding colony site recorded in Alaska, at Seal Rocks near Hinchinbrook Entrance, only recently became habitable as a result of uplift during the 1964 earthquake (Isleib and Kessel 1992:48). It is also unlikely that this bone is from a red-faced cormorant. While similar in size to small double-crested or large pelagic cormorants (70-75 cm), it is an uncommon local resident, with only a single nesting colony recorded in southwest Prince William Sound (Isleib and Kessel 1992:48-49).

A single Oldsquaw (*Clangula hyemalis*) sternum was recovered. A common winter visitant throughout inshore waters of Prince William Sound, oldsquaws also are common seasonal migrants, although generally more numerous in spring than fall. They are rare local breeders, and uncommon summer visitants, with non-breeders present in inshore waters and locally common during some summers (Isleib and Kessel 1992:64-65).

A merganser sternum recovered appears to be comparatively closer to red-breasted merganser (*Mergus serrator*) than common merganser (*Mergus merganser*). Although the red-breasted merganser is only abundant during seasonal migrations, it also occurs as a common winter visitant and an uncommon summer visitant and local breeder. Winter visitants in bays and inlets are recorded as associating with common mergansers (Isleib and Kessel 1992:69).

Two fragmentary limb bones were identifiable as *Anatidae*, but not to species. One is a radius, about the size of a Bufflehead (*Bucephala albeola*). The other is a fibula about the size of a common goldeneye (*Bucephala clangula*) or common merganser. Buffleheads are abundant spring migrants in the Prince William Sound area, with reports of flocks up to and over 1,000 birds in size. They are common to abundant in winter and during fall migration when they are found in small flocks. Although buffleheads occasionally are present in freshwater areas or the heads of fjords, they are generally absent in summer, with no reports of breeding (Isleib and Kessel 1992:64). Common goldeneyes are abundant in the sound during the winter in flocks of over 100 birds, common during spring and fall migrations, and rare but present in the summer (Isleib and Kessel 1992:63). The common merganser is more numerous than red-breasted mergansers in the summer, breeding throughout the region. Migrants occur commonly in the spring and occasionally in the fall, with winter visitants most common in protected coastal waters and open fresh water (Isleib and Kessel 1992:68-69).

Five bones were only identifiable as bird. One is a sternal fragment from a large goose-size bird which resembles the greater white-fronted goose (*Anser albifrons*). The second is an ulna shaft portion of a duck-sized bird. The three others are a portion of a sternum of a small duck, or grebe; and two limb bone portions representing a small to medium sized bird, and a bird smaller than a duck. Five species of geese migrate in the vicinity of Prince William Sound, in varying degrees of abundance. The white-fronted goose is of medium to large size (about 76 cm) and is within the general size range of Canada goose (*Branta canadensis*) (63-109 cm) (Peterson 1990:40), but is smaller than the "dusky" or "white-cheeked" subspecies (*B. c. occidentalis*) of Canada goose which is prevalent in the sound. It is unlikely, from a morphological point of view, that the sternum fragment is from a black brandt (*Branta nigricans*), a snow goose (*Chen caerulescens*), or an emperor goose (*Chen canagica*) as these species are smaller than white-fronted and dusky Canada geese. In addition, the emperor goose is extremely rare, with historic sightings confined to southeast Prince William Sound and the Copper river flats region.

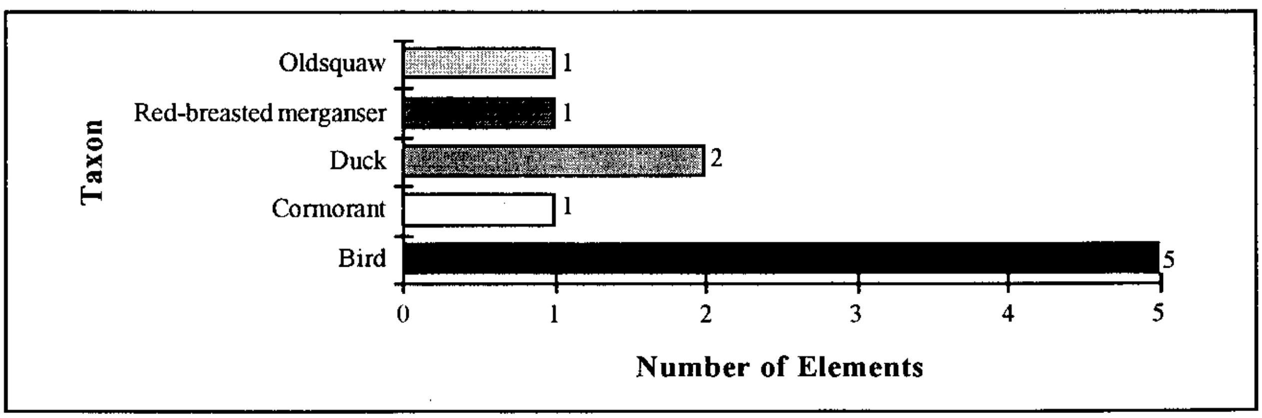


Figure 16. Birds identified from SEW-440.

Molluscs

Shells, shell fragments, and periostraca were recovered from only two units, N21E30 and N25E33. The 13 Venus clams (family *Veneridae*) from N25E33 were found in both upper and lower strata (Figure 17). The over 50 identifiable mussel (*Mytilus* sp.) fragments from the same unit were found in a discrete stratum between the Venus clams. The majority of the shellfish remains were recovered from N25E33 in a fish bone matrix. Thirty-six of these are Venus clams, over 130 are mussel fragments, 4 are cockles (family *Cardiidae*), one is a gastropod (class *Gastropoda*), and 15 are chitons (class *Amphineura*).

Ethnographically, shellfish were an important, although not necessarily predominant, resource in Prince William Sound. Chugach informants indicated to Birket-Smith (1953:18) in 1933 that, "when hunting failed, [mud flats and shoals] were resorted to as a nearly always full larder." A variety of clams, snails, and chitons were collected during periods of bad weather, especially in the spring, when other hunting or gathering was precluded (Birket-Smith 1953:42). This was also a protein source which could be fairly easily procured by group members who were not able to hunt.

Amphineura. Fifteen chiton plates are present in the collection. An intertidal zone animal preferring a rocky habitat, chitons have eight back plates. The size of the specimens indicates they are likely to be from a large species, such as the giant chiton (*chryptochiton stelleri*) of the family *Cryptoplacidae*, which are commonly 15-20 cm, and have been recorded up to 30 cm, rather than black Katy (*Katharina tunicata*), also known as gumboot, of the family *Mopaliidae*, which commonly attains a size of 5-7 cm (Morris 1980). The latter species also has deep diagonal grooves on the sides of the plates which are not present on the SEW-440 specimens. Ongoing research by this author has revealed the presence of similar chiton remains from tests at SEW-430 on western Eleanor Island.

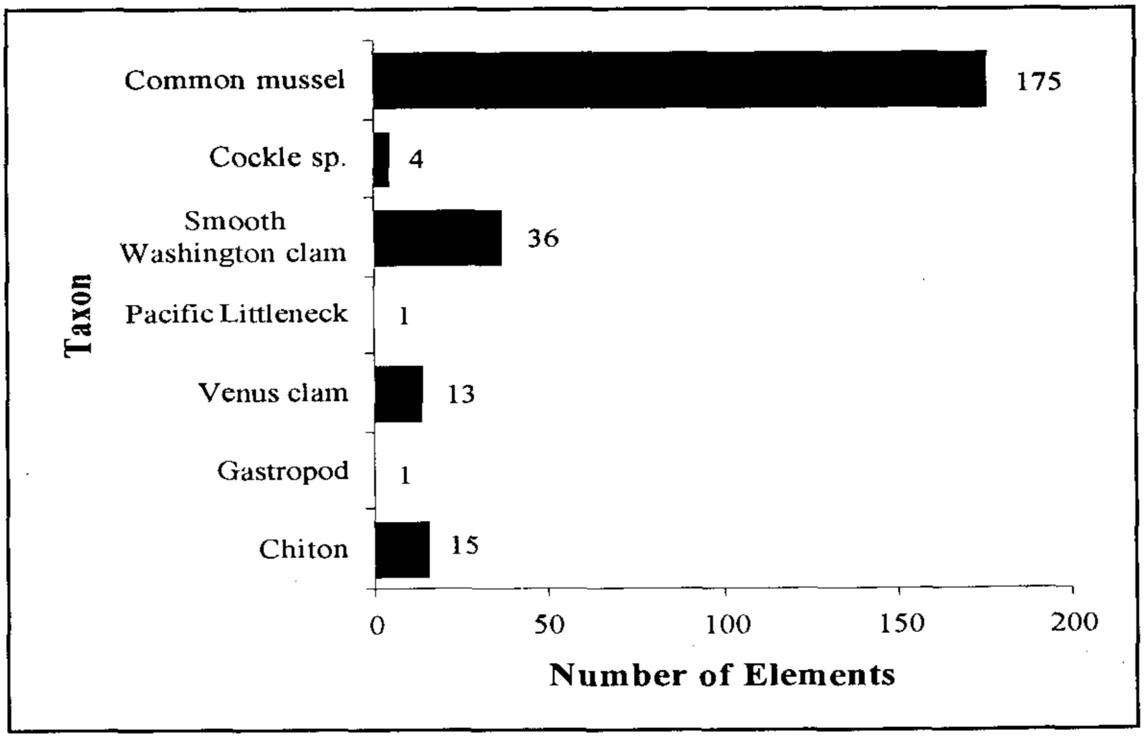


Figure 17. Molluscs identified from SEW-440.

Gastropoda. One fragment of a small spiral shell was recovered, but was not identifiable to family or lower taxon. Several varieties of gastropods have been found at other sites in the sound. The excavations at Palugvik yielded whelks, snails and limpets (de Laguna 1956:49), and tritons and top shells were found at Uqciuvit (Yarborough and Yarborough 1996)

Pelecypoda. Fifty fragments of Venus clams were recovered from the site, of which 36 are smooth Washington clam (*Saxidomus giganteus*) and one is Pacific littleneck (*Protothaca staminea*). Venus clams are extremely common along the southern Alaskan coast (Abbott 1968:236). Smooth Washington clams, or butter clams, are found from the intertidal zone to depths of 9 m and inhabit well protected beaches with mixed sand or mud and gravel substrates (Paul and Feder 1976:16). They are easily disturbed by sudden tectonic movement, requiring 20 years or more to regain a harvestable population after an event of the magnitude of the 1964 Alaskan earthquake (Paul and Feder 1976:19). Pacific littleneck clams are smaller than butter clams, but are found in a similar habitat of well protected beaches with mixed gravel and mud substrates. They live within 15 to 20 cm of the surface and occur between the +.9 and -.9 m tide line. The densest concentrations, however, are found in the mean low water area (Paul and Feder 1976:21). Pacific littlenecks often are found in association with smooth Washington clams, but appear to have a greater settlement success rate. Within 10 years of the 1964 earthquake, Pacific littlenecks had successfully reestablished themselves on beaches where they previously had been decimated (Paul and Feder 1976:21).

The four cockle (*Clinocardium* sp.) fragments recovered were not identifiable to species. Cockles are found in a variety of substrates, and sometimes in eelgrass beds. They live close to the substrate surface due to their very short siphons, and generally occur in the lower tidal zone, although they occasionally are found subtidally to depths of 24.4 m (Abbott 1968:228; Paul and Feder 1976:19). Nuttall's cockle, called *Cardium corbis* by Birket-Smith (1953:18), has been noted as a traditional Chugach food source.

Over 175 mussel fragments were recovered. These are probably common blue mussel (*Mytilus trossulus*). Because of their crushed state, which is not unusual in an archaeological midden, it is impossible to ascertain how many individuals may be represented. Ethnographically, the Chugach collected common blue mussels both for food and for their shells, using a special knife to scrape the bivalve from the rocks (Birket-Smith 1953:42). After consumption of the edible portion, the remaining shell was sometimes used as a skin or bark scraper (Birket-Smith 1953:75).

Six of the mollusc remains from the lower portion of the unit are periostraca. It is likely that these are from mussels.

Resource Use and Seasonality

Although the species found in the site could perhaps have been hunted, fished or gathered throughout the year, the season when all are most easily procured is spring. At that time of year, both adult and young cod are found at shallow depths, oldsquaws are abundant in the sound, and red-breasted mergansers, other ducks, and geese are migrating through the area. The paucity of salmon in the faunal collection also suggests a season when, for the most part, salmon were not commonly available.

The SEW-440 faunal collection as a whole is quite different from the collections from Uqciuvit and Palugvik. The latter are interpreted as probably representing village sites which were occupied during much, if not all, of the year. The number of sea mammal elements from the SEW-440 collection is much smaller than from the Uqciuvit or Palugvik collections, where pinnipeds, cetaceans, and sea otters make up close to 60% of the remains. In contrast to SEW-440, where fish remains make up 61% of the fauna and cod make up 83% of the fish, very few fish remains were recovered from Uqciuvit and Palugvik, a difference which does not seem to be related to preservation conditions at the latter sites. The proportions of species are also different. The majority of fish recovered in 1988 from Uqciuvit and in 1996 from Palugvik are salmon. A small percentage are halibut and gray cod, with a few additional herring and dogfish from Palugvik, and tom cod from Uqciuvit (de Laguna 1956:49; Yarborough and Yarborough 1996; L. Yarborough 1996). There is a complete lack of cetaceans, harbor seals, sea otters, and wild land mammals in the SEW-440 collection. This may indicate a lack of local habitat for these species, or it may reinforce the above suggestion of a seasonal focus on a particular resource–gray cod–supplemented by shellfish, incidental catches of other fish, and an occasional bird or sea lion.

Cultural Material Distribution and Relationships

The greatest number of artifacts are from unit N21E30. Among them are a lamp fragment, a scraper, 16 fragments which may represent one or two complete whetstones, polishing and burnishing stones, fragments of ground stone, utilized beach pebbles, a variety of beach cobble and slate flakes, and miscellaneous pieces of debitage. All were found together with the large deposits of fauna, which appear to be primarily the refuse from butchering fish. While whetstones were likely to have been used to sharpen knives for food processing, it is not suggested that all of these tools were used in this area to butcher fish and birds. Instead, this part of the site appears to have been used for disposal of broken or unwanted items and garbage. The slate flakes and debitage suggest that tool manufacture, possibly of expedient butchering tools, took place at the site. Diagnostic artifacts associated with wood working–quartz gravers and an adze flake–were recovered from N25E33, along with numerous pieces of slate and igneous debitage. In the cultural layer above were a variety of whetstones and whetstone fragments, and polishing stones, with a few pieces of flake debitage. In the fibrous organic layer below, the only cultural material is a variety of small pieces of debitage. The other unit in which cultural material appears to have been deposited at approximately the same time as these two is N32E38. This unit contained a large amount of fire-cracked rock, but only a few pieces of lithic material which appeared to have been worked or utilized: a piece of red ochre, a waterworn siltstone flake, and a piece of slate debitage.

Summary of Archaeological Data

Only two periods of cultural activities are well delineated at SEW-440: an early Palugvik phase use of the site at the beginning of the first millennium AD, and one or more periods of Chugach phase occupation during the middle of the second millennium. None of the data from the testing program suggests that the site was utilized during the 1000 years between these periods of habitation. The spruce-hemlock forest was well established during both periods of occupation. However, the earlier occupation took place during a climatic period that may have been similar to twentieth century AD conditions. The later occupation took place during the Little Ice Age glacial advance, a time when temperatures were likely somewhat colder than modern temperatures, and precipitation was greatly increased, probably much of it in the form of snow during a longer winter. More of the sound's glaciers reached tidewater than today, and many either filled or partially filled fjords or extended into the sound itself. Icebergs were undoubtedly prevalent in more parts of the sound than today. Terrestrial habitat conditions for various animals may have been slightly different than today. It is also possible that lower sea-surface temperatures may also have affected the marine habitat such that fish populations might have have differed from today's populations.

The early Palugvik phase occupation seems to have resulted in the deposition of a minimal amount of material, and there is little to indicate what activities occurred at that time, although slate awls may indicate some hunting of marine mammals. The Chugach phase residents left evidence of fishing, hunting, tool manufacture and woodworking , sweat bathing, the use of oil lamps for light and heat, processing of red ochre for paint, and possibly using of some of grinding stones to process botanical resources.

In comparison to the data from Palugvik and Uqciuvit, sites which were occupied for much of the year, the artifacts from SEW-440 do not represent a full complement of prehistoric cultural activities. Among the types of artifacts which were found at Uqciuvit and Palugvik, but not at SEW-440, are hammerstones, knives, bone and copper tools, decorative objects, and heavy woodworking tools such as axes, mauls, saws, and choppers.

The recovered artifacts notwithstanding, the species represented in the faunal collection suggest that other tools were used at this site which were not present in the test units. The presence of cod, rockfish and sculpin implies a technology for marine, as opposed to stream, fishing. Such artifacts have been found elsewhere in the sound. Open ocean fishing tools found at Palugvik included bird bone and wood fish hooks. Similar hooks, as well as gaffs, leisters and spruce root snares were reported to have been used traditionally for catching fish (Birket-Smith 1953:41-42).

In general it appears that this site was used briefly, perhaps as a hunting camp, early in the first millennium AD, then repeatedly for a specific activity, marine fishing, throughout the first half of the second millennium AD. The species recovered would have been readily available less than a kilometer north of Eleanor Island,where the sound floor drops rapidly to over 100 m in a series of shelves. The site location is protected from severe weather, and kayak landing and defensive considerations are met by the presence of beaches on opposite sides of the site. The presence of a large amount of fire-cracked rock is consistent with other late prehistoric sites in the sound, and is one of the characteristics distinguishing sites which post-date about 1000 AD.

Site Condition

The ITZ of this site was heavily oiled and received high pressure water treatment. A sample taken for monitoring purposes on the southeast shore of the site in the ITZ indicated that fluid oil from the spill is still present under 20 to 30 cm of gravel. However, there are currently no indications that the site extends very far, if at all, into the ITZ, or that the oil which is still present is injurious to the site.

Despite careful observation, no un-filled excavation could be located in the horizontal surface of the site. Natural erosion is occurring along the pre-1964 beach, and could easily be exacerbated by foot traffic. However, it does not appear to be occurring currently at a high rate, and indeed, it appears that the eroding areas are experiencing natural revegetation. In general, this site seems to have undergone little further disturbance since the oil spill cleanup period.

CHAPTER 5: RESTORATION PROJECT AT SEW-488

INJURY TO SEW-488

As a result of the *Exxon Valdez* Oil Spill, the intertidal zone of SEW-488 was covered with a 2-3 cm thick layer of oil. Cleanup operations in July resulted in the discovery of a stone lamp in the upper ITZ and notification of the cultural resource program staff. James Gallison (1989) visited the site and reported that about 5-7 m of the upper ITZ had been hot-water washed. A year later, although the surface of the ITZ was clean, oil was still present in the underlying gravel (Gallison *et al.* 1990). However, in early May, 1990, inattention to segment cleanup constraints resulted in a landing craft beaching at the site, creating furrows in the ITZ, and a cleanup crew digging pits for tar patties in the upper and middle ITZ (Bowers 1990, Reanier 1990).

Field Investigations Prior to Restoration

Gallison (1989) surveyed the site and collected three artifacts in late July 1989, although the thick oil covering the intertidal zone made survey work difficult. Exxon archaeologists returned to the site in April, 1990, and made a sketch map of the intertidal zone, showing artifact locations, and the adjacent upland area. Seven soil probe tests were made in the upland and the recent camp materials present on the surface were noted (Gallison *et al.* 1990).

The site was visited again between May 5 and 11, 1990, by Exxon archaeologists after the landing craft/cleanup crew incident. At that time, artifacts mapped in April were relocated, 14 new artifacts were noted and mapped, and a test was excavated in the upper ITZ (Bowers 1990, Gallison 1990, Reanier 1990). Slate and chert flakes were recovered from between 20 and 50 cm below the surface, and peat and organic samples were taken from deposits encountered between 40 and 70 cm below the surface (Bowers 1990).

SEW-488 was visited again in 1991 by a crew under contract to the USDA Forest Service as part of an Exxon Valdez Oil Spill damage assessment. Shovel test pits were excavated to determine the site boundaries. Two 1 m by 1 m tests were excavated in the site, one in the upland, and one in the ITZ adjacent to the 1990 test excavated by Exxon archaeologists. Dates for radiocarbon samples obtained during the course of testing ranged from about 3400 BP to about 2800 BP in the ITZ test, and and from about 1000 BP to 600 BP in the upland test. Deposits encountered in the ITZ test included peat, gravelly organics, hardpan and sandy gravels. Artifacts were located in the peat and gravelly organics. The upland test yielded sod and humus, gravels, organics and mixed gravel-organic layers, wood chips, and coarse, "greasy" organics. Artifacts were recovered from those layers with high organic content (Dekin *et al.* 1993:398-400).

Site Description and Stratigraphy

The site is on a small tombolo (Figure 18). Spruce and hemlock are the dominant vegetation, while the understory is composed of alder, labrador tea, rusty menzezia, and devil's club.

Tests excavated by the 1991 assessment crew suggest that the site covers the southeast half of the small isthmus and may extend onto the western portion of the headland (Dekin *et al.* 1993). Because of site limit definition in 1991, no additional boundary testing was undertaken in 1994 and 1995. Using the 1991 estimates, SEW-488 covers about 200 square meters of

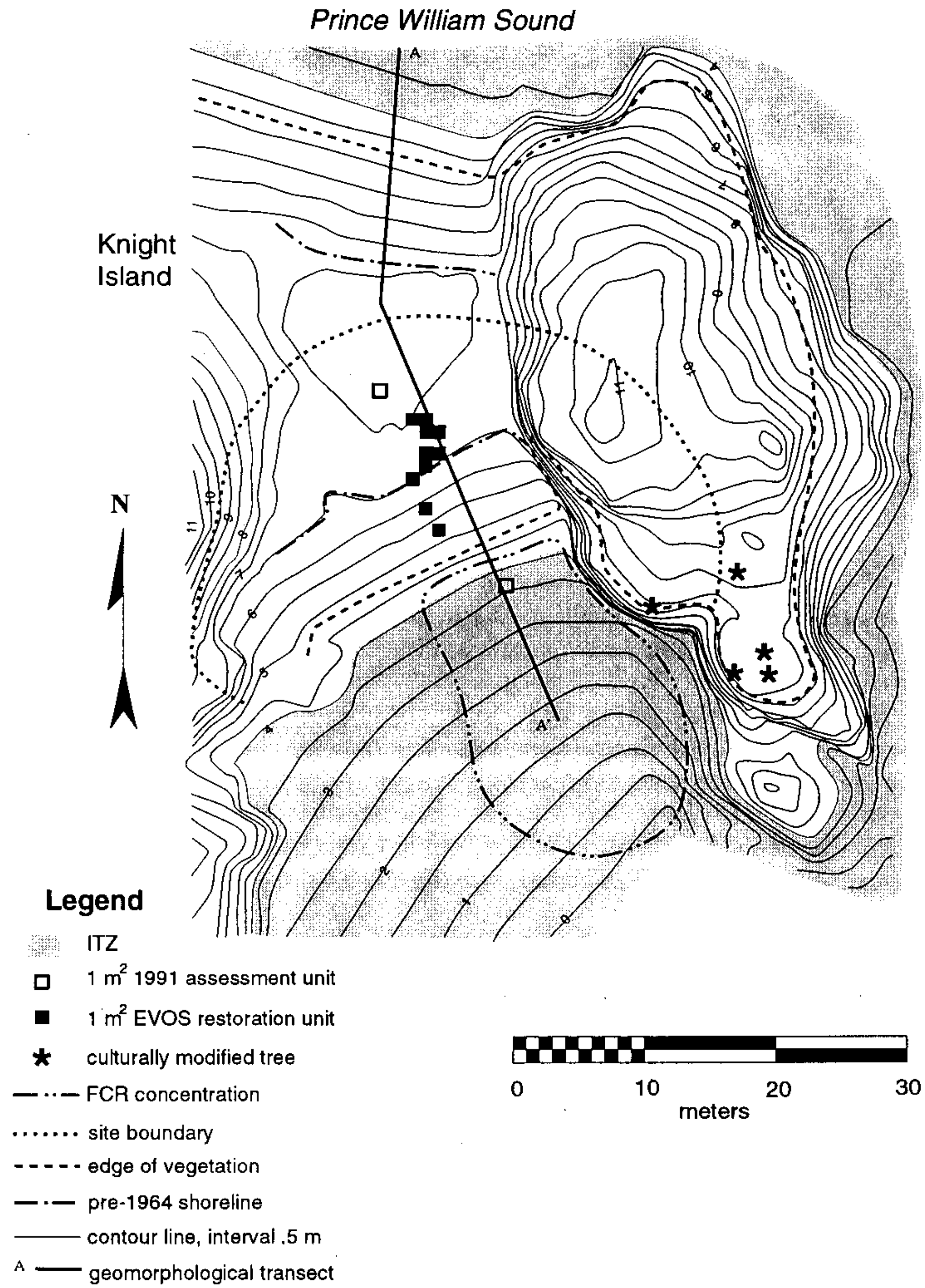


Figure 18. SEW-488.

upland and upper intertidal zone.

Three 1 m^2 units were opened in 1994, revealing both historic and prehistoric components. These tests were excavated to between 80 and 110 cm deep in 1994, were closed at the end of the 1994 field season, and reopened in 1995. Seven additional 1 m^2 tests were opened during the 1995 field season. The tests were excavated to depths varying from 85 cm to 256 cm. It is estimated that the site may comprise as much as 400 m^3 of deposit, of which approximately 12 m^3, or 3%, were excavated during this testing program.

Historic strata, varying from 20 to 30 cm in depth, were evident in all restoration project tests. Deeper layers contained prehistoric remains. Cultural layers were interspersed with non-cultural layers of gravel and tephra (Figures 19-21). What appears to be an intact forest floor was uncovered in one square. Glacial deposits appear to be present at 256 cmbs.

Beneath the top few centimeters of surface vegetation, the upland tests were characterized by a brown (10YR2.5/1) decomposing forest duff-organic layer varying in thickness from a few to about 10 cm, with burned wood in the northernmost units. This layer and the 3-8 cm of brown-gray (5YR3/1) gravelly soil below it contained historic artifacts and 1912 Novarupta lapilli. The lapilli occurred in a layer up to 20 cm thick near the pre-1964 shoreline, but thinned to a scattered layer of single lapilli in the north part of the site. Beneath the gravelly soil was another dark reddish brown (2.5YR2.5/1 to 10YR2/1) forest loam, which was from 10 to 15 cm thick. This was underlain by a 7-14 cm thick gravel layer characterized by a small amount of black (5YR2.5/1) soil present among the gravel. Below this rather dry gravel was a 35-40 cm thick layer of black (5YR2.5/1 to N2.5) sticky, "greasy" soil with a high gravel content. This layer contained a large amount of fire-cracked rock, which in unit N21E23 appeared to be distinguishable as a distinct layer throughout approximately the middle of the gravelly layer. The lower portion of this layer contained an increased amount of charcoal. Another organic layer, 8-18 cm thick, with an increased amount of gravel and fire cracked rocks underlay the charcoal and fire cracked rock. The next soil encountered was a mixed woody organic gravel, 5-15 cm thick. This was often interspersed with a layer of gravel, and a 2-4 cm layer of *Pinaceae* needles which seemed to represent a forest floor. Beneath this deposit was a compact gray-black (10YR2/1) forest duff, with inclusions of spongy yellowish brown (10YR5.6) wood. Beneath the forest duff was a 6-7 cm layer of mottled orange (10YR5/6) rotting wood with a somewhat sandy texture. The lowest layer excavated in many of the upland tests was a compact brown-black (10YR2/1) forest duff containing logs or large roots. It extended to at least 182 cmbd.

Beginning at 182 cmbd in Unit N22E23, a 25 by 25 cm area was excavated to a depth of 256 cmbd. The brown-black organics continued, grading through dark red-gray brown to dark gray brown organics, extending almost 30 cm down to 211 cmbd. At 211 cm the deposit changed abruptly to an 8 cm thick light brownish gray (10YR6/2) gravelly sandy silt. Below this was a layer of dark yellow brown (10YR4/4) sandy organics with gravel which continued to a depth of 247 cmbd. This was underlain by a very compacted olive (5Y5/3) gravelly sandy silt which appears to be lodgement or redeposited till. No cultural material was recovered below 182 cmbd, and it appears that no human activity is represented in the lowest 74 cm of excavated deposit.

The strata recognized in test unit #2 of the 1991 assessment program are roughly comparable to what was found in the 1994-1995 testing. They include, from the top, approximately 10 cm of reddish black (10YR2.5/1) forest duff with roots of the modern vegetation, a 34 cm thick layer of black (7.5YR2/0) organics with fire-cracked rock and round pebbles. Beneath the layer with fire-cracked rock were a thin (3 cm) dusky red (10R2.5/2) woody layer mixed with gravel and a few sticks, and a thin (3 cm) dark reddish-gray (10R3/1) woody layer with less gravel and more sticks, separated by 6 cm of gravel mixed with organic silt or peat. These were underlain by a 2-3 cm yellowish brown (10YR3/2) probable tephra layer, a very dark gray (5YR3/1) 2 cm wood layer containing sticks with little silt or gravel above a 3-5 cm wood chip layer, a 9-10 cm thick bed of black (7.5YR2/1) well-sorted beach gravels mixed with organic silt or peat, and a 6-7 cm thick fibrous layer containing charcoal and a wood artifact. The layers below showed no cultural evidence, and consisted of dark reddish brown (5YR2.5/2 to 2.5YR3/4) black (5YR2.5/1) and brown (7.5YR3/2) peats with twigs and roots, a tree stump, grass, leaves, and possible hemlock needles. These lowest excavated layers of Test Unit 2 likely correspond to the forest floor detritus seen in many of the restoration project tests between 80 and 100 cmbd.

Features

In 1994, two rock-lined post holes, evidence of some type of a structure, were discovered at about 80 cm depth in the unit N22E22. Additional evidence of the same or possibly different structure was seen in a 5-10 cm thick layer of closely packed fire-cracked rock between 70 and 80 cm depth in units N21E23 and N19E23. Closely spaced rocks were also found in several of the 1995 tests at approximately the same depth.

Prehistoric structures are rarely found in Prince William Sound sites, and their designs and functions are poorly understood. They are rarely related to surface features, unlike sites in Kodiak and Cook Inlet where structures are often indicated by surface depressions still visible thousands of years after their abandonment. During her early twentieth century surveys of the sound, De Laguna (1956:12, 19) found surface features at only two sites. She noted "several depressions, some opening into each other" on a gravel ridge at COR-081 in Constantine Harbor on Hinchinbrook Island, and two rows of shallow pits at COR-041 on Hawkins Island. Surface features are present at SEW-056, in Esther Passage, but are not necessarily related to the subsurface house remains which exist at that site (Yarborough and Yarborough 1996). COR-001 on Hawkins Island does not have discernible surface features, yet has yielded subsurface evidence of two houses. One house was over 9 m long, with at least four house posts (de Laguna 1956:43-44). The other, suggested to have been a small winter hut, was about 3 m wide and 5.5 m long. It contained a stone fireplace, a discernible mud or clay floor, and a wall marked by a line of four post holes (de Laguna 1956:46-48). The post holes at SEW-488 are similar to those found at SEW-056 and COR-001, and are not associated with any surface features.

Fire-Cracked Rock

Over 1,011 kg of fire-cracked rock were removed during excavations at SEW-488. The unit totals ranged from 28.1 kg in N21E24 to 211.25 gr in N17E22. Large amounts of fire-cracked rock appear to be only associated with deposits which post-date 1000 AD. The gravel layers of the upper portions of the site contained the majority of the fire-cracked rock, with little to none occurring in the water-logged forest duff and organic layers below 100-140 cmbs. Variation between units in the amount of fire-cracked rock does not appear related to distance from the shore, but is most likely related to the location of dwellings and associated sweatbaths,

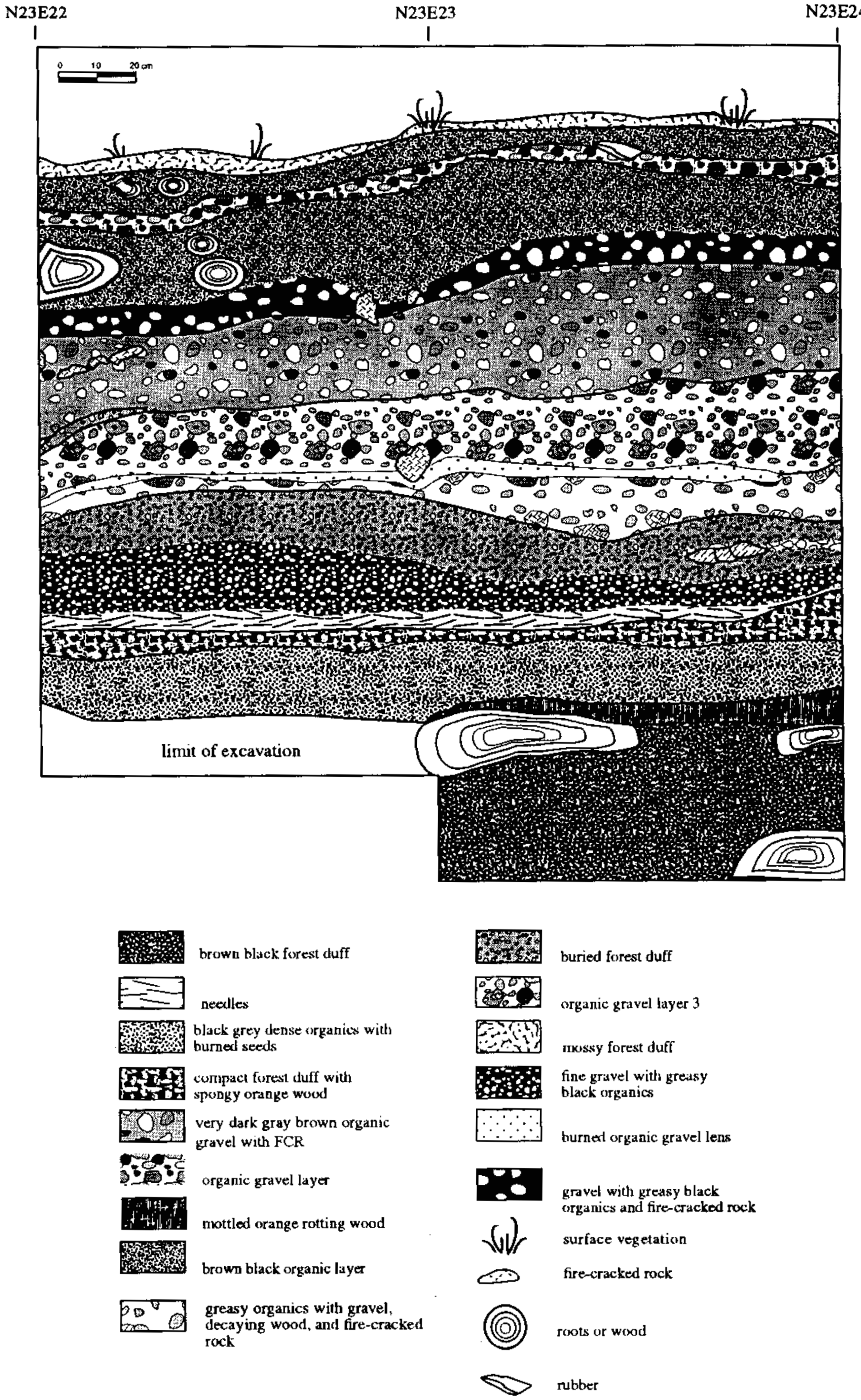


Figure 19. N23 wall between points N23E22 and N23E24, SEW-488.

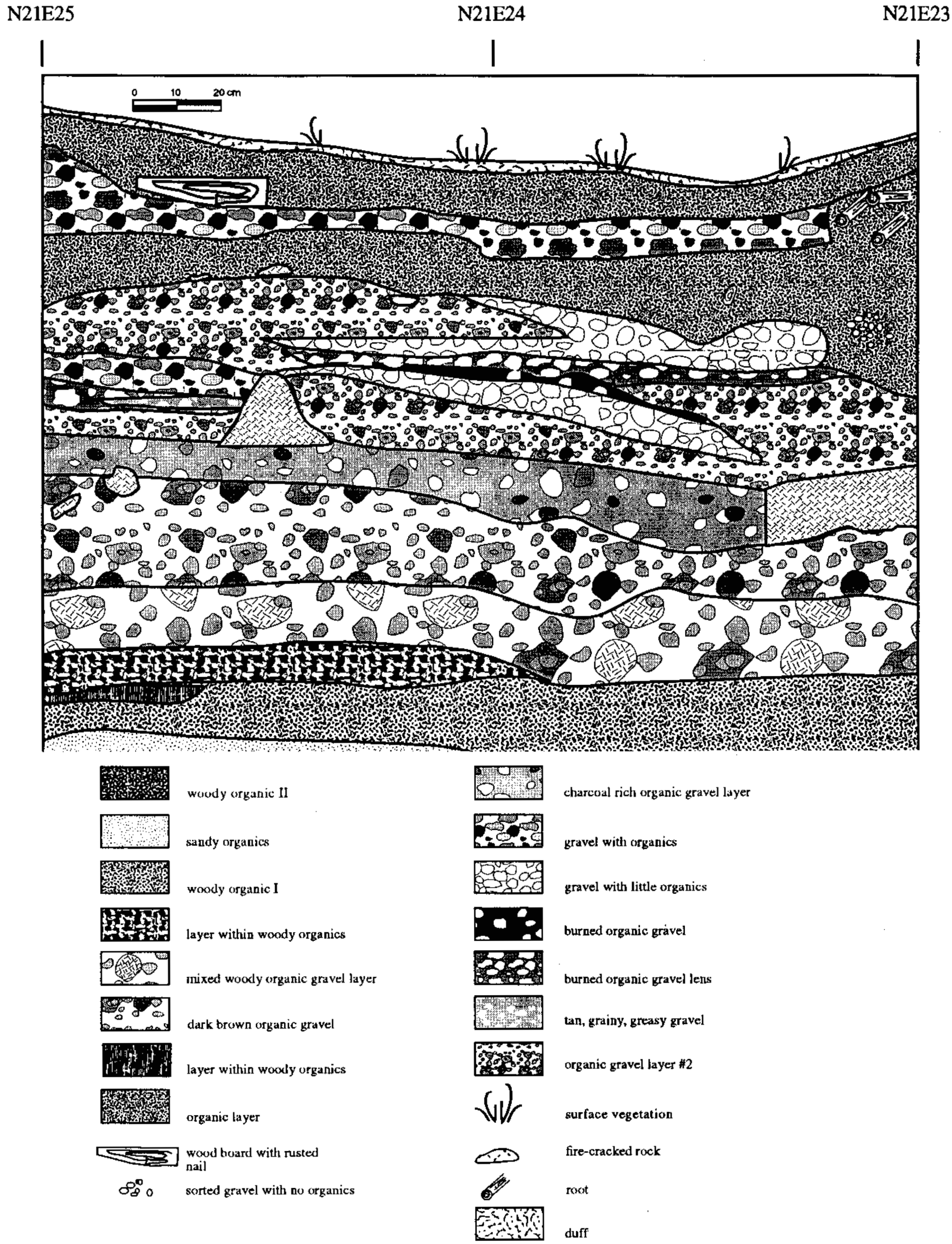


Figure 20. N21 wall, between points N21E23 and N21E25, SEW-488.

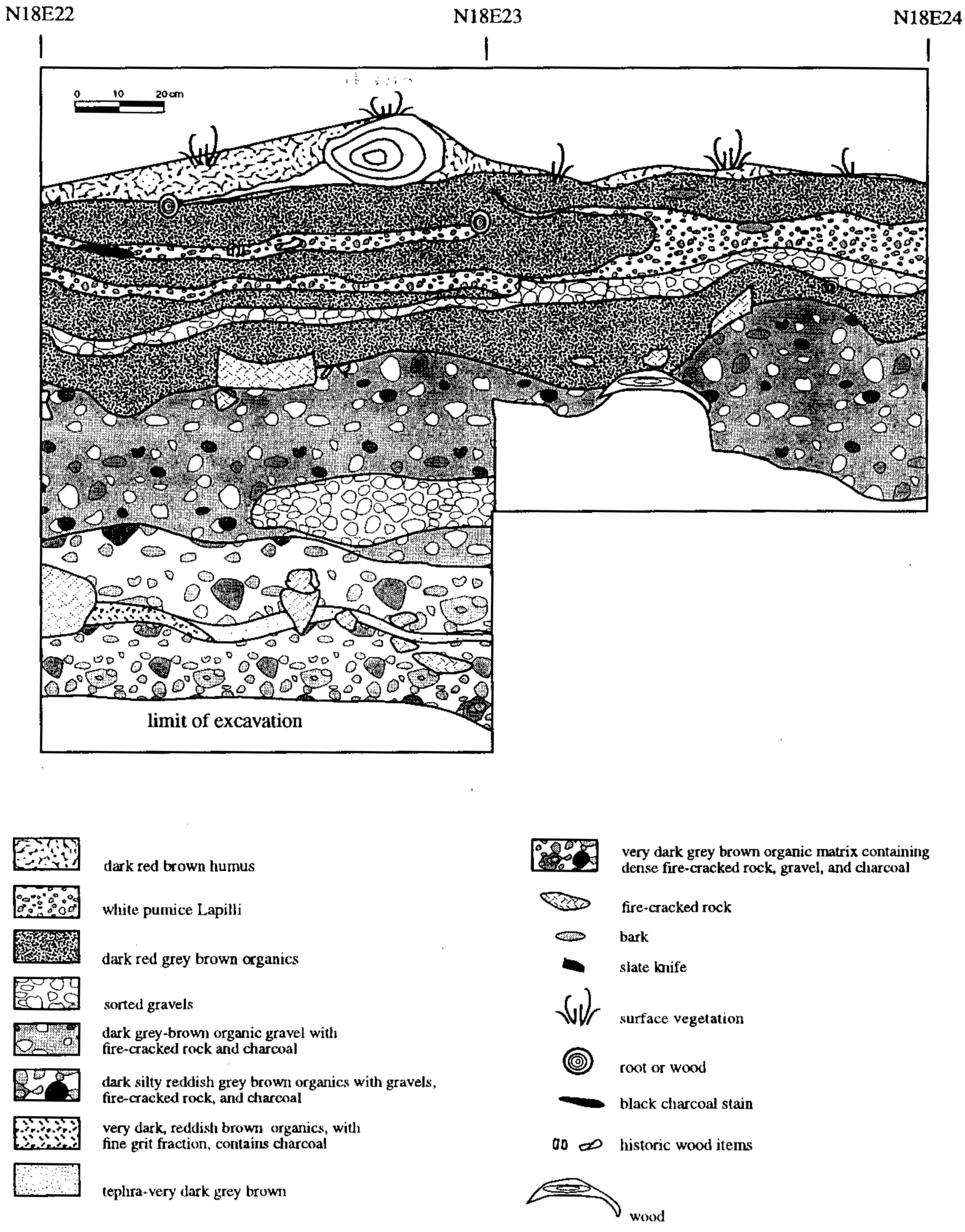


Figure 21. N18 wall between points N18E22 and N18E24, SEW-488.

or other distinct activity areas within the site.

The data from SEW-488 reinforce the concept that the presence of large amounts of fire-cracked rock is a marker of the late prehistoric period. The same trend is seen at SEW-440, as discussed above, as well as Palugvik and Uqciuvit, and other north Pacific coastal sites.

Tephra

Fourteen soil samples taken from SEW-488 proved to be volcanic in origin. After analysis, four of these appear to be rounded pumice or lapilli from the 1912 Novarupta or "Katmai" eruption on the Alaska Peninsula (Riehle 1996, Begét 1996). This result is strengthened by association with a date of 30±50 BP from a charcoal sample at 17-21 cmbd in N22E22 (Beta 78764) and the general association of the lapilli with twentieth century historic remains. The pumice occurs throughout the site in a layer which varies in thickness from a single, 2 cm diameter piece in some of the upland portions of the site, to over 10 cm in areas near the pre-1964 shoreline (Figures 16-18). Allowing for stratigraphic variation within the site, these lapilli are nevertheless found throughout the area at depths of less than 40 cmbs. The lapilli are likely to have floated to the site and washed up on shore, with some of these very light weight pieces being blown further up onto the land during storms (Begét personal communication 1996).

Deeper volcanic soil samples were more challenging to interpret. Although not directly associated with a radiocarbon date, the chemical composition and stratigraphic context of a tephra recovered from 35 cmbd in N22E22 suggest that it may be a sample of the Valdez ash, which is believed to have been deposited sometime between 1000 and 500 BP. A sample of what appears to be the same ash was collected from the non-cultural, wet meadow soil sample, at 8 cm below the surface, 2 cm above a sample of organic material dated at 580±60 BP (Beta 89061). A tephra sample from N22E22 found at 92 cmbd may be an example of either the White River east lobe (1260 BP) or Rude River (1420±65 to 1265±30 BP) ashes. The radiocarbon date on a charcoal sample found 10 cm above this tephra is 810±50 BP (Beta 78766). Pumice from a depth of 135-140 cmbd in unit N22E23 is associated with a radiocarbon date of 1130±80 (Beta 89056). It too appears to be either White River east lobe or Rude River ashes, based on chemical composition and date. This tephra may also be represented in an undated wet meadow sample taken at 13 cmbd, which occurs between organic samples dated at 580±60 BP, and 3640±60 BP (Beta 89062). Although no further recognized tephras or pumice samples were collected from SEW-488, an older ash was recovered from the wet meadow test at 32 cm below the surface, occurring between a sample radiocarbon dated 3640±60 BP, noted above, and an organic sample dated at 6520±70 BP (Beta 89063). It may represent the Bligh Island (<5230±60 BP) or Oshetna (5600-5200 BP) ashes (Beget personal communication 1996; Begét *et al.*, in press).

Soils

Like the soils at SEW-440, the pH tests on the bulk samples from SEW-488 yielded acidic results for the upper strata which are consistent with the Sitka spruce-western/mountain hemlock vegetation on the site (Table 5). However, the pH became increasingly neutral at greater depths, a situation which appears to be directly related to the collection of rainwater draining from higher upland areas immediately northeast and southwest of the site into the swale in which the site is located. Deposits deeper than 1 m were saturated.

Table 5. Soil pH values, SEW-488.

Sample#	cmbs	pH
3.s.1	03 - 13	4.80
3.s.2	10 - 20	4.40
1.s.2	25-30	4.50
3.s.4	30-40	4.60
3.s.5	40-50	5.80
1.s.4	40-50	5.00
2.s.6	60-70	4.90
3.s.7	60-70	5.70
1.s.6	60-70	5.60
6.s.21	65	6.00
2.s.7	70-80	5.10
3.s.8	70-80	6.00
1.s.8	80-90	6.20
2.s.8	80-90	5.40
3.s.9	80-90	6.30
3.s.10	90-100	6.10
3.s.11	100-110	6.30
1.s.10	100-110	6.10
1.s.11	102	5.90

This saturation and more neutral pH at a depth of greater than 1 m seems to have provided an anaerobic environment which enhanced the preservation of botanical remains, although it appears to have also decreased the chance of preservation of calcium-rich materials such as shell, as discussed below. Numerous remnants of decomposed wood, which appear to have been local spruce or hemlock, were encountered in the historic portion of the site. The preservation of the historic wooden artifacts, which were recovered in the upper 30 cm of deposit, may be due in part to the type of wood of which they were made, or materials with which they were treated, such as paint or lacquer. The only other wooden artifacts recovered were in saturated soils deeper than 1 m. What appear to be the remnants of preserved forest floors were also present in these deeper wet deposits.

Site Chronology

Because few diagnostic artifacts were recovered from SEW-488, and due to a desire to compare the strata in the northern upland part of the site with those of the intertidal zone, 30 charcoal samples were submitted for radiocarbon analysis (Table 6). The stratigraphy and associated radiocarbon dates suggest as many as four general periods of occupation. One historic and two prehistoric periods of habitation are represented by cultural remains associated with charcoal samples from upland tests. One additional period of prehistoric use may be

Table 6 Analysis results for radiocarbon samples from SEW-488.

49SEW488 catalog #	Beta #	unit	cmbd	conventional C14 age	calibration 2∑ 95% probability	C14/calibration curve intercept
6.c.3	89039	N17E22	41-48	250±50	AD 1515-1585, 1625-1685, 1740 -1810, 1930-1950	AD 1655
2.c.1	78764	N22E22	17-21	300±50	AD 1695-1725, 1815-1920	none
1.c.14	78761	N19E23	66	350±50	AD 1450-1665	AD 1525,1560, 1630
7.c.1	89040	N18E23	54	360±60	AD 1435-1660	AD1505, 1595, 1620
3.c.12	78768	N21E23	64	380±50	AD 1435-1650	AD 1485
6.s.7	89043	N17E22	>71	430±50	AD 1420-1525, 1560-1630	AD 1450
6.s.10	89044	N17E22	100-106	430±50	AD 1420-1525, 1560-1630	AD 1450
3.c.9	78767	N21E23	55-60	460±60	AD 1410-1640	AD 1450
9.s.9	89046	N21/E24	60-63	520±50	AD 1315-1345, 1390-1455	AD 1420
6.s.12	89045	N17/E22	108-122	560±60	AD 1295-1450	AD 1410
9.s.14	89047	N21/E24	99-109	560±70	AD 1290-1455	AD 1410
10.s.14	89055	N22/E23	~130	570±70	AD 1290-1450	AD 1405
10.s.8	89052	N22/E23	>100	590±60	AD 1290-1435	AD 1400
1.c.30	78763	N19E23	108	600±60	AD 1285-1435	AD 1395
4.c.1	89038	N12E24	>38	600±60	AD 1285-1435	AD 1395
1.c.28	78762	N19E23	101	610±60	AD 1290-1435	AD 1400
10.s.12	89054	N22/E23	~120	620±80	AD 1265-1440	AD 1315, 1345, 1390
10.s.5	89051	N22/E23	~33	700±60	AD 1235-1400	AD 1290
2.c.6	78766	N22E22	82-85	810±50	AD 1165-1290	AD 1245
9.s.23	89048	N21/E24	128-138	820±60	AD 1045-1105, 1115-1290	AD 1235
2.c.4	78765	N22E22	69-71	900±70	AD 1005-1275	AD 1170
9.s.24	89049	N21/E24	152-156	910±90	AD 980-1285	AD 1165
9.s.25	89050	N21/E24	159-174	990±60	AD 970-1195	AD 1025
10.s.16	89056	N22/E23	135-140	1130±80	AD 705-1035	AD 905, 920, 950
10.s.19	89057	N22/E23	~150	1290±50	AD 655-875	AD 705
4.s.7	89042	N12E24	88-101	1680±50	AD 245-465, 475-515	AD 395
10.s.21	89058	N22/E23	182-185	2680±60	BC 925-785	BC 820

*picked from fish bone layer
†sample from just above sloping bedrock

indicated by material from an ITZ test.

The earliest use of the site, during the early first millennium BC, is represented by a single, non-diagnostic slate artifact at 182 cmbd in unit N22E23, associated with a conventional radiocarbon date of 2680±60 BP (calibrated 925-785 BC, Beta 89058). The extent of this occupation is not known, as other units were not excavated to the same depths. This period of use corresponds roughly to, but appears slightly earlier than, the early Palugvik phase reoccupation of Uqciuvit, and the first occupation of Palugvik. It also roughly predates by several hundred years the end of the first Holocene Neoglacial advance.

Radiocarbon dates from samples recovered from an ITZ test during the 1991 archaeological assessment project yielded similar but slightly older dates: 3395±160 BP and 2770±130 BP on one split botanical sample, and 3070±135 BP and 2980±130 BP on a slightly lower split botanical sample (Dekin *et al.* 1993:400). However it is not known if these dates represent human occupation.

Occupation of the site during the early first millennium AD is suggested by a radiocarbon date of 1680±50 BP (calibrated AD 245-465 and AD 475-515, Beta 89042). However, use of the site during this time is uncertain. The charcoal which yielded this date was from a soil sample collected from a layer of dark decaying organics or peat in unit N12E24. This unit is slightly higher in the ITZ than 1991 test unit 1, but below the 1964 shoreline (figure 18). Despite the undisturbed appearance of the deposits from this unit, recent historic materials were recovered from depths up to 110 cmbd. Most were found during screening, but several were recovered from the wall of the unit. Greenstone and felsic tuff debitage, and a wooden peg which certainly appear to be prehistoric were recovered at about 110 cmbd, and the deposits between 45 and 60 cmbd were also characterized by a polished stone, a slate knife fragment, and various pieces of stone debitage. It is possible that at least some of the historic artifacts may have washed or fallen into the lower levels of the unit, but it is not impossible that mixing of the deposit may have also occurred as a result of wave action prior to uplift of the ITZ during the 1964 earthquake. It may also be due to human disturbance during cleanup activities. Consequently, the relationship of this charcoal sample to prehistoric cultural remains in this unit is suspect. Additionally, the situation raises some doubts about the cultural significance of the radiocarbon dates associated with prehistoric artifacts in unit 1 of the 1991 assessment project mentioned above. However, it is possible that several thousand year old cultural deposits may still be present *in situ* in the ITZ. Occupation of SEW-488 by the late first millennium AD is indicated by a radiocarbon date of 1290±50 BP (calibrated to AD 655-875, Beta 89057). The calibrated dates of 24 additional charcoal samples indicate that use of the site continued to the middle to late second millennium AD. Their standard deviations overlap to such an extent that it is impossible to define any breaks in habitation during this period of as much as 1000 years.

Evidence of an early twentieth century AD use of the area is seen in a variety of historic artifacts spread across the site just above, or occasionally mixed with, lapilli from the 1912 Novarupta volcanic event. Manufacturing dates for one of the cartridge cases in the historic assemblage indicate that this use of the site probably post-dates AD 1930.

Artifacts–Historic

The majority of the historic artifacts described below were recovered from an early twentieth century component present in upland units of SEW-488. A few artifacts which appear to be more recent were recovered from unit N12E24 in the upper ITZ. Artifact types are categorized by type of material and function. The following descriptions include measurements in millimeters, although many of these items may have been manufactured according to English measurements. These measurements have been included where appropriate.

Lead weights

Eight small weights from a fishnet lead line were recovered. Five were found together in unit N19E23 at a depth of about 24 cmbd, and three were from unit N18E23. They are all slightly "barrel-shaped" (cylindrical with an expanded middle). Seven of them are about 32 mm long and 27.7-29.3 mm in diameter. They have a 14.4-15.3 mm opening through the center. The thickness of the weight at the edge of the center opening is 3.2 to 4.7 mm. One is longer and thinner (43.1 cm long and 14.8 mm in diameter) and about 1 mm thick at the edge of the opening. All have line of an unknown material running through them.

Nails/Spikes

Seven large iron spikes and four small iron nails were recovered from units N15E23, N19E23, N22E22, N21E23, and N21E24. The later are all common wire nails. The largest spike, found in unit N22E22, is 215.9 mm (8.5 in.) long, and is bent at a 117 degree angle. Two spikes from unit N21E24 are 199.0 and 176.0 mm long, and appear to be 8 and 7 inch cut spikes, respectively. A fourth large spike from unit N19E23 is 155.57 mm (6 1/8 inches) long and 18.7 mm diameter. Three 60 pennyweight nails from N21E24 are between 151.3 and 152.5 mm long. One smaller nail, 93.9 mm long, from the same square is either 16 or 20 pennyweight. An 8 penny nail was found in unit N19E23. It is 63.5 mm (2.5 inches) long, and is broken about 28.57 mm from the top, exposing a hollow interior. A small 6 penny nail, 52.4 mm (2 inches) long, was found in unit N15E23, and the mid-section of a nail, 16.4 mm long and 2.4 mm diameter, was recovered from unit N21E23.

Rifle cartridge casings

Seven brass cartridge cases and one bullet were collected from the historic deposits. Six of the cases, and the hollowpoint round bullet, all Super-X Hornet .22 caliber, were found in unit N18E23. The bullet is covered with melted plastic. The seventh case is a .25-.35 centerfire rifle cartridge with a round firing pin, found in unit N22E22.

The .22 Hornet was developed in the late 1920s and first marketed commercially in 1930 by Winchester. This small bore, high velocity cartridge became a standard ammunition size within a few years. Current manufacturers are Remington, Winchester, and Norma (Barnes 1992:17). The .25-.35 Winchester was introduced in 1895. Both European and American manufacturers produced rifles for it, although American companies stopped manufacturing rifles for .25-.35 ammunition in 1944. Winchester still produces this caliber ammunition, although rifles which will chamber it are becoming obsolete (Barnes 1992:33). Both the .22 Hornet and the .25-.35 Winchester are most effective for shooting small game.

Containers

The remains of at least one small metal container, one metal cooking pot, and a 55 gallon drum were recovered from the site. Numerous metal fragments which were not identifiable also may be remnants of these or other containers.

A thin rectangular container in two large fragments and several small pieces was found in unit N22E22. It has no identifying marks. The dimensions of the can bottom are 76.2 mm (3 in.) by 24.4 mm (1 in.) and the section is 108.3 mm (4.375 in.) high. The bottom is recessed 2.2 mm (0.08 in.). The metal fabric is 1.5 mm (0.06 in.) thick. The top of the can has a 3.6 mm (0.14 in.) wide raised ridge around it, about 5.2 mm (0.2 in.) down from the rim. The opening of the can is not present. The can has been flattened in the middle and broken diagonally across this area. It is completely rusted.

Additional rusted fragments of a can and rim recovered from a similar depth in the western portion of adjacent unit N21E23 may be part of the same item, or portions of one or more different cans. The rim piece is broken in two which together measure 45.9 mm by 8.3 mm by 2.9 mm thick (1.8 by 0.32 by 0.11 in.). The largest of 15 irregular flat metal pieces found with this rim is 17.7 mm (0.7 in.) long, 15.9 mm (0.63 in.) wide, and 1.9 mm 0(.07 in.) thick.

A "U"-shaped handle and four large pieces of metal recovered from unit N22E22 may represent the rusted remains of a cooking pot. The handle is a 13.3 mm (just over 0.5 in.) round piece of 304.8 mm (12 in.) long metal bent into a "U" shape. It is flattened to 50.8 mm (2 in.) by 19.05 mm (0.75 in.) by 12.7 mm 0.5 in.) thick at each end. The handle was fastened to a container or pot with metal rivets or screws, the heads of which are still visible beneath the rust. A rectangular piece of the pot is still attached to one end of the handle. The ends of the handle are about 8.89 cm (3.5 in.) apart, and are bent to an angle of approximately 25 degrees where they attach to the container.

Additional pieces of rusted metal found about 15 to 20 cm deeper in the same square may be portions of the same or a different cooking pot. A roughly rectangular rim piece is 56.1 mm (2.2 in.) long, 4.8 mm (0.19 in.) wide, and 2.8 mm (0.11 in.) thick. A rounded piece from the bottom of a container is 18.4 mm (0.72 in.) long, 15.6 mm (0.61 in.) wide, and 3.9 mm (0.15 in.) thick. The largest of 16 irregularly shaped pieces associated with the two above pieces is 33.6 mm (1.3 in.) long, 31 mm (1.22 in.) wide, and 4.0 mm (0.16 in.) thick.

The rusted remains of a 55 gallon drum were visible on the surface, and present within and below the root mat on the east side of unit N21E23, and the west side of N21E24. Pieces of the rim, flat top and bottom, and curved sides are present. Of 41 identified rim pieces, the largest is 145.6 mm long, 12.1 mm high and 9.7 mm thick. The largest piece of over 400 drum fragments is 64.6 mm long, 63.0 mm wide, and 5.4 mm thick. There is no evidence as to what liquid may have originally been in this drum.

Stove parts

Two possible coal stove parts were recovered from just below the surface in unit N19E24. One piece is a cast iron grate with a J-shaped cross section. It is 440.3 mm (17.33 in.) long, 74.9 mm (2.95 in.) wide, and 70.9 mm (2.79 in.) thick. The curved bottom of the"J" contains two rows of holes which are 12.6 mm (.5 in.) in diameter. One end has a short 22.6 mm (.89 in.) diameter shaft, while the opposite end is broken off. The other possible stove part is a pedal or arm which may have been attached to a clinker pan. It is a 313.0 by 26.0 by 16.0 mm (12.3 by 1.0 by 0.62 in.) bar with a short axle at one end that hinges in two stirrups on bottom of a 113.6 by 89.0 by 5.4 mm (4.47 by 3.5 by 0.21 in.) rectangular plate. There is an offset "t"-shaped key on the opposite end of the bar. A row of 4 rivets on each side of the plate which once attached this piece to another has now corroded away.

Ceramics (Figure 22)

Three ceramic items are represented by approximately 140 fragments distributed throughout five units. Although all are decorated, none have makers' marks or other features which would indicate their place or date of manufacture.

One is a whiteware plate, with two 0.8 mm wide, overglaze gold lines encircling the

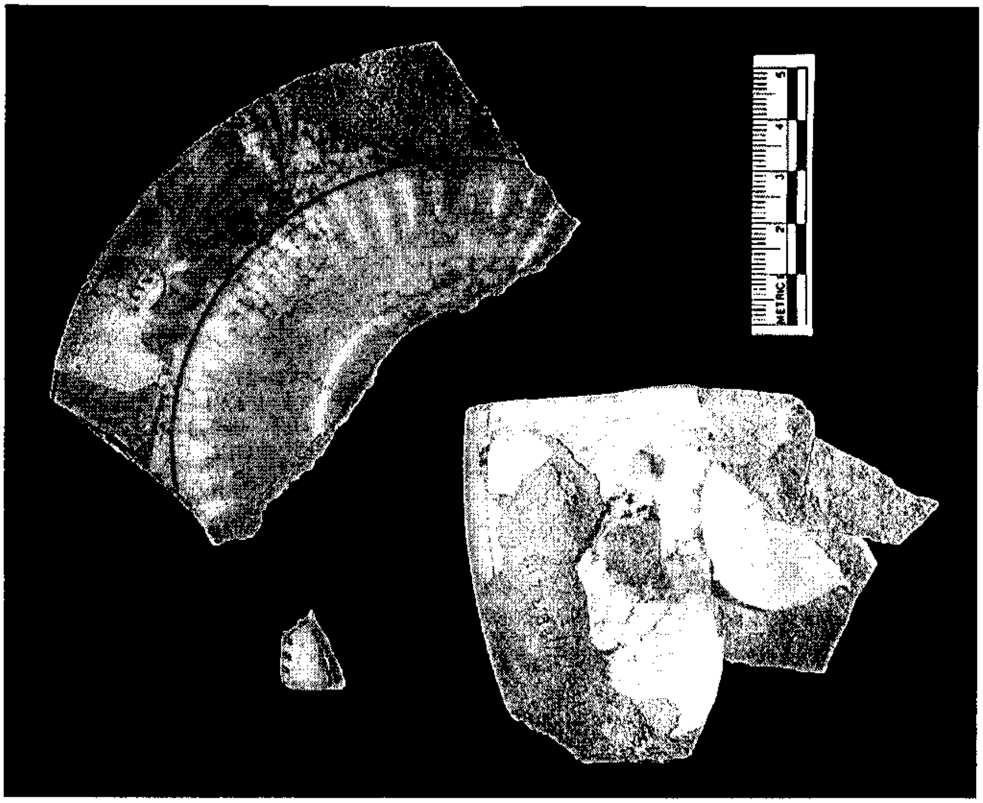


Figure 22. Ceramic fragments: floral design (10.1), white with green stripes (6.6),white plate with gold edge stripes (3.7).

interior just inside the rim. The center of the plate is about 5.3 mm thick, while the rim is roughly 4.8 mm thick. The plate may have been about 304.8 mm (12 inches) in diameter. Over 135 fragments of this plate were recovered, the majority of them from unit N21E23. Two pieces were also found in N22E23, and one in N15E23.

Three pieces of a saucer were recovered, one from unit N17E22 and two from N21E24. The largest fragment is 29.0 mm long, 25.5 mm wide, and 5.1 mm thick. This item appears to be a piece of common dinnerware, with a green dashed line encircling the interior. A rounded 2.9 mm thick ridge circles the base on the outside. The saucer stands 30.0 mm high overall.

The third item appears to be a whiteware saucer. It is represented by only one shard found in N22E23. This piece is 92.5 mm long, 56.6 mm wide, and 3.6 mm thick, and comprises about a fifth of the original item. The saucer is handpainted, with a floral motif in red, yellow, orange, and green, bordered at the outer and interior edges by blue lines. The flat interior of the saucer has a molded decoration of lines which radiate from a slightly depressed center to the innermost painted blue line. The glaze is crazed and darkened from heat.

Table leg

A rectangular sectioned wooden table leg with three wire nails in it was found in unit N19E24. This tapering piece appeared to have been commercially milled.

Stake

Roughly rectangular in cross section, this small stake tapers to a point at one end. The opposite end appears to be both broken and deteriorated. The stake is 114.0 mm long, 33.0 mm wide, and 32.5 mm thick.

Ax-cut wood

A small branch with a single transverse ax cut at one end was recovered from unit N22E22. This long, thin, slightly curved piece of wood is 750.0 mm long, 37.5 mm in diameter at the cut end, and 25.0 mm in diameter at the opposite, broken, end.

Float (Figure 23)

Two pieces of a flat, circular, cork float were recovered from unit N19E23 in association with five of the lead weights mentioned above. These pieces are 48.0 mm long, 30.5 mm wide, and 35.7 mm thick, and 70.0 mm long, 28 mm wide, and 30.6 mm thick. Together they form about half of the complete float, which appears to have been about 107.6 mm in diameter. The diameter of the hole through which a line would have passed was about 41 mm. It was most likely part of the same fishnet represented by the lead weights.

Lantern fragments

Thirty one pieces of thin, slightly curved, clear glass are likely the remains of a lantern globe or chimney. There are no maker's marks or other identifying attributes. All are between 0.8 and 1.0 mm thick, with the largest piece collected measuring 46.1 by 34.0 mm. The smallest is 7.6 mm long by 3.5 mm wide.

Window glass

A spall of clear plate glass with a slight bluish tint was recovered from unit N17E22. This

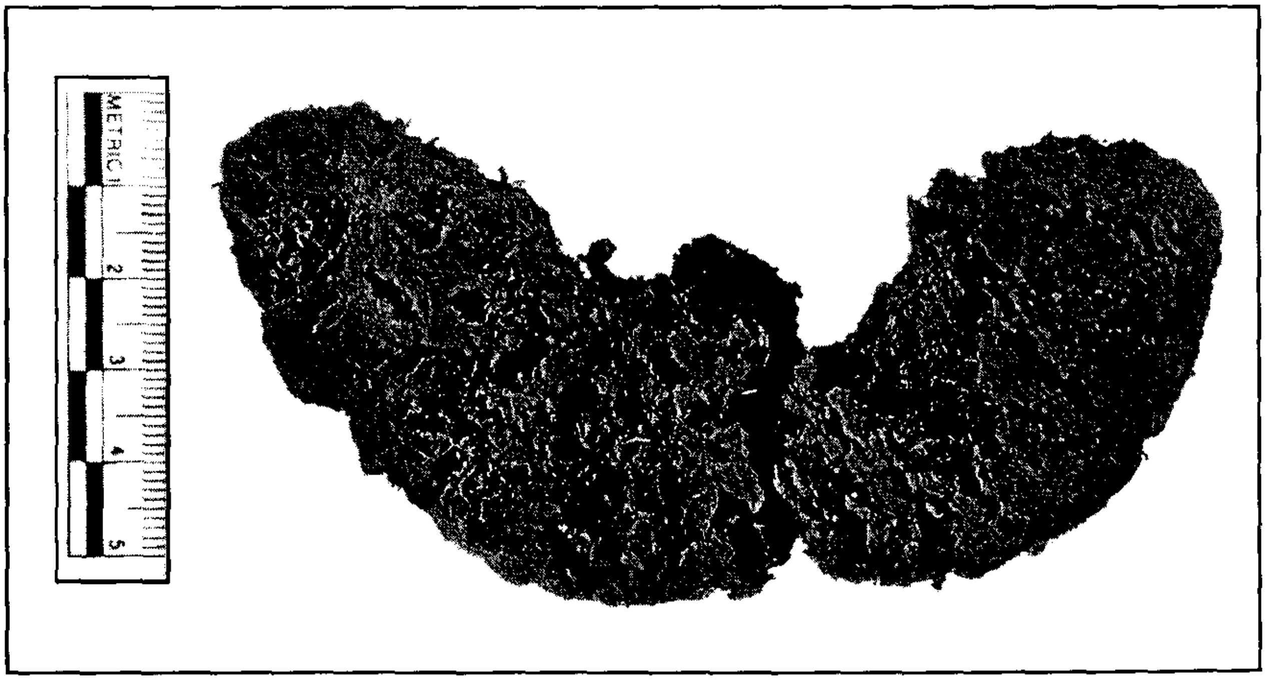


Figure 23. Cork float (1.4).

irregular fragment is roughly 31.1 mm long, 22.3 mm wide, and 3.4 mm (3/16 in.) thick. Window glass has generally increased in thickness from the beginning of the nineteenth century to the present. A thickness of 3/32 in was prevalent at the turn of the twentieth century and shortly thereafter. Common glass thicknesses today are 1/8 in, 3/16 in, and 1/4 in (Shinkwin *et al.* 1978:202).

Bottle glass

Most of the fragments of bottle glass recovered from the site are too incomplete to date, or even classify, by manufacturing technique. The few datable attributes which are present suggest that twentieth century technology is represented by these shards.

Three examples of clear bottle glass were recovered from two upland units. Two are from unit N19E24. Six pieces found together form an incomplete rectangular bottle base. It is 75.0 mm long and 40.0 mm wide, and the glass is 2.7 mm thick. There are no maker's marks or numbers on the base, and no seam is present. The other example from this test is a partial bottle base formed of four fragments. It was octagonal in cross section, with a faint base inscription of "made in USA" and "1" in a round depression. This fragment is 124.7 mm long, 91.1 mm wide, and 3.6-5.0 mm thick. A portion of a clear bottle finish was recovered from N15E23. This neck fragment has a crown finish and is 43.4 mm long, 28.8 mm wide, and 4.2 mm thick. The inside diameter at the top is 15.5 mm, and the lip is 6.7 mm thick. The manufacture of clear glass bottles began in 1880, and crown caps or finishes have been in use from 1895 to the present (Newman 1970:74, 75).

One of six pieces of brown glass from the site was recovered from unit N21E23. This slightly curved, unweathered container fragment is 19.2 mm long, 12.5 mm wide, and 3.1 mm long. The remaining five brown glass bottle pieces are from unit N15E23. Two of the fragments are frosted. One is 25.5 mm long and 22.6 mm wide, while the other is 28.2 mm long and 20.9 mm wide. They vary in thickness from 4.1 to 5.2 mm. A third, undistinguished brown fragment is 21.8 mm long, 15.0 mm wide, and 3.3 mm thick. A curved fragment which may be the shoulder of a bottle is somewhat thinner (2.1 mm) than the others. It is 28.0 mm long, 15.1 mm wide, and is embossed with the letter "T". Because of the fragmentary nature of this piece, and the use of the letter "T" in conjunction with other letters by various manufacturers, it is not possible to assign this to a particular maker. The fifth fragment from N15E23 is from a threaded jar rim. It is 16.7 mm long, 12.6 mm wide, and 5.3 mm thick. This shard is of particular note because of its threads. Continuous thread caps became popular after 1917, were in general use by 1919, and were standardized in 1924 (Rock 1981:12).

A curved body fragment of amber glass was found in unit N12E24. This piece is 20.1 mm long, 12.3 mm wide, and 3.5 mm thick. Amber glass can result from the aging process of clear glass made with selenium. The use of selenium began during World War I when manganese, supplied by Germany, became unavailable to American glass makers (Rock 1981:17).

Of three green-blue glass bottles represented by shards from two squares, only the one found in N21E24 has potentially distinguishing marks. These four fragments are from the oval base and shoulder of a bottle basemarked "8" in a circle, "O" or "0" in a square, and "4" in a circle. It also has part of a sidemark which reads in part "...with lime and soda". These fragments together measure 75.4 mm by 51.5 mm by 131.5 mm. The "8" and the "4" are likely serial and/or design numbers, rather than part of a trademark (Toulouse 1971:10). However, the "O" in a square suggests that the bottle was made by the Owens Bottle Company of Toledo, Ohio, which used that mark between 1911 and 1929 (Toulouse 1971:393).

Two other pieces of green-blue bottle glass were recovered from unit N15E23. One body fragment with visible bubbles has a faint seam, and is 23.3 mm long, 20.5 mm wide, and 2.7 mm thick. The second is a frosted blue-green shoulder fragment, which is 33.5 mm long, 28.4 mm wide, and 2.6 mm thick.

While one piece of green glass was recovered from N17E22, and a piece of frosted white glass was found in N15E23, neither has identifying marks which would link either to a particular maker or time period. The former is a body sherd which is 22.1 mm long, 10.0 mm wide, and 2.6 mm thick. The latter, from the curved shoulder/neck area of a bottle or jar, is 24.5 mm long, 17.8 mm wide, and 4.2 mm thick.

<u>Cloth</u>

A fragment of canvas, and two pieces of wool were located in two upland squares. The canvas, from unit N22E23, is metallic blue-green in color, and coarsely woven. It is 37.0 mm long, 32.0 mm wide, and 1.5 mm thick. It does not appear to be rubberized. Both wool pieces are from N22E22. One appears to be part of a dark blue, gray or black woven blanket. Its folded dimensions are about 153 mm long and 137 mm wide. The material is 1.5 mm thick, with a thread count of 32x20 or 24 to the inch. It has been folded twice, and is matted with roots. Also from this unit was a dark colored piece of wool fabric which had deteriorated into three fragments. The largest fragment is 82.0 mm long, 30.0 mm wide, and 1.4 mm thick. The thread count is 32x40 to the inch. These were found under the metal U-shaped handle described above.

<u>Rubberized material</u>

Eight scraps of rubber or rubberized fabric of several colors were recovered from three upland units. Part of the sole of a small black rain boot or shoe covering, about 220 mm long, 94 mm wide, and 1 mm thick, was found in unit N19E24. Two pieces of white rubberized canvas, which may be parts of the same item, were found in N18E23. One is 120.0 mm long, 73.0 mm wide and 0.9 mm thick, while the other is 27.1 mm long, 32.1 mm wide, and 1.1 mm thick. Three distinct pieces of similarly colored green rubberized fabric were found in unit N22E22. While they all have different thread counts, it is nevertheless possible that they were originally part of the same article. A stiff, fragile piece of a fairly tight weave, with a thread count of 40x36 to the inch, was found associated with the remains of one of the cans described above. It had broken into over 50 fragments, the largest of which is 24.0 mm long, 10.3 mm wide, and 0.8 mm thick. A similar piece, composed of one large and seven small fragments, has a similar thread count, about 40x48 to the inch. The third piece, with a 40x36 to the inch thread count, is composed of four fragments, the largest of which is 15.9 mm long, 9.3 mm wide, and 0.5 mm thick. A piece of black rubberized fabric was also found in unit N22E22. It had broken into four fragments, the largest of which is 103.9 mm long, 47.0 mm wide, and .02 mm thick. It has a thread count of 64x64 to the inch. One piece of black material, composed of thin, folded and crumpled fragments, is either rubber, or leather. The largest of the fragments is 27.1 mm long, 21.0 mm wide, and 0.5 mm thick.

<u>Plastic/Synthetic Rubber (Figure 24)</u>

The collection includes twenty plastic artifacts. While some of them may date from the

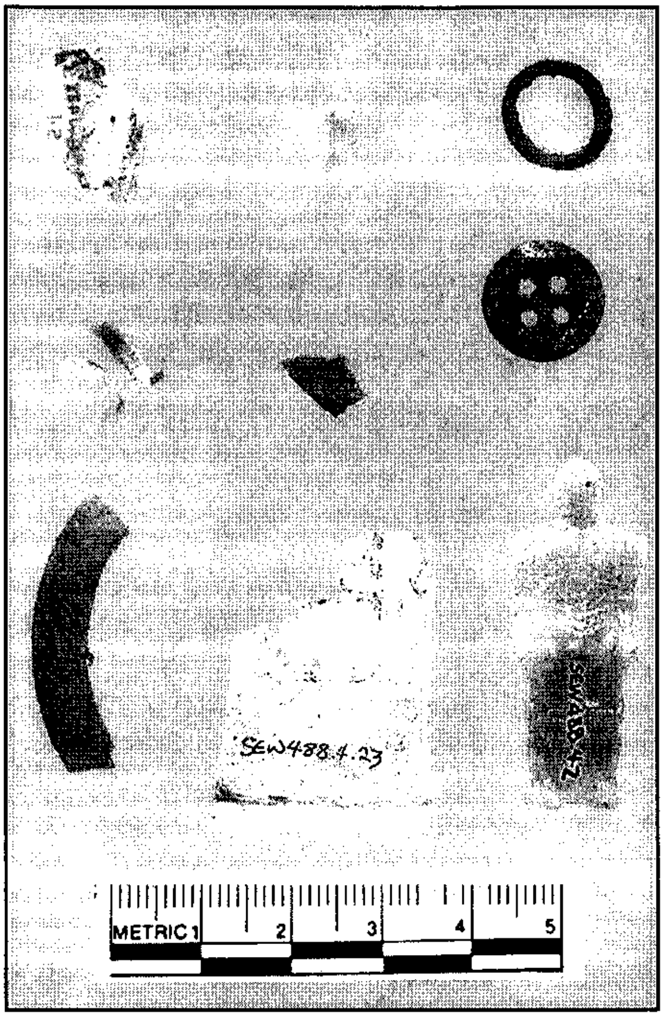


Figure 24. Plastic fragments (5.1, 4.24), balloon mouth (7.05), plastic band fragment (3.9), plastic. fragment (4.25), button (4.1), plastic fragment (4.22, plastic container fragment (4.23), plastic "Star Wars" figurine (4.2).

beginning of the twentieth century, others are as recent as 1977. Eight pieces came from four upland units. Twelve others were found in ITZ unit N12E24.

The eight upland specimens include part of a balloon, pieces of two bags, three bits of what may be a plastic milk jug, a white scrap of opaque plastic with blue printing, and a fragment of blue hard plastic. The blue balloon fragment found in unit N18E23 is from the rolled rubber mouth. It is 12.6 mm long, 2.1 mm wide, and 1.7 mm thick. In the same unit was an almost complete tobacco pouch. This rectangular, plastic, ziplock bag is 175.0 mm long, 100.0 mm wide and 2.4 mm thick. It has a red lined opening and a circular logo with a horse head surrounded by green and yellow letters reading "Jim Scrap, Smoke, Chew" and labeled "May 3-1898". One corner of the bag is torn or chewed away. Reclosable ziplock-type plastic bags were first marketed by patent holder Dow Chemical Company in 1972.

A clear plastic bag fragment, consisting of two sheets of plastic bonded together to form an overlapping seam, was found in unit N17E22. This fragment is 80 mm long, 53 mm wide, and 0.6 mm thick. A small fragment of hard, opaque, light aqua-blue plastic, 6.1 mm long, 2.7 mm wide, and 1.5 mm thick, was found in unit N21E23. From the same unit at 15 cmbd came a curved white piece of plastic, stiff but thin enough to be somewhat flexible. It is likely part of a wrapper. This piece is about 40 mm long, 24 mm wide, and is 0.3 mm thick. It is flat on the outside curved edge and has beveled edges running the length of the piece on the inside, giving the piece a trapezoidal cross section. On the inside, flat area between the edge bevels is printed lengthwise in blue ink "REG IN USA".

The twelve plastic artifacts from ITZ unit N12E24, described in the following paragraphs, include some of the site's most recently deposited items. Their recovery from depths as great as 110 cmbd in deposits which have also yielded prehistoric artifacts indicates the mixed nature of the strata in this unit.

A round, four-hole, brown plastic button is 13.8 cm in diameter and 2.6 mm thick. The holes, each 2.1 mm in diameter, are in a square pattern surrounded by a raised round area. Plain, drab color, Bakelite buttons were produced after the invention of this synthetic plastic between 1907 and 1909. They continued to be popular until about 1930, when the use of other plastics expanded (Rock 1981:22).

Also from this unit is a white, luminescent molded plastic "C3PO" Star Wars figurine with Japanese script on its side, found at a depth of 20 cmbd. This artifact post-dates the Hollywood release of the first "Star Wars" film in 1977, when collectible representations of the film's characters became available and popular.

Two pieces of plastic and what appears to be a disposable Japanese soy sauce tube were recovered from N12E24. One piece of plastic is translucent white, gently curved, cracked and weathered. It is 9.4 mm long, 7.2 mm wide, and 1.4 mm thick. The other is a weathered piece of hard flat green plastic which is 10.7 mm long, 6.1 mm wide, and 2.2 mm thick. The clear plastic tube fragment is a stepped and fractured portion of the closed end of a small container with Japanese script. The fragment is 36.2 mm long, 24.5 mm wide, and 0.7 mm thick.

Two pieces of opaque white, hard, flat plastic and a segment of an oil-stained, clear, flat, flexible plastic ring were recovered from the above unit. The white plastic pieces, both 0.8 mm thick, may be part of the same object. One measures 14.7 mm long and 14.0 mm wide, while the other is 14.4 mm long and 9.7 mm wide. The ring fragment is 31.1 mm long, 6.3 mm wide, and 1.5 mm thick, and has scars from its previous attachment to another segment at a 90 degree angle.

One of the four remaining pieces of plastic is a fragment of a melted plastic green garbage bag which is 11.0 mm long, 6.2 mm wide, and 0.2 mm thick. The second is a fragment of a thin white styrofoam sheet which measures 24.8 mm long, 18.5 mm wide, and 2.5 mm thick. A thin piece of water-washed white plastic is 14.7 mm long, 12.3 mm wide, and 1.0 mm thick. The last is a piece of relatively thick flat, opaque white plastic which is 12.6 mm long, 9.6 mm wide, and 2.3 mm thick.

Other

A button made of a very regularly porous material was recovered from near the surface of unit N21E23. It has four holes in a square pattern, surrounded by a circle in the center of the button. This circular center is recessed on the front of the button and raised on the back. It is 10.2 mm in diameter on the front and 7.2 mm diameter on the back. The material from which this item is manufactured is difficult to identify without destructive testing. The pores seem too regular to be bone or wood, although the button appears to be made of a natural material. The possibility also exists that it is plastic.

Six irregular objects which may be melted and burned plastic were recovered from near the surface in three upland units. They have the appearance of shiny, gray, honey-combed nuggets of solidified foam. They vary in length from 17.5 to 43.0 mm, in width from 10.5 to 25.1 mm, and in thickness from 9.7 to 24.9 mm. One is from unit N17E22, two are from N21E23, and three are from N19E24.

Artifacts–Prehistoric

During the 1994 and 1995 field seasons, 314 prehistoric artifacts were recovered from SEW-488. Most are ground, pecked, and flaked stone, although there are also a few wood, copper, and quartz crystal implements. These cultural remains are described below, following categories defined for the most part by de Laguna (1956) in her analysis of artifacts collected during her seminal work in the sound. Length, width, and maximum thickness or diameter are provided for each item, and the categories are arranged in a manner similar to de Laguna's (1956) work and the recent Uqciuvit site report (Yarborough and Yarborough 1996). Although 130 unretouched flakes or pieces of debitage were found, the most common artifacts from the site are grinding stones and whetstones. More diagnostic implements include slate points, copper knives, a crystal graver, and ground stone adzes.

A cobble grinding stone or anvil, a triangular lamp, and a mammal rib fragment were retrieved from the ITZ of SEW-488 during the course of archaeological and cleanup work in 1989 (Mobley *et al.* 1990:296). As none of them were found *in situ*, no dates are associated with them. During the course of assessment work at the site in 1991, the archaeological crew recovered 37 stone and 23 wood artifacts (Dekin *et al.* 1993:404-413). They are discussed below in connection with other similar artifacts recovered during the restoration work.

Adzes

De Laguna (1956:110, 117) proposed that heavy adze blades, thicker than wide, ungrooved, or with a groove or one or two ridges or knobs for hafting, be designated splitting adzes, and that smaller and lighter "grooveless celts, wider than they are thick" be called planing adzes. These terms may be functionally inexact, as some of these items may have also been used as scrapers, hammerstones (Clark 1974a), picks or axes, but as these two distinguishable types are present at this site and others in the sound, this nomenclature will be used for the sake of comparison.

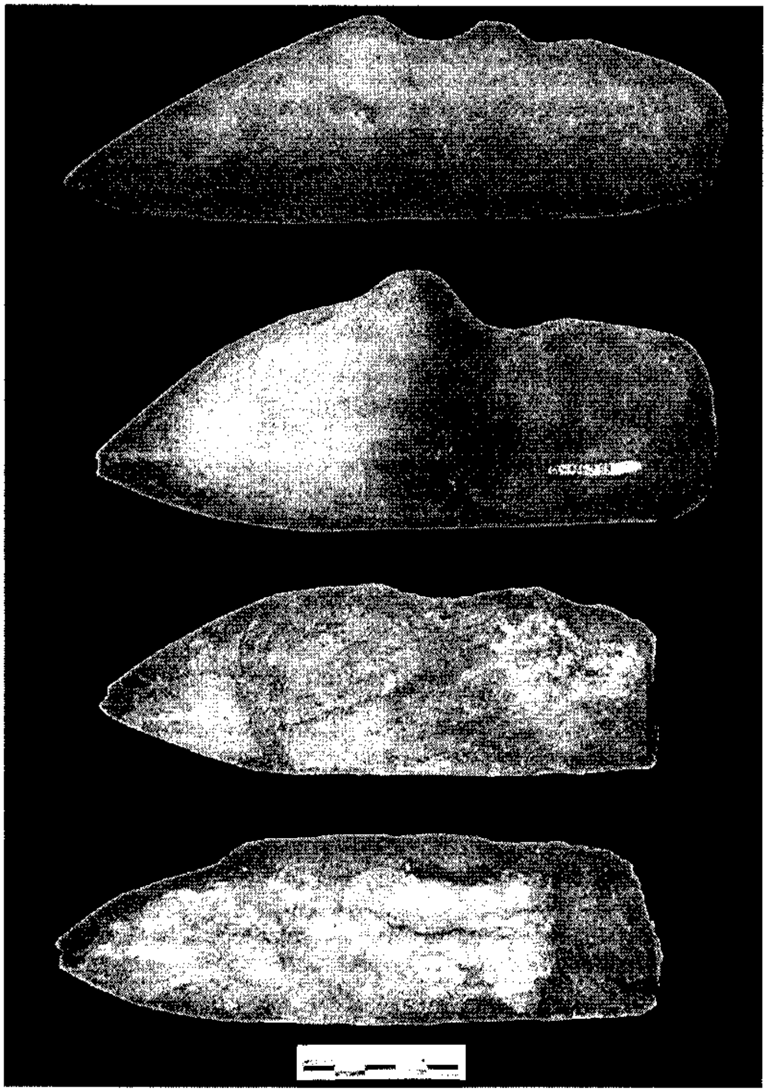


Figure 25. Splitting adzes (top to bottom: 9.37, 2.58, 2.59, 2.60).

Splitting Adzes (Figure 25)

Four splitting adzes of igneous or metamorphic stone were recovered from the site, three of them from unit N22E22 and a fourth from N21E24. All three splitting adzes from N22E22 were found relatively close together just above a charcoal sample which was radiocarbon dated to 900±70 BP (calibrated AD 1005-1275, Beta 78765). The first is 192.2 mm long, 82.6 mm high, 47.0 mm wide, and has a rectangular butt or poll end. The impact damaged bit is formed by intersecting polished facets. It has two lashing grooves separated by a prominent knob. The second adze is 171.5 mm long, 59.5 mm high, and 46.1 mm wide. It has broad, polished, edge facets, two lashing grooves (the proximal of which is polished) and a squared butt. The third is a thin adze, 186.4 mm long, 61.3 mm high, and just 31.3 mm wide. Both ends are damaged by repeated impact flaking. Its poll end is bifacially worked up to the edge of a single, long, curved, hafting notch, and the bit and some areas of the faces and edges are highly polished. A larger and somewhat thicker splitting adze was found in unit N21E24, a few cm below a charcoal sample dated to 567±70 BP (calibrated AD 1290-1455, Beta 89047). This well finished specimen has been pecked and ground to shape, and is 204.0 mm long, 65.0 mm high, and 52.1 mm wide. Numerous use flakes have been removed from the flat base. The proximal end tapers to a narrow keel-shaped butt, which is marked by the removal of one large and several smaller impact flake scars. Polished facets flank the face or dorsal edge of the bit. It, too, is impact fractured, with five or more flakes removed. The hafting portion of the head is distinguished by two shallow rounded well-defined lashing grooves. The distal and proximal grooves are 31.0 mm long and 24.0 mm long, respectively.

Splitting adzes seem to make their appearance in the sound around the middle of the first millennium AD (Yarborough and Yarborough 1996). De Laguna also notes that splitting adzes became more popular "in later times" (de Laguna *et al.* 1964:92), and they are more abundant in the upper, later, layers of Palugvik (de Laguna 1956:113). Splitting adzes are also found in late prehistoric contexts in Kachemak Bay and on Kodiak Island, although it has been suggested that they might have been introduced earlier (Workman and Workman 1988:345; Jordan and Knecht 1988:273-274).

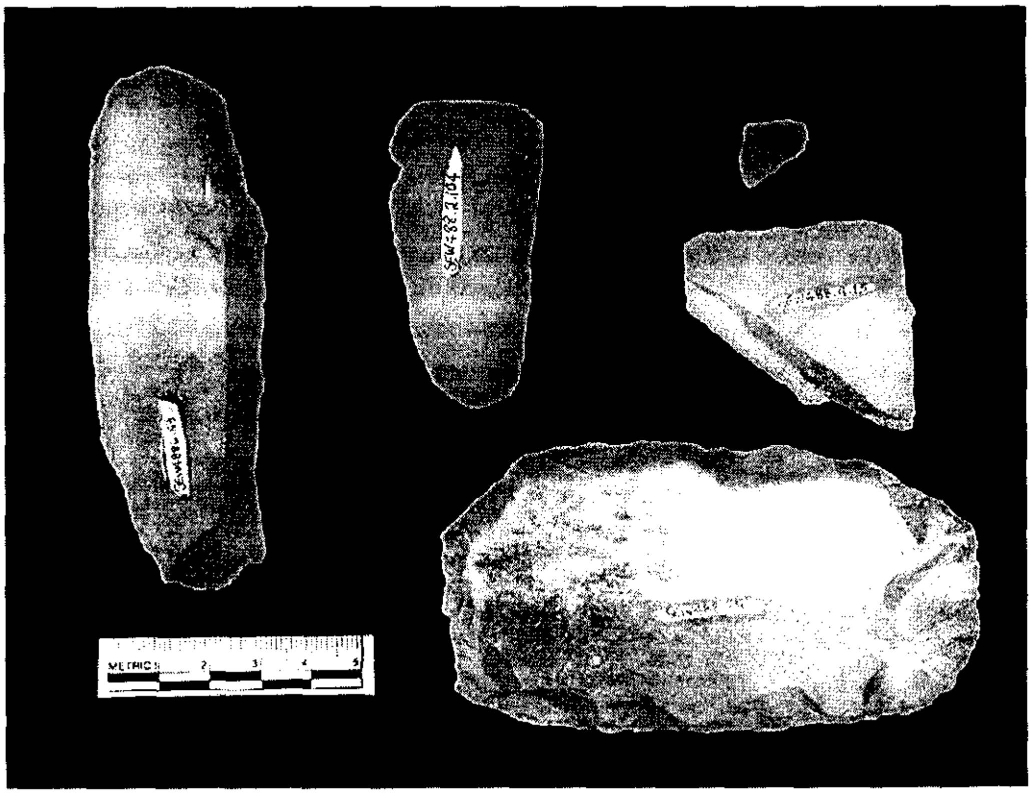


Figure 26. Planing adzes (6.43, 2.104), adze flakes (top: 7.16, bottom: 4.15), adze blank (0.4).

Planing Adzes (Figure 26)

A relatively flat, triangular slate planing adze was located in unit N22E22. The base of the triangle has been ground into a straight cutting edge which bears transverse, parallel, oblique striations. The other two margins have simply been roughly flaked. One face has also been partially ground. It is 62.0 mm long, 30.5 mm wide, and 6.6 mm thick. Although not associated with a date or other diagnostic material, this artifact was found about 20 cm below a charcoal sample radiocarbon dated 810±50 BP (calibrated AD 1165-1290, Beta 78766).

What appears to be a planing adze blank was recovered from the surface of the ITZ on the south side of the site. This undated, subrectangular artifact is 104.1 mm long, 55.8 mm wide, and 21.8 mm thick. It has one flat and one concave face, a subrectangular cross section, and margins which have been crudely bifacially flaked but not ground. This artifact may not have been completed because of a flaw in the stone which precluded flaking to the proper shape.

A planing adze was found in one of the soil tests during the 1991 assessment testing. This light colored chert piece is chipped at the butt and side margins, and bifacially ground at the tip. It is smaller than the above planing adzes, measuring 46 mm long, 27.0 mm wide, and 10.0 mm thick (Dekin *et al.* 1993:409).

Planing adzes were found at Uqciuvit in early Palugvik, late Palugvik, and Chugach contexts (Yarborough and Yarborough 1996). At Palugvik, planing adzes were much more numerous in earlier than later strata (de Laguna 1956:118).

Adze flakes

An adze fragment and two adze flakes were found in three units close to, or within, the ITZ. No date is ascribed to the fragment, although the flakes are from late prehistoric contexts. The green chert or siltstone fragment, probably from a planing adze, was located in unit N12E24. This bit fragment is 57.7 mm long, 38.8 mm wide and 9.8 mm thick, and has a flat rectangular cross section. It appears to have been completely ground only at the bit and its cutting edge is flaked from use.

A thick triangular green siltstone adze flake recovered from unit N18E23 is 17.1 mm long, 11.3 mm wide and 3.0 mm thick. Its even cutting edge is chipped on one face, ground and polished on the other, and exhibits some hinged and stepped use fractures on the edge of the bit. It is also slightly water-worn. A slaty siltstone flake from unit N17E22 may be from a planing adze. This parallel-sided spall is 104.2 mm long, 34.4 mm wide, and 9.2 mm thick. Cortex is evident on one face and there is a polished facet on one face opposite the cutting edge. Its edges are beveled, perhaps as a result of natural bedding planes, and steep, rounded and lightly worn.

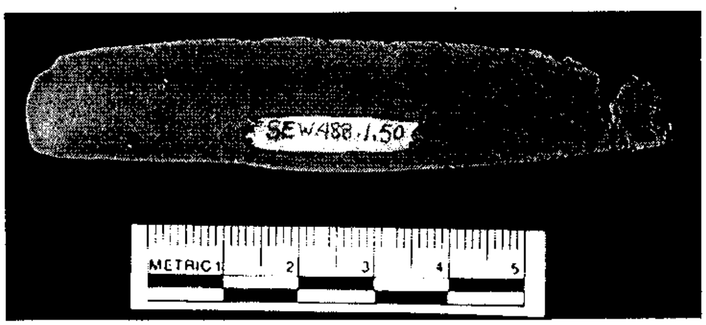


Figure 27. Chisel (1.50).

Chisel (Figure 27)

The one slate chisel recovered from the site came from early to mid second millennium deposits in N19E23. It is long, thin and slightly curved, measuring 85.2 mm by 17.9 mm by 7.2 mm. with margins and one face which are roughly shaped and ground. Almost all of the other face has split off. One end is rounded, while the other has been bifacially ground into a bit which is 12.0 mm wide at its edge. The cutting edge is crushed and exhibits transverse and oblique grinding striations.

Both of the slate chisels found at Uqciuvit are from late Palugvik and Chugach contexts. With the exception of two chisels from earlier layers at Palugvik, the same seems to hold true for most of the sound and the Yakutat area (de Laguna *et al.* 1964:97-98).

Crystals

A small, clear, prismatic, quartz crystal was found in unit N19E23 associated with a charcoal sample which was radiocarbon dated to 350±50 BP (calibrated AD 1450-1665, Beta 78761). It is 12.75 mm long, and its diameter narrows from 7.0 mm at its widest point to 4.5 mm at its narrowest. This artifact has microscopic use wear on the pointed end of the crystal. Two additional quartz crystal masses were recovered from N21E24, one associated with a rock feature, and the other in a layer of rotted wood. The first is an angular chunk of milky quartz crystal with a 17.0 by 112.0 mm concavity which is filled with fine orange-red ochre powder. This piece is 27.8 mm long, 22.2 mm wide, and 15.2 mm thick. The second is an irregular mass of white to clear quartz with small clear crystals and stumps of larger crystals on the same surface. This chunk is 53.2 mm long, 31.0 mm wide, and 30.0 mm thick. A charcoal sample slightly above the first crystal mass yielded dates of 520±50 BP (calibrated AD 1315-1345, AD 1390-1455 and AD 1290-1455, Beta 89046) while another sample a few centimeters above the second mass yielded dates of 820±60 BP (calibrated AD 1045-1105, and AD 1115-1290, Beta 89048).

The terminal end of a quartz crystal graver was found at Uqciuvit in a late prehistoric context. Two similar quartz crystals found at SEW-440 are roughly dated to the first half of the second millennium AD (see above). Quartz crystal gravers and drill bits have been recovered from several prehistoric and historic Koniag phase sites on Kodiak Island (Clark 1974a:95). Hafted quartz crystals were traditionally used on the Northwest Coast as cutting and carving tools (Stewart 1973:87).

Whetstones/grinding stones (Figure 28)

Of the thirty two whetstones and whetstone fragments recovered from the site, six can be refit to form three larger portions. Three others may be fragments of one artifact. With the exception of two, all are associated with second millennium AD dates. Six are associated with early second millennium AD dates, while twentyfour are from deposits dated to the middle of the second millennium AD. The two undated whetstones are also likely to date from late prehistoric times.

Units N12E24 and N15E23 yielded two whetstones from undated contexts. One is a surface spall of a flattened cobble. It is 69.9 mm long, 56.7 mm wide, and 24 mm thick, and has one concave surface which is somewhat polished with scattered pecking. The second is a long, flat, slate pebble with the edges and faces removed from one end. The remaining faces are very smooth and striated. It is 128.5 mm long, 26.6 mm wide, and 13.0 mm thick.

Four whetstone fragments from unit N22E22 are associated with radiocarbon dates of 900±70 BP (calibrated AD 1005-1275, Beta 78765) and 810±50 BP (calibrated AD 1165-1290, Beta 78766). Two fragments which fit each other are made of slaty schist. One of these thin plates of exfoliating material is heat-reddened, and each has a slightly curved, smooth polished surface. One is from the central area of the whetstone. It is 37.4 mm long, 34.9 mm wide, and

5.0 mm thick. The other is from the margin of the stone, and is 45.5 mm long, 15.6 mm wide, and 7.3 mm thick. A third fragment is a large angular spall of heat altered igneous rock. It is 97.8 mm long, 43.2 mm wide, and 24.4 mm thick, with a flat ground face bordered by a curved, use-rounded edge. Another fragment of a slaty siltstone whetstone is a subrectangular plate, 52.9 mm long, 24.5 mm wide, and 7.1 mm thick. A preserved edge section is smoothly ground and striated. One end retains some of the original cortex, while the other end displays a transverse snap facet.

A whetstone fragment and a complete whetstone were found in unit N21E24. They were located between charcoal samples which yielded dates of 820±60 BP (calibrated AD 1045-1105, and AD 1115-1290, Beta 89048) and 910±90 BP (calibrated AD 980-1285, Beta 89049). The fragment is a fine-grained, sandstone-like material with one face which retains a remnant of a ground and polished surface, and two broken edges. It measures 53.2 mm by 27.7 mm by 9.3 mm. The complete whetstone is a flattened oval graywacke pebble, 43.3 mm long, 33.3 mm wide, and 12.7 mm thick. One face has a ground flattened facet, while the other features a smooth rounded concavity.

The mid-second millennium AD whetstones and fragments described below can be generally characterized as flattened cobbles, and spalls with evidence of grinding, many of which are fire-cracked.

Two fine and two coarse-grained whetstones and fragments were found in unit N17E22. A "diamond"-shaped heat-reddened spall from an igneous cobble is 110.1 mm long, 72.7 mm wide, and 15.9 mm thick. One surface is ground flat and smooth. Its thin, irregularly rounded edge is backed by two intersecting thick edges, giving it a triangular cross section. Two articulating fragments form a very fine-grained tabular whetstone, smoothed flat on both faces and rounded on edges and ends, with low relief grooves and striations. Together they are 54.3 mm long, 24.9 mm wide, and 16.4 mm thick. An oblong, schistose slate beach cobble is oval to flattened-oval in cross section, with a flatter face which has been smoothed by use for about two-thirds of its length. It is 105.3 mm long, 25.8 mm wide, and 16.4 mm thick. A sandstone whetstone was recovered from this unit. This small slab is roughly triangular in shape and rectangular in cross section, 85.6 mm long, 65.2 mm wide, and 15.2 mm thick. One ground face is flat and polished, while the other has two facets intersecting along a gently curving line to form a broad concave depression which runs its length.

Two slaty siltstone fragments from unit N19E23 are 30.8 mm long, 6.5 mm wide, and 3.3 mm thick; and 50.8 mm long, 12.4 mm wide and 8.9 mm thick, respectively. The first is an edge spall of a slab with a ground surface. The second is part of a well-made whetstone, with one edge produced by the intersection of two ground and striated facets, one flat and the other convex. A flattened cobble and two cobble spall fragments, all of igneous material, were also recovered from this unit. The cobble is 60.5 mm long, 33.4 mm wide, and 17.2 mm thick. It has a flattened "kidney"-shape with a polished depression on one face. One igneous fragment is a large flat spall, 87.7 mm long, 68.1 mm wide, and 18.8 mm thick. It has broad rounded grooves on one face, and is reddened by heat. The other igneous fragment is an irregular section of a flattened cobble, with a smooth face and a highly abraded area. It is 94.2 mm long, 51.5 mm wide, and 49.5 mm thick and is fire-cracked.

One whetstone and three fragments were found in unit N21E23. The oblong, thick flat cobble whetstone is very smooth. It is 62.3 mm long, 35.3 mm wide, and 24.2 mm thick. The three fragments are all made of the same igneous material and are all fire-cracked. Although they do not fit together, it appears likely that they are pieces of the same whetstone. They range in length from 54 to 74.2 mm, in width from 33.7 to 47.6 mm, and in thickness from 16 and 29.5 mm. One has a slightly ground face and highly polished edge. Another has one flat to slightly concave face and an irregularly concave face with two smoother edges. The third has a remnant of a smoothed, slightly concave face and edge.

Eight whetstones and fragments were located in unit N22E22, five of them near a concentration of fire-cracked rock. One of these five is a brown pumice abrader fragment, 52.9 mm long, 41.3 mm wide, and 17.7 mm thick. This rounded slab, with its triangular cross section, thick, ground edge and very flat, grinding surface, resembles a modern brick. Two small, unique whetstones are made of a whitish felsic tuff material. The rather singular source of this material is a geologic deposit in eastern Prince William sound, near Kayak Island and Bering Glacier. One is an elongated cube, with smoothly ground edges and surfaces displaying transverse striations, some facetted edges, and a flat tapering facet at one end. It is 32.4 mm long, 8.0 mm wide, and 6.6 mm thick. The other is prismatic, with squared and beveled edges. Its flat surfaces are polished, with scattered striations. It is 18.0 mm long, 13.5 mm wide, and 4.7 mm thick. Two other whetstone fragments from this unit are made of slaty siltstone. One is a very thin slab which is 38.2 mm long, 32.2 mm wide, and 3.4 mm thick. One edge section is smoothly ground while the others are snapped, and both faces are ground flat. The other appears to be a large whetstone fragment which was reused. It is 116.0 mm long, 20.2 mm wide, and 10.0 mm thick. This slender, tapering spall has a thick cross-section that includes the edge of a flat, ground face with a fine, worn groove. Its fractured edge has been retouched to a steep scalloped edge, with some rounded and polished facets.

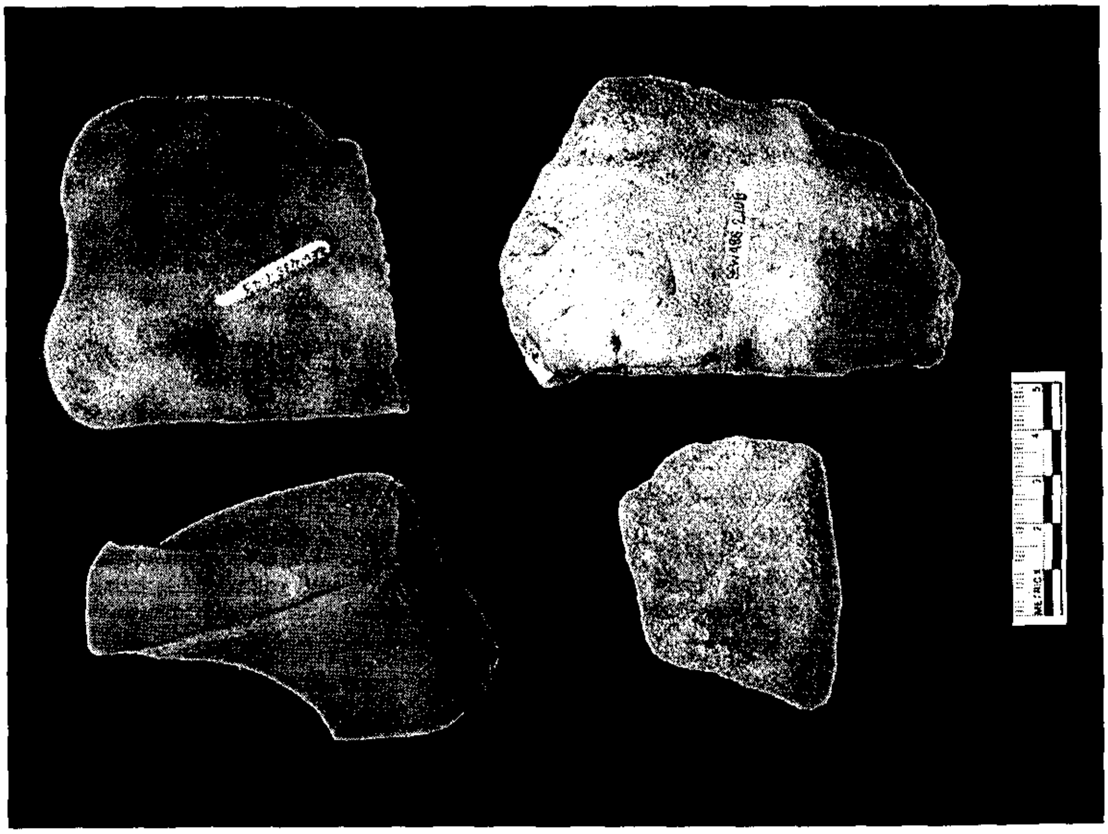


Figure 28. Grooved Whetstones (1.43, 2.108, 9.12, 3.57).

The three other whetstone fragments from N22E22 are also associated with late prehistoric dates, but are from lower deposits. Two are slaty siltstone fragments which fit together. One of these is an irregular slab with some cortex, and a flat ground and striated surface on each face. It is 51.5 mm long, 38.8 mm wide, and 9.0 mm thick. The other is flat and triangular, with smoothly ground and striated faces. It measures 36.8 mm by 24.1 mm by 6.9 mm. One of its margins is the polished edge of the whetstone. The third whetstone edge fragment is from an igneous cobble and is 37.3 mm long, 13.0 mm wide, and 6.9 mm thick. The converging ground facets of this heat-altered piece result in a rounded slightly curved edge.

A fragment of a trapezoidal slaty siltstone cobble whetstone from unit N21E24 is unusual in that a longitudinal V-shaped striated groove, 5.0 mm wide and 2.5 mm deep, has been sawed in one face. Adjacent to the groove is an edge which has been ground flat. Measuring 84.1 mm long, 52.6 mm wide, and 33.0 mm thick, this piece was originally rectangular in cross section. A segment of one face is moderately concave with a 33.0 by 25.0 mm striated ground facet. A complete trapezoidal flat cobble whetstone was found in the same square. It is 136.5 mm long, 56.4 mm wide, and 20.5 mm thick, with beveled edges; even, smooth flat surfaces; and polish sheen.

Two small grinding slabs were recovered from unit N21E24. One is made from a coarse, almost pumice-like, gray stone. It is 95.9 mm long, 50.1 mm wide, and 47.3 mm thick. This irregularly conical whetstone has longitudinally ground facets which converge to a broad rounded tip. Its broad end or base is irregularly concave, partially flattened by another ground facet. A spall from the edge of a quartz porphyry cobble is 179.5 mm long, 68.7 mm wide, and 31.7 mm thick. This fire-cracked whetstone tapers to a point and has one slightly concave and irregularly smoothed face which rounds to the adjacent, flat and polished edge.

<u>Saws</u>

Two stone saws were found in an upland unit, one in an upper ITZ unit, and one on the surface of the ITZ. A roughly triangular dacite boulder spall which has been used as a saw was recovered from unit N22E23. This artifact is 63.6 mm long, 36.8 mm wide, and 8.1 mm thick, with a plano-convex cross section. Its longest edge is slightly convex, evenly rounded, and polished on both faces adjacent to the edge. The deposits in which it was found appear to be late prehistoric, as the artifact's location was 40 to 50 cm above a radiocarbon sample dated AD 1235-1400. The other saw or possible flake knife from the same unit is a thin subrectangular siltstone piece. It is 49.7 mm long, 42.4 mm wide and 7.3 mm thick, with one naturally straight edge. The opposite edge is possibly use retouched, with intersecting sides which are possibly dulled by use. It is associated with a radiocarbon sample dated between AD 1205 and 1300.

A coarse sandstone saw was located in ITZ unit N12E24. This thin subrectangular slab is shaped like a truncated triangle. Its base and one adjacent edge are slightly rounded and dulled from use. It is 66.3 mm long, 58.5 mm wide and 7.6 mm thick. A greenstone saw or chopper was found on the ITZ surface. Measuring 116.0 mm long, 80.5 mm wide, and 18.8 mm long, this subrectangular slab has a plano-convex cross section. All its edges are battered, and the parallel long edges are crushed and rounded. It does not appear to be waterworn. Because of the apparently mixed nature of the deposits in N12E24, and the lack of *in situ* provenience of items from the ITZ surface, it is impossible to suggest an approximate age for either of these artifacts.

A possible saw was recovered from the 1991 assessment excavations in ITZ unit #1. It lacks polish, but is similar in shape to other saws illustrated for Prince William Sound (Dekin *et* *al.* 1993:406).

De Laguna (1956:127) recognized six types of saws in her work in south-central coastal Alaska, of which three appear to be represented here. She characterized them as small, thin slabs of abrasive stone, with smoothly ground surfaces. One saw from unit N22E23 and the beach find appear to fall into her category of rectangular saws with three or four cutting edges, while the other from N22E23 is an example of a complete saw with one cutting edge, and the saw from N12E23 is illustrative of a saw with two parallel edges. Types not represented at SEW-488 are fragments with one cutting edge, fragments with two edges meeting at right angles, and paddle-shaped saws.

<u>Scrapers</u>

Two complete and two fragmentary scrapers were recovered from three units. One greenstone scraper was found in unit N22E22 among gravels beneath a layer of fire-cracked rock. This irregular split pebble is 81.4 mm long, 53.3 mm wide and 25.3 mm thick. Unifacial retouch has given it a steep, slightly serrated rounded edge. The cortex on the face opposite the flaking is slightly polished. A grawacke flaked stone scraper, 94.0 mm long, 57.8 mm wide and 17.3 mm thick, was found in unit N22E23. This subrectangular flattened piece has a lenticular cross section. The unflaked portion of one edge still retains its original rounded cobble cortex. One long edge, both ends, and about half of the other long edge are bifacially flaked. The complete flaked edge and one end are irregular and dulled from use and the other edges are battered.

A gray, roughly rectangular, chert fragment, which appears to be the rounded end of a bifacially flaked scraper, was found in unit N19E23. Measuring 24.9 mm long, 17.9 mm wide, and 5.9 mm thick, this specimen has very worn, rounded ends which are connected by an offset neck. The item is also water-worn. Another fragment of a scraper or knife was found in unit N22E22. This piece of the rounded edge of a slate tool is 29.9 mm long, 17.5 mm wide, and 4.8 mm thick. One face is flat and the opposite is ridged. The edge is discontinuously crushed and polished.

A scraper and an endscraper were found in 1991 in assessment unit #2. The former is chipped, with grinding on portions of one face. The latter is unifacially chipped. A trapezoidal slate flake which resembles "slate scrapers from late Kachemak contexts in Cook Inlet" (Dekin *et al.* 1993:406) was also found, although it is labeled as a slate blade in the report.

A bifacially chipped scraper was found at Palugvik (de Laguna 1956:131). Twelve scrapers were found at Uqciuvit, all of them chipped and then ground or polished (Yarborough and Yarborough 1996).

<u>Grooved stone</u>

The concave groove across one face is the distinguishing feature of this oval to slightly rectangular piece of coarse-grained igneous rock. Found in N22E22, this grooved rock is 91.0 mm long, 70.8 mm wide, and 30.5 mm thick. It is triangular in cross section, with one naturally flat margin. Three of its edges are acutely broken or flaked.

<u>Hammerstones</u>

Eleven hammerstones, were recovered from six of the ten restoration units, six of them from unit N17E22. Two are undated, but the rest come from cultural deposits which have been radiocarbon dated to about the middle of the second millennium AD. Most are igneous or metamorphic cobbles, although one is a quartzite pebble.

The two hammerstones from unit N15E23 are very similar in size: one is 112.3 mm long, 62.6 mm wide and 48.5 mm thick, and the other is 113.4 mm long, 68.0 mm wide, and 46.2 mm thick. The first is roughly rectangular, with a triangular cross section and a transverse fracture. Its more pointed end has been battered to an edge with a semicircular notch. Its fractured face is battered. The second is irregularly oval in cross section, with areas of repeated, overlapping impact scars on each end. Its concave face appears to have been smoothed from additional use as a polishing stone.

Four of the hammerstones from unit N17E22 were recovered relatively close together in a layer of organics, gravel and fire-cracked rock. They vary in length from 134.6 to 20.5 mm, in width from 83.7 to 15.2 mm, and in thickness from 64.2 to 9.3 mm. The largest exhibits light pecking on each end and is also lightly pecked in the center of each face. Two of the four are small slender cobbles. One of these two has a rounded end opposite a flattened end. The surface of the latter has been removed by repeated impacts. The other small slender cobble is oval in outline but flat in cross section. It has one lightly battered end and one heavily battered end with an adjacent "impact notch". The fourth hammerstone from this layer is a small, oblong, irregularly-shaped brown quartz beach pebble which is battered at one end.

Two additional hammerstones were recovered from a deeper level in N17E22. One is a small irregular cobble, with a thin margin which has been evenly rounded by extensive, repeated battering. It is 83.8 mm long, 79.0 mm wide and 55.7 mm thick. The other is a transversely fractured, oval-sectioned, smooth surfaced, slender beach pebble with light impact scarring on one rounded end. It measures 30.1 mm by 12.8 mm by 10.3 mm.

The two hammerstones from unit N21E23, and one from unit N22E23 appear only to have been used for striking or pounding. The first of these is an oval cobble with a smoothed face which has one area of repeated impact scarring, as well as scattered impact scars. It is 73.5 mm long, 56.7 mm wide, and 49.8 mm thick. The second, an angled, flat cobble with a battered, flaked end, is 102.1 mm long, 43.6 mm wide, and 12.0 mm thick. The third is a long oval pebble with an oval to triangular cross section. It is 81.1 mm long, 23.9 mm wide and 13.2 mm thick. One end is bifacially flaked and flattened from repeated impacts, while the opposite end shows faint impact scars.

Hammerstones have been found at a majority of sites in Prince William Sound and have a broad temporal distribution (de Laguna 1956:137, 139; Yarborough and Yarborough 1996). They are similarly widely distributed in Cook Inlet and on the Kodiak archipelago (de Laguna 1975:59; Clark 1974).

Multipurpose hammerstones/whetstones

Not all hammerstones and whetstones can be neatly categorized into a single type. Fourteen artifacts were recovered which had both grinding/polishing surfaces and battered areas. Four such implements were found in unit N17E22. One is a slender flattened slate pebble which appears to have been used both as a burnisher and a hammer. Measuring 54.1 mm long, 16.1 mm wide, and 5.8 mm thick, this tool has rounded ends and edges. It is polished with striations and gouges scattered on its faces. Microflakes have been flaked from one end. A second is an evenly rounded oval igneous cobble which is 90.8 mm long, 59.8 mm wide, and 48.8 mm thick. Its broadest face is characterized by polish sheen, but the more pointed end of the cobble exhibits scars from pecking. A large oval hammer/whetstone with an oval cross section is heavily pecked along one margin. There are smoothly ground intersecting facets on one face which form a slight "apex", indicating its additional use as a whetstone. The piece is 135.4 mm long, 97.1 mm wide, and 59.8 mm thick. A triangular cross sectioned whetstone-chopper fashioned from a sandstone cobble slab was also recovered from this unit. The base of the triangle is ground, with a broad, asymmetrical "v"-shaped notch in the opposite edge. The notched, concave edge is flaked and worn through use, perhaps as a chopper, or a spoke-shave. This artifact is 101.1 mm long, 66.8 mm wide, and 35.6 mm thick, with rounded ends and edges. One end is lightly battered and the faces are polished, striated, and grooved.

Two hammer/whetstones were found in unit N19E23. One, a slender, rounded pebble measures 80.2 by 24.3 mm by 17.2 mm. It is smoothed as if used as a burnisher, but also has one fractured edge with an adjacent battered area. An oval quartz porphyry cobble, recovered from the same square is 135.1 mm long, 59.4 mm wide, and 49.2 mm thick. It has a triangular cross section. The base of the triangle has been ground flat to slightly concave. There is heavy pecking at one end of the cobble and lighter pecking at the other. The "apex" of the triangle is also heavily battered.

One tool from unit N19E24, and four from N21E24 have also been used as both hammers and whetstones. A large cobble from N19E24 has been extensively pecked on one end, both faces, and one lateral edge, and also polished on one slightly concave face. It is 139.3 mm long, 105.7 mm wide and 67.1 mm thick. The larger of two cobbles from the upper deposits of N21E24 is 114.6 mm long, 104.8 mm wide, and 70.7 mm thick. It is very smooth, heavy and rectangular with a triangular cross section. Its base is concave and polished, while the opposite corners of the basal edge are battered. The smaller cobble is an elongated tear-shape, slightly pecked at the more pointed end, more heavily battered at the broader end, and very smooth and polished over all its surfaces. It measures 83.8 mm long, 34.9 mm wide, and 26.7 mm thick. A bipointed slate splinter from slightly deeper in this unit is rhomboidal in cross section. It measures 94.5 mm long, 7.5 mm wide, and 4.4 mm thick. It has cortex present on all four sides, and some grinding on each side, especially at the edges. Its wedge-like ends are rounded and blunted, and one has a slight impact fracture. A small fractured slate pebble from unit N21E24 has both an uneven edge produced by an impact fracture, and grinding striations on each face near the edge. Slightly irregular in shape, it is 48.2 mm long, 23.4 mm wide, and 5.7 mm thick.

Three hammer/whetstones were found in unit N22E23. The smallest is a trapezoidal plate of fine sandy siltstone with an evenly thick rectangular cross section, and evenly smoothed flat faces, both with scattered light impact scars. It is 44.3 mm long, 37.8 mm wide, and 9.6 mm thick. Next in size is a bipointed spall of an igneous cobble which measures 61.0 mm long, 24.3 mm wide, and 6.4 mm thick. It has cortex on one face which has been evenly smoothed flat, and unifacially trimmed edges which are steep and rounded from use. The third is a long, narrow slate flake split by impact on its rounded and polished end. The opposite end has a beveled and probably polished rounded edge, with a flake removed by impact fracture. One face with cortex has longitudinal striations. This tool is 81.1 mm long, 13.6 mm wide, and 5.6 mm thick.

Two grinding slabs from unit N21E23 also appear to have been used as a choppers. One is a thin roughly rectangular piece of gray sandstone which has been well ground, with one very concave face. However the longest of the four edges is flaked from use, with the majority of the flakes on the concave surface. This specimen is 183.2 mm long, 108.8 mm wide, and 22.1 mm thick. The second slab is a basalt cobble which is rectangular in shape and triangular in cross section. It is 117.2 mm long, 92.3 mm wide, and 38.0 mm thick. The three faces of the triangle are smoothed from grinding, while the three edges of the broad "base" are unifacially and heavily flaked from use.

A pebble which appears to have been used as both a whetstone and an abrader was found in unit #2 during the 1991 assessment testing.

Twenty seven hammerstones which had also been used as polishing stones or whetstones were recovered at Uqciuvit. One specimen from Palugvik is both ground and pecked (de Laguna 1956:139), and a few hammerstones from Kachemak Bay are also ground (de Laguna 1975:59).

Lamps

A lamp fragment made from a piece of well-cemented sandstone was recovered from N17E22, lying on top of a late prehistoric layer of fire-cracked rock. This broken half of an oval lamp with a convex bottom is 127.5 mm long, 71.9 mm wide, and 36.1 mm thick, with a 13.0 mm deep, rounded, smooth depression forming the upper oil holding portion. Portions of the rim are missing. The lamp is heat reddened, with some traces of soot in the central depression. The undated, roughly triangular lamp made from a graywacke cobble found in the ITZ during the 1989 Exxon shoreline cleanup program is much larger: 179.0 mm total length, 149.8 mm total width, and 61.4 mm in thickness, with a depression 22.4 mm deep (Mobley *et al.* 1990:296).

Stone lamps, used during prehistoric and early European contact times to burn rendered oil, or sea mammal blubber, are ubiquitous in sites in Arctic and subarctic coastal areas, from northeastern Asia across North American Greenland. Lamps are known from as early as 3900-3500 BC on Kodiak Island , and 1700-800 BC in the eastern Arctic (Dumond 1977, McGhee 1990). Lamps from Prince William Sound sites range from large and heavy to small and portable (de Laguna 1956, Yarborough and Yarborough 1996). De Laguna (1956:143) suggests that the residents of Prince William Sound used lamps for light rather than cooking, as hearths were present in the houses which she excavated.

Knives/ulus–slate (Figure 29)

Eight slate knives were recovered from five units, all in late prehistoric contexts. Six are broken pieces of knives or ulus, one is a complete drilled ulu, and one is a roughly finished ulu or ulu-blank.

Unit N12E24 yielded only one knife fragment, which is 24.9 mm long, 21.3 mm wide and 2.4 mm thick. Its flat faces are well ground and finely finished, although the cutting edge is nicked and damaged.

The one ground ulu or knife fragment from unit N15E23 is triangular in shape It is broken from the rounded back to the badly chipped and broken cutting edge. This piece is 49.3 mm long, 33.1 mm wide and 4.6 mm thick.

Two ulus or knives were recovered in unit N17E22. An ulu with a rounded notch was found in a late prehistoric deposit characterized by fire-cracked rock. This piece is 56.0 mm long, 40.3 mm wide, and 4.9 mm thick. The edges of this thin slate slab are evenly flaked, one side is bifacially ground to a straight, rounded edge with apparent use damage, and its faces are striated. One face has been ground until the edge is concave. A second ulu fragment is 74.6 mm long, 34.6 mm wide, and 6.2 mm thick. The piece has a lenticular cross section and its remaining sides have curved edges. Its long edge has been finely ground to a bi-beveled curved cutting edge. One end is characterized by two intersecting broken facets.

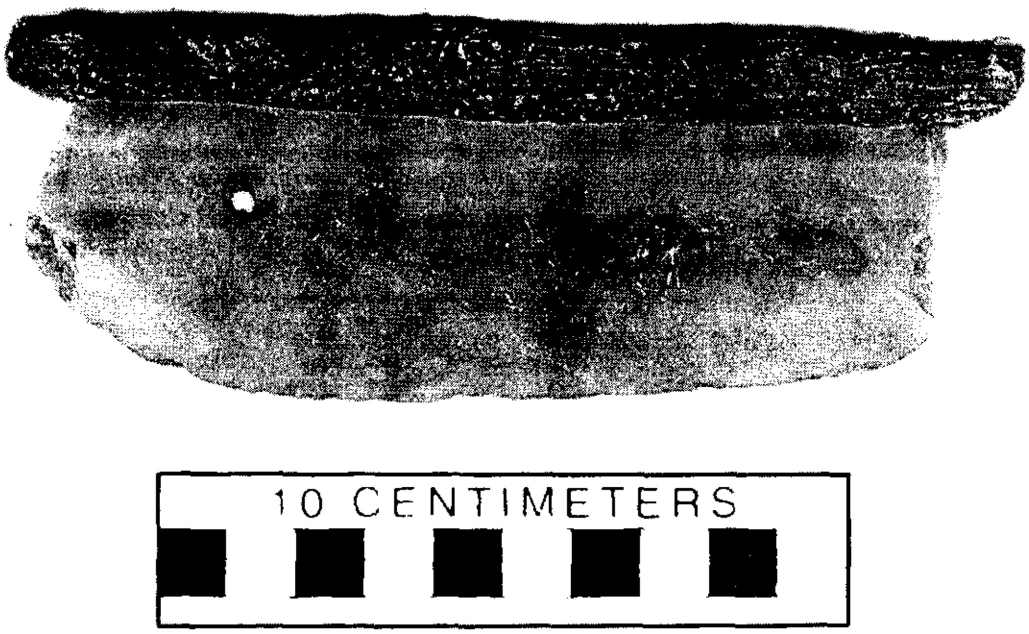
A subrectangular slab with layered edge facets as a result of flaking or crushing was also recovered from N17E22. This fragment, which appears to be a very roughly finished flaked ulu or ulu blank, measures 69.9 mm long, 43.0 mm wide, and 6.1 mm thick. One face is incised with parallel and curving lines, although these seem almost incidental. This piece is not like the incised slate plaques found at Uqciuvit (Yarborough and Yarborough 1996) or Palugvik (de Laguna 1956).

One slate knife fragment was found in unit N21E23. This flat, sub-triangular fragment has a gently curving broadly rounded cutting edge and broken margins. It is 49.8 mm long, 27.4 mm wide, and 4.3 mm thick.

A drilled ulu and an edge fragment of a knife were found in unit N22E23. The faces of the edge fragment are evenly ground to a plano-convex section, and its edges taper to a narrow flat facet instead of a sharp edge. It is triangular in cross section and 84.6 mm long, 11.5 mm wide and 5.2 mm thick. Both its ends and base have been damaged by impact fractures, while its unbroken edge is rounded and blunt.

The drilled slate ulu, complete with a composite wooden handle (described below) was found in the organic gravel below a forest duff in unit N22E23 (Figure 29). Measuring 124.9 mm long, 46.5 mm wide, and 6.1 mm thick, this flat rectangular ulu has a convex, bifacially ground edge opposite a concave, flat facetted back, and straight ends. A hole, 25.7 mm from one end, was formed by drilling two holes towards each other from both faces along the central axis. The edge is nicked from use and the faces bear grinding striations. This implement is associated with a calibrated radiocarbon date of AD 1205-1300.

A fragment of a drilled and notched ulu was also recovered in the 1991 excavation of upland unit #2. None of the ulus found at Palugvik are drilled, although one from Uqciuvit is



L.J. Evans, 1996

Figure 29. Drilled ulu showing wooden handle in place, as found *in situ*, SEW-488.

partially drilled (de Laguna 1956:149; Yarborough and Yarborough 1996). This type of modification for handle attachment is slightly more common in Cook Inlet and frequent on Kodiak Island (Clark 1974a:105; de Laguna 1975:75).

Knives/ulus–other lithic materials

Six knife-like implements or fragments made of material other than slate were recovered during the course of work at SEW-488. While not all of these are associated with dated samples, several are from mid-second millennium AD deposits, and it appears likely that the others are from that general time period as well.

A ground tool fragment, reworked as a knife, was recovered from unit N19E23. This flat, slaty siltstone spall, which may have also used as a scraper, is 49.5 mm long, 37.3 mm wide, and 6.4 mm thick. It has a curved ground and polished face, a ground edge, and fracture faces and edges which have been ground and facetted. A knife fashioned from a large igneous cobble spall was found in unit N21E23. This cobble fragment has a rounded cortex surface and may have originally been ulu-shaped, but is broken across the middle, from its back to its edge. The knife back is rounded and intentionally dulled, while its curved cutting edge and sharp irregular end are bifacially flaked. It is 88.9 mm long, 61.0 mm wide, and 16.2 mm thick. Also located in N21E23 was the blade portion of a green slaty siltstone ulu. It is evenly ground on both convex faces and is 31.7 mm long, 20.5 mm wide, and 5.3 mm thick. A flaked knife or ulu of vesicular basalt was found in unit N21E24 in a late prehistoric organic gravel deposit. This thin, exfoliated flake has a rectangular to slightly triangular shape with slightly converging straight sides. One long edge is backed or flattened while the other is a sinuous cutting edge which has been slightly dulled and rounded from use. It measures 94.9 mm by 34.6 mm by 9.7 mm thick. A slaty siltstone knife or scraper fragment from N22E22 has flat polished faces and one bifacially ground edge with irregular fractures. This piece is 33.7 mm long, 20.4 mm wide, and 4.3 mm thick. A blade-like flake knife found on the surface of the ITZ southeast of the site is 83.3 mm long, 37.1 mm wide, and 10.6 mm thick. It is made from a thick triangular cross sectioned slab of siltstone. The two dorsal faces and the opposite side have been ground smooth. They meet at one straight ground edge.

A bifacial point or knife of a rough sandstone-like material was found on the surface during the 1991 work at SEW-488 (Dekin *et al.* 1993:404). Several knives or blades made of chert and igneous flakes were found at Palugvik, and de Laguna (1956:131) speculates that some of them may have been used as scrapers. Similar flaked non-slate knives or blades have also been found on the Alaska Peninsula and, more rarely, on Kodiak Island (Clark 1974a:84).

Blades and Projectiles (Figure 30)

Two almost complete and six fragmentary points or lances were recovered from SEW-488. Seven are ground slate and one is flaked chert. In the discussion below, they have been categorized as two slate awls, four points, and an end blade.

Slate awls (Figure 30)

Two fragments of this lance type, named for their appearance rather than their function (see Chapter 4, above), were found in two upland units. A very small proximal midshaft fragment was recovered from unit N22E23. This narrow wedge with one smoothly rounded face measures 24.6 mm by 9.7 mm by 5.3 mm and exhibits an irregular broken edge opposite a transversely snapped edge. The other slate awl fragment, located in unit N17E22 appears to be part of an unfinished lance. This slender, irregularly-sectioned fragment is 114.7 mm long, 10.0 mm wide, and 8.4 mm thick. Two longitudinal faces are present. One has a marked striated facet adjacent to an edge. The opposite edge is curved by grinding, and its lateral edges still bear evidence of being sawed and snapped. The first piece described above was found in deposits which date to the first half of the second millennium AD, while the second fragment is in a slightly later second millennium AD context.

Complete slate awls are rarely, if ever, found. The most common breakage pattern is in thirds, resulting in the recovery of points, mid-sections, and bases. Awls were found more frequently in the early strata of Palugvik than in the upper, later, layers. De Laguna (1956:161) suggests that hunting techniques may have altered, requiring different types of points and lances, or that some change occurred in the populations of sea mammals which were being hunted. Slate awls were also more common in earlier layers than in later ones at Uqciuvit (Yarborough and Yarborough 1996). None were found in the late prehistoric Chugach phase layers. The slate awl from SEW-440 (see Chapter 4, above) is also from an early second millennium AD context.

Slate points

One base and three tip portions of ground slate points were recovered from three units. The base and two tips were found in contexts dating to the first half of the second millennium AD. One tip, from N21E23, is probably from the same time period as well.

The base was found in unit N17E22 in a matrix of organic gravel with fire-cracked rock. This broken mid-blade portion of a narrow lenticular sectioned ground slate point is 47.2 mm long, 9.5 mm wide, and 4.3 mm thick. There is a pronounced sudden transition from its parallel sides to its tapering, impact-crushed base. There are offset ground facets on each tapering face.

A fragment of a ground slate lanceolate point with an asymmetrical cross section was located in unit N19E23. This slightly sinuous piece has more or less parallel sides which taper abruptly to its point. One edge is beveled with a ground facet, its base terminates in an impact fracture, and it has grinding striations on all of its edges and faces. It is 98.3 mm long, 14.7 mm wide, and 6 mm thick.

A second lanceolate ground slate point fragment, found in N21E23, is 118.3 mm long, 15 mm wide and 4.8 mm thick. It has a flattened lenticular cross section. Its precisely even edges are not parallel, but bulge outward before contracting to its tip, the distal point of which is broken. Its base is missing and the proximal end is impact fractured with a flake removed from each face. Subtle facets extend the entire length of each face and diagonal grinding striations on each face have produced a chevron pattern.

The distal end of a biconvex sectioned ground slate projectile point was also found in N21E23. The proximal end of this lance point tip is impact fractured. Its straight edges taper to a very fine point, the extreme distal tip of which is missing. It is 16.7 mm long, 6.2 mm wide, and 2.6 mm thick. Its appearance is very similar to the ground slate point described above.

A ground slate projectile point was recovered from upland unit #2 in 1991. It has a contracting straight-sided stem and a rounded base. It is believed to have been barbed, although the margins are somewhat damaged, and there are grooves on both sides of the piece proximal to where a barb might have been (Dekin *et al.* 1993:408).

Blades and points similar to these have been found in late prehistoric contexts at Palugvik and Uqciuvit (de Laguna 1956:155; Yarborough and Yarborough 1996). Two of the blades or projectile points from Uqciuvit have grooves similar to the point from unit #2. These appear to be "drawn-on" continuations of small barbs.

End blade (Figure 30)

This late prehistoric thin triangular slate projectile point, found in unit N22E23, is 57.3 mm long, 24.9 mm wide, and 3.9 mm thick. Its bifacially ground edges curve to a sharp point, The edges are not evenly ground, giving this piece a rectangular cross section. A ground hafting channel originates at the base on one face and continues almost to the point. While the other face is also somewhat ground, it does not have a definite channel. The impact crushed base appears to have been straight instead of concave.

Two end blades were recovered from Uqciuvit. Both blades have slightly convex sides, and thinned hafting beds (Yarborough and Yarborough 1996).

Chert Point (Figure 30)

A bifacially flaked gray chert point or blade with a lenticular cross section was recovered in unit N22E22. This piece has sinuous edges, a rounded base and very slight shoulders. It is 32.2 mm long, 13.9 mm wide, and 5.8 mm thick. The material may have been heat treated prior to production. The deposits from which it was recovered appear to date to the mid-second millennium AD.

Although a broken, unfinished chert or altered greenstone lance blade was recovered from the younger layers at Palugvik, chipped stone blades are rare in Prince William Sound. De Laguna (1956:131) suggested that the technology of the sound "resembles more closely that of the Northwest Coast, where chipped stone is virtually unknown." Most of the chert flakes from Uqciuvit are believed to be the by-products of adze manufacture, and no chipped points or blades were found at the site (Yarborough and Yarborough 1996).

Piercing tool

A slate tool, which may be a type of awl, was found unit N21E23. This long, thick, hexagonal cross sectioned fragment tapers to a facetted tip. Its proximal end is characterized by a wide impact fracture. One face is smooth due to grinding or sawing, and an adjacent edge is nicked and rounded. The piece is 59.1 mm long, 18.9 mm wide, and 11.4 mm thick. The deposit in which this artifact was found is between two late prehistoric radiocarbon samples. One yielded a date of 460±60BP (calibrated AD 1410-1640, Beta 78767) and the other is dated at 380±50 BP (calibrated AD 1435-1650, Beta 78768).

Burnishers and/or splinter tools

Four slate pieces which are likely burnishers and/or splinter tools were found in unit N17E22. All are from late prehistoric contexts. Three are splinters which have been smoothed and rounded. One heat-reddened example has a bluntly rounded point at one end, and is "squared-off" at the other. One face is ground. It is 83.1 mm long, 10.7 mm wide and 9.3 mm thick. A slightly larger, elongated, flattened tear-shaped smooth cobble has rounded ends, and possible polish on the narrower end. It is 85.3 mm long, 19.3 mm wide, and 9.6 mm thick. A smaller splinter, which may be a fragment of a larger splinter, is 20.9 mm long, 5.2 mm wide, and 3.4 mm thick. Its unbroken end is a rounded and polished tip from which a large pressure

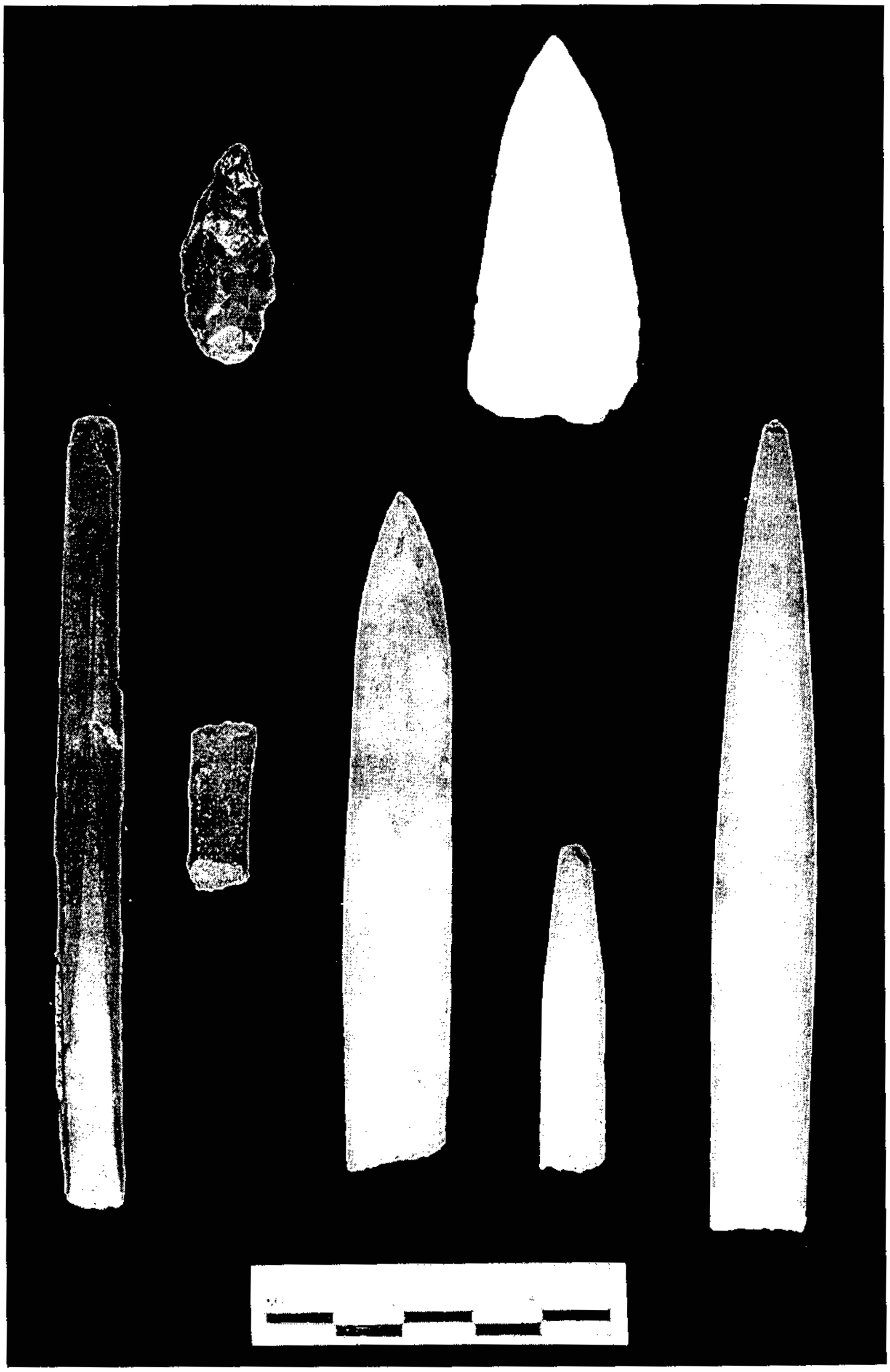


Figure 30. Chert point (2.28), end blade (10.22), slate awl proximal half (6.65), slate awl mid-section fragment (10.33), slate points (1.51, 3.36, 6.111).

flake has been removed. One unbroken burnisher is a 107.9 mm long, 18.8 mm wide, and 9.2 mm thick tool. This slender, water-smoothed, flattened pebble has one end which tapers to a fine rounded tip which is slightly polished from use. The opposite end is broad, flat, and possibly polished from use. On one face adjacent to the broad flat end is a polished facet.

Similar splinter tools with rounded points were found at Uqciuvit in early Palugvik phase layers (Yarborough and Yarborough 1996). A number of similar tools, suggested to be creasers or embossers, are known from sites in the Kodiak archipelago (Clark 1974a:95). These are somewhat wider than the Uqciuvit specimens and almost chisel-like at the polished end. In the latter attribute, they are similar to several of the SEW-488 pieces.

Smoothed, polished and/or ground pebbles

Ten smoothed, polished or ground pebbles were recovered from the upland portion of the site.

Two slender, flattened, slate pebbles, from unit N17E22, are smoothed with rounded ends. They measure 27.0 mm long, 6.4 mm wide, and 3.8 mm thick; and 39.8 mm long, 10.1 mm wide, and 4.3 mm thick, respectively. The former is fire-reddened. A thin, slender ground slate pebble found in unit N18E23 has one end with a curving facet. The other end is slightly broken. It is 80.0 mm long, 7.5 mm wide, and 7.3 mm thick. An irregular smoothed and polished green stone pebble was found in unit N19E23. It measures 23.9 mm by 15.8 mm by 8.9 mm. Also from this unit is a slender rounded pebble, which has narrow opposing edges on one end that are ground to a straight edge. This edge is flaked. There are also discontinuous facets with transverse striations which extend along the length of the artifact. This piece is 54.5 mm long, 9.6 mm wide, and 7.9 mm thick. One broken roughly triangular graywacke pebble found in unit N21E23 is 46.3 mm long, 22.5 mm wide, and 9.1 mm thick. It has an smoothed and slightly concave angled edge.

Three pebbles were found in unit N22E23. One, a smoothed semicircular thin pebble, is 20.8 mm long, 13.3 mm wide, and 3.0 mm thick. Another, an almost spherical polished hard dark gray stone, has a flaked area at one end. A facet about 17.0 mm in diameter seems to be the result of bedding structures within the piece. It is 63.0 mm long, 60.5 mm wide, and 59.3 mm thick. A fractured pebble, now a thin trapezoidal plate 45.6 mm long, 17.2 mm wide, and 4.0 mm thick, has a break at one end which is beveled, smoothed, and polished along the sloping face. The opposite end has a fresh transverse break. All the other edges and surfaces are very smooth and evenly worn. Two pebbles were found in unit N21E24. The first is an oblong slate beach rock, which has been split lengthways. One end is broken, the opposite, more blunt end, is lightly polished. It is 78.8 mm long, 20.5 mm wide, and 10.7 mm thick. The second is a broken pebble 60.6 mm long, 26.8 mm wide, and 9.8 mm thick. Its edge is rounded, crushed, and microflaked. An elongated polished pebble has a plano-convex end with a smoothly rounded edge. It measures 73.5 mm by 12.4 mm by 8.8 mm.

Tool fragments

Thirty-one tool fragments which do not fit any particular category were recovered from seven of the tests. These are generally pieces that show evidence of having been worked or used, but are not complete enough to assign a function or type. All are from second millennium AD deposits, with the exception of two pieces: one artifact in unit N22E23 which is associated with a date of 2680±60 BP (calibrated 925-785 BC, Beta 89058), and an undated beach find.

A tool fragment from N22E23 is the only artifact from the early first millennium BC deposits at SEW-488. This rectangular to triangular shaped slaty siltstone slab is 84.8 mm long, 56.8 mm wide, and 9.1 mm thick. It has a rectangular cross section and its short edges are broken. The long, straight, cleavage plane margin forms a back for the opposite roughly flaked curving edge which is dulled and rounded from use.

Eight ground stone tool fragments of a variety of materials were recovered from unit N17E22. Four are from a stratum of organic gravels with fire-cracked rock. One of these is a greenstone spall with a striated, polished surface. It is 52.9 mm long, 14.5 mm wide, and 9.7 mm thick. A second is a fine gray trapezoidal sandstone piece with flat, smooth edges. This piece measures 22.3 mm long, 14.3 mm wide, and 5.2 mm thick. Two pieces are of slaty siltstone. One of these is rectangular with a very flat rectangular cross section. It is 39.1 mm long, 25.5 mm wide, and 3.4 mm thick. One of its edges has been bifacially flaked and then ground dull and flat by use. The second slaty siltstone piece is a flat angular fragment, 27.4 mm long, 14.6 mm wide, and 4.2 mm thick, with one face which retains a remnant of a ground surface. Of the four other fragments from this unit, one is a triangular, tear-shaped, slaty siltstone piece with a plano-convex cross section. It is 51.0 mm long, 22.8 mm wide, and 7.0 mm thick. While one edge is roughly fractured, the opposite long edge is ground evenly smooth, with the grinding extending onto the adjacent faces. The longitudinal ridge on the convex face and the apex also show evidence of grinding. Two other pieces are slate. One is a triangular fragment with two intersecting faces that appear to be a worn bifacially ground edge. It is 23.8 mm long, 21.0 mm wide, and 4.2 mm thick. The other is a long, thick, trapezoidal-sectioned slab which is 143.3 mm long, 48.1 mm wide, and 21.9 mm thick. This piece has one smooth but unevenly ground face, continuous use-flaking and crushing on one long edge, and scattered use-flaking on the opposite edge. The last piece from this unit is a split igneous cobble fragment, with a thin fracture edge which is flaked and crushed from use, adjacent to a curved cortex face which is smoothed and possibly polished. It measures 68.0 mm by 64.2 mm by 16.6 mm.

Three of the four fragments from unit N19E23 are ground, and one is highly polished. The latter is a slate flake with a curved, highly-polished dorsal face and scattered striations. It is 17.9 mm long, 13.3 mm wide, and 1.5 mm thick. Of the other pieces, one is a rectangular igneous groundstone spall which also has a well-polished round facet on one face. It is 15.6 mm long, 11.1 mm wide, and 5.2 mm thick. A slender, pointed slate spall, with square margins, and lightly ground faces and edges, is 92.0 mm long, 10.8 mm wide, and 7.6 mm thick. A multifaceted greenstone spall, measuring 19.3 mm long, 10.4 mm wide, and 4.2 mm thick, has two finished, obliquely striated and polished facets which intersect as a evenly ground edge with impact nicks.

Only one unidentifiable ground tool fragment was recovered from N19E24. This small rectangular slab of slate is 83.1 mm long, 34.3 mm wide, and 16.3 mm thick, and has a rectangular cross section. Its two lateral edges are naturally flat, but its two ends are angled and formed by concave breaks. Its sharp edges show possible use wear.

Seven ground tool fragments were found in unit N22E22. Three of four in the upper part of the unit are slate. One, a thin rectangular slab with rounded corners, and ground, rounded edges, is 77.4 mm long, 52.8 mm wide, and 5.6 mm thick. It is diagonally fractured, and has a straight incision on one face. The second, an irregular fragment with two smooth worn faces joined by a broad rounded edge, is 45.4 mm long, 16.8 mm wide, and 10.9 mm thick. The third is a split pebble with margins formed by transverse fractures. It has a smooth worn facet adjacent to one rounded edge. The split pebble measures 40.5 mm long, 33.5 mm wide, and 6.7 cm thick. What appears to be another piece of angular felsic tuff was found near the above three slate pieces. It is 23.3 mm long, 13.7 mm wide and 7.9 mm thick and has weathered surfaces and only a few grinding striations. Three ground tool fragments were found in slightly deeper deposits in this unit. One is an exfoliated amphibolite spall with a highly polished surface. It is 14.7 mm long, 11.1 mm wide, and 2.7 mm thick. The second is a piece of gray brown chert with lightly rounded and polished intersecting facets. It is 29.3 mm long, 13.8 mm wide, and 9.8 mm thick. The third is a thin ground slate spall which has portions of two intersecting ground surfaces, and which is 20.2 mm long, 11.9 mm wide, and 2.3 mm thick.

Both ground tool fragments from unit N21E23 are slate. One is a long, slender fractured spall with one thick, ground and striated edge. It measures 77.8 mm by 11.2 mm by 5.9 mm. The other is a thin rectangular flake which is ground on one face. One long edge is rounded from use, and the other three edges are broken. It is 37.6 mm long, 23.1 mm wide, and 3.1 mm thick.

A thin rectangular piece of slate was located in N22E23. Measuring 73.5 mm by 66.7 mm by 5.8 mm, it has roughly jagged edges, segments of which have been straightened by light grinding or use. Both faces show light striations and localized smoothing. A triangular fragment of a fairly flat, thin, slaty siltstone tool edge fragment was also found in this unit. It is 16.2 mm long, 10.1 mm wide, and a 3 mm thick, and has one bifacially chipped edge.

Four tool fragments were recovered from unit N21E24. One is a flaked beach rock shaped like a conical microblade core. Cortex is still present on one face of the 69.9 mm long, 18.8 mm wide, and 15.3 mm thick tool. The three other faces are composed of negative blade scars, the two longest of which were struck from different directions. However, between the cortex and the two long blade scars is a polished facet. A bifacially flaked tool fragment from this unit is 54.5 mm long, 27.6 mm wide, and 9.0 mm thick. This roughly rectangular fire-cracked fragment with a bi-convex cross section has two broken edges. One edge and end are bifacially flaked, and rounded and straightened from use. The third is a transversely fractured flattened cobble with a battered notch in the rounded end. Flake scars extend from this notch onto both faces, but both faces also have smoothed facets. This piece is 68.2 mm long, 65.0 mm wide, and 30.6 mm thick. The last, a flaked, broken, flattened oval beach cobble, has cortex on one face, while the other is fractured. Its broken edges display possible use wear. It is 96.3 mm long, 76.8 mm wide, and 32.5 mm thick.

A blocky, rounded fragment of a fire-cracked cobble of unknown age was found on the surface of the ITZ southeast of the main part of the site. It is 60.2 mm long, 37.9 mm wide, and 37.3 mm thick, and has smooth facets on several faces.

Tool blanks

Three items which have been shaped to some extent, but do not appear to have been used, have been tentatively categorized as tool blanks. A thin, pointed, greenstone piece from unit N19E23 has been roughly bifacially flaked. Each face is longitudinally ridged and the edges are crudely beveled. It is 63.5 mm long, 25.9 mm wide, and 8.2 mm thick.

Two slate pieces were found in unit N22E22. One is a robust spall with thick snapped edge facets and an irregular snapped edge. It measures 110.7 mm by 17.6 mm by 8.6 mm. The other is a thick, pointed spall which is 81.9 mm long, 166.3 mm wide, and 6.2 mm thick. It has a thick cross section and rough margins, one of which is transversely fractured.

Twenty roughly triangular, rectangular, and semilunar tool blanks were found in 1991 (Dekin *et al.* 1993). Although chipped to rough outlines, they also could not be assigned to definite tool types.

Notched stone

An elongated, slightly flattened, irregularly oval igneous cobble, with an oval to triangular cross section, was found in unit N15E23. It is ground on one face, with rough shallow notches pecked and flaked in each end. This artifact is 119.0 mm long, 51.5 mm wide, and 35.5 mm thick.

Although a number of notched pebbles were found at a site on southwestern Montague Island (Jensen 1990), notched stones are not a common artifact type in the sound. One notched cobble of similar size was found at Uqciuvit (Yarborough and Yarborough 1996).

Sawed and snapped slate

Three examples of sawed slate were found at the site. An elongated triangular slab with a rectangular cross section found in unit N15E23 has one sawed and two fractured edges. This artifact is 82.5 mm long, 27.9 mm wide, and 7.2 mm thick. One face is smooth and flat, while the other has a 2.5 mm wide and 2.0 mm deep sawed groove running lengthwise across it.

Another example is a slender, thin flake. It has a straight flat edge with a narrow lip where it was snapped off after sawing. Found in unit N22E22, this piece of sawed debitage is 26.1 mm long, 8.4 mm wide, and 2.5 mm thick. A third example is a rounded tool fragment with a worn use facet from unit N21E23. One edge of this piece has a striated sawed face, and a broken snapped surface. It is 36.2 mm long, 15.6 mm wide, and 5.0 mm thick.

Sawing tool blanks to shape is an economical use of raw material, resulting in less wastage than flaking (Lightfoot 1983:50). Although only a few sawed pieces were found at SEW-488, several examples are known from other sites in Prince William Sound (de Laguna 1956, Yarborough and Yarborough 1996) as well as from Kodiak (Clark 1974a,b) and Kachemak Bay (de Laguna 1975). The debitage resulting from sawing slate is for the most part simply slate dust, and would be difficult, if not impossible, to discern.

Retouched flakes

There are only three retouched flakes in the SEW-488 collection. A bifacially retouched, slaty siltstone flake fragment was recovered from unit N22E22. This fragment is the snapped end of a thin slab whose margins have been shaped by bifacial edge retouch. It measures 38.7 mm by 30.7 mm by 4.2 mm. The other two examples are both unifacially retouched and slightly waterworn. One, recovered from unit N17E22, is an edge fragment of a thick plano-convex sectioned graywacke flake. It is 38.7 mm long, 26.7 mm wide, and 9.9 mm thick. The other, a transversely fractured gray chert flake fragment with unifacially trimmed margins, was found in unit N15E23. It is 16.6 mm long, 11.3 mm wide, and 4.1 mm thick.

Utilized flakes

Eleven flakes show evidence of use retouch. Four were found in unit N22E22. One is a flat slate flake fragment that is 30.4 mm long, 24.7 mm wide, and 4.4 mm thick. It has weathered cortex on one face, and three of its edges are fractured. The fourth edge is rounded from use. The second, a siltstone fragment 34.6 mm long, 20.6 mm wide, and 7.5 mm thick, has one edge which is roughly rounded by step fracturing. Its other edges are snapped. The third, a flat, angular slate fragment, is 15.8 mm long, 11.3 mm wide, and 2.1 mm thick. It has a striated facet adjacent to one edge which may be from use. The fourth flake from this unit is a broad based, slaty siltstone flake. It is 40.6 mm long, 36 mm wide, and 8.6 mm thick. It may have been used as a scraper. The striking platform is crushed and one edge is notched.

Three siltstone flakes were recovered from nearby units. A flat, gently curving flake from unit N21E23 is 63.2 mm long, and 23.6 mm wide. It tapers from a 5.0 mm thick cortical edge to a thin opposite margin damaged by notching and rounding. A pointed, ridged flake, 67.5 mm long, 32.0 mm wide, and 7.6 mm thick, with slightly jagged sides and use retouch was recovered in unit N21E24. An oblong cortical flake was found in unit N19E23. It measures 81.3 mm by 34.9 mm by 8.5 mm. It has a thick edge opposite thin curved edges which are lightly flaked, nicked, and rounded.

Three utilized flakes were recovered from unit N17E22. One is a thin spall of igneous material, possibly an olivine gabbro, that is 48.6 mm long, 20.3 mm wide and 5.7 mm thick. It has one curved edge backed by a broken facet, and one margin which is finely scalloped with very rounded projections. The other two examples are slate flakes. One is a thin flake with straight and curved margins worn to rounded edges. It is 33.4 mm long, 23.0 mm wide and 3.0 mm thick. The other has snapped edges, a striated facet on one face and one edge which is ground straight and flat by use. It is 28.7 mm long, 21.9 mm wide and 4.1 mm thick.

Utilized cobble

A longitudinally split igneous cobble fragment was recovered from unit N17E22. This specimen is 116.0 mm long, 82.0 mm wide, and 31.7 mm thick. The intersection of the fracture plane with the cortex forms a plano-convex edge with regular nicking, flaking, and rounding. It is somewhat flattened from use.

Flake cores

Three crypto-crystalline flake cores were recovered from the site. An oval, gray-green chert cobble, found in unit N21E24 in an early first millennium AD context, is 92.4 mm long, 84.1 mm wide, and 57.6 mm thick. The piece has been heavily flaked and battered. Because of the low quality of the material, the core is badly step-fractured. Two reddish jasper specimens from N22E22 are from a mid-second millennium AD context. The first is a microcore, 19.7 mm long, 17.0 mm wide, and 12.0 mm thick. It is somewhat rounded with flake facets and a crushed, battered keel-like edge. A flat platform facet has been prepared by removing four flakes. However, no flake scars were struck from the platform facet even though it appears ready for initial microblade or flake removal. The second example is a small, possibly heat-treated, flaked fragment of a depleted core. It has a prepared platform, but is too small to produce useful flakes or microblades. This piece is 18.9 mm long, 9.7 mm wide, and 6.9 mm thick.

Boulder spalls

Only two boulder spalls were recovered. One, a rounded rectangular graywacke flake, found in unit N22E23, has a triangular cross section. It is 76.1 mm long, 31.6 mm wide, and 10.4 mm thick. Flakes which have been removed from the striking platform extend onto both faces. There is also a wide, battered use wear facet on the dorsal face of the distal end, and possible use wear on the thin acute edge. A graywacke flake from unit N17E22 is 72.1 mm long, 36.4 mm wide, and 13.6 mm thick. It has flaked, rounded edges.

Only eight other boulder spalls have been collected in Prince William Sound. Four were collected by de Laguna (1956:131), and four were found at Uqciuvit (Yarborough and Yarborough 1996). This contrasts with Kachemak Bay, where boulder spalls are common in most sites and all cultural stages. Boulder spalls are also common in many sites on Kodiak Island (Clark 1974a:81).

Fractured pebbles

Fractured slaty siltstone and slate pebbles were recovered from unit N22E22. The former is 82.7 mm long, 55.6 mm wide, and 8.7 mm thick. It has transversely fractured edges and a rounded, weathered edge. The latter is 27.5 mm long, 21.8 mm wide, and 2.5 mm thick, and has three snapped edges.

Five split pebbles, only one of which is polished, were found in SEW-440. Two of the polishing pebbles from Uqciuvit are fractured, and fractured pebbles were also used as chisels and hammerstones (Yarborough and Yarborough 1996). These pebbles may be debitage, or they might be a type of blank for an unfinished tool.

Flakes and debitage

Most of the 130 flakes and pieces of debitage collected were recovered during screening. A variety of lithic materials are represented: 74 are slate, 36 are siliceous or crypto-crystalline, and 16 are igneous or metamorphic. Most have impact or percussion fractures, and a few exhibit striking platforms.

Mineral specimens

Two mica laminae were found in two units. One from unit N19E23 is 6.0 mm long, 4.1 mm wide, and 0.2 mm thick. The other, found in unit N21E24, is 12.2 mm long, 10.2 mm wide, and 1.1 mm thick. Neither flake shows any obvious cultural modification, although this mineral is not known to occur naturally in the immediate vicinity of the site. Both are from late prehistoric contexts.

Pieces of mica are not common, but are not unknown from other prehistoric Alaskan and Yukon sites. The use of mica in pre-contact times is not clear. Laminae found in the southwest Yukon Territory at site JjVi-7 are over 1,000 years old (Workman 1978:354). Pieces recovered from the Fish Creek site on Knik Arm are from a very late prehistoric or early contact Tanaina Athapaskan occupation (Dumond and Mace 1968:11).

Wood

Three prehistoric wooden artifacts were recovered during the course of the restoration project. Two pieces found in unit N22E23 form the hemlock (Regis Miller, personal communication 1995) knife handle of a drilled slate ulu (see above). One piece is 135.0 mm long, 14.3 mm wide and 7.4 mm thick. The second is a mirror image of the first, although one end is broken so that it is only 91.9 mm long, 14.6 mm wide, and 8.1 mm thick. Each handle piece is a semicircular in cross section. The intact ends are rounded. An 8.1 mm wide incised depression that is 4.4 mm from one end of the intact piece appears to have held a lashing which secured the handle together and in place. Several cuts 2.4 mm from the opposite end seem to have served a similar function. Like the intact piece, the incomplete piece has a 12.0 mm wide eroded or carved area 10.0 mm from the unbroken end to accommodate fastening with some type of flexible thong or lashing. Striations from smoothing are evident on the flat surface of this piece. Microscopic analysis of the handle pieces indicates that they were not made from a branch of a tree, but rather from the heartwood of the trunk of a large tree (Regis Miller, personal communication 1995). This composite handle and ulu is associated with a date of AD 1290-1435.

A third piece of worked spruce (Regis Miller, personal communication 1995), recovered in the same square, is 97.1 mm long, 14.6 mm wide, and 5.2 mm. This long, thin, roughly rectangular slat has squared ends. It is associated with a date of AD 1265-1440.

During their 1991 assessment, the SUNY Binghamton crew recovered 12 pieces of worked wood from SEW-488. Two possible stakes, two possible pegs, one possible wedge, and one possible fire drill were found in upland test #2. Three possible stakes, two possible pegs and one possible wedge were collected from ITZ test #1 (Dekin *et al.* 1993). The terms "stakes" and "pegs" were used to indicate larger and smaller wood shafts, respectively, and are not necessarily representative of function (Dekin *et al.* 1993:410-411).

A stake or wedge, a small peg, and a whittled branch stub were recovered from late prehistoric deposits at Uqciuvit. These were associated with wooden "floors" (Yarborough and Yarborough 1996). De Laguna (1956) reported finding similar wooden stakes and pegs, a wedge, splinters, and chips with chop and cut marks at several sites in the sound. She also collected a variety of unique wooden artifacts including dugout canoes, prow handles, fragments of bidarka frames, paddles, armor, arrow and lance shafts, a lance foreshaft, a harpoon head, a fragment of a bow, knife and spoon handles, trap or snare parts, decorated bars, a small box, a shovel, fire drills and a fire board, house posts, and pins. These items probably represent only a few of the actual artifacts made from wood by prehistoric inhabitants of the sound.

The wedges found at SEW-488 in 1991 are 20.5 cm by 4.1 cm by 2.4 cm, and 24.4 cm by 4.6 cm by 3.6 cm. They are larger than the late prehistoric Uqciuvit wedge, which is 130.0 mm long, 25.2 mm wide and 22.5 mm thick. However they are smaller than the one from the earliest levels at Palugvik, which measures 30.5 cm long and 3.5 cm wide. The SEW-488 wedge from upland test #2 is between strata dated to the early second millennium AD, while the other is not associated with a date (Dekin *et al.* 1993).

Two fairly complete wooden "stakes" were recovered from SEW-488 in 1991. The longer of the two is suggested to be more similar to harpoon or lance foreshafts described by de Laguna (1956) than to stakes which might be used to hold a tent or drying skins in place, the suggested function of the shorter "stake" and three "stake" fragments . The possible "pegs" range from 10.2 cm to 18.2 cm in length, 0.6 cm to 1.0 cm in width and 0.4 cm to 0.9 cm in thickness, and are suggested to have been used for purposes such as skin drying, although one is also described as similar to a wick-tender (Dekin *et al.* 1993:411-412). The size and shape of a "peg" fragment from Uqciuvit are comparable to the size and shape of the "stakes" found at SEW-488 (Yarborough and Yarborough 1996). De Laguna (1956) found stakes and pegs at Palutat, Palugvik, and another site on Hawkins Island, which range from complete specimens even larger than the largest "stake" from SEW-488 to small specimens similar to the SEW-488 "pegs". The two "pegs" and two of the "stakes" from ITZ test #1 are not associated with dated material. One possible stake from this test was found in a level dated to 2770±130 BP and 3395±160 BP. However, the connection between the wood artifact and the dates is not clear. The dated sample is from a peat layer upon which the stake was lying. The peat layer may simply be the deposit remaining after marine erosion of gravel and organic layers such as those present in the upland portion of the site. Upper levels of this test were not dated.

The burned ends of a piece of wood collected in 1991 suggest that it may be a fire drill (Dekin *et al.* 1993:413). The four fire drills collected by de Laguna are burned at one end, rather than both, and worn at the end which revolved in the drill rest (de Laguna 1956:192). However, they are similar in length. The specimen from SEW-488 is 17.2 cm long, and the two complete examples from Palutat are 19.0 cm and 19.7 cm long.

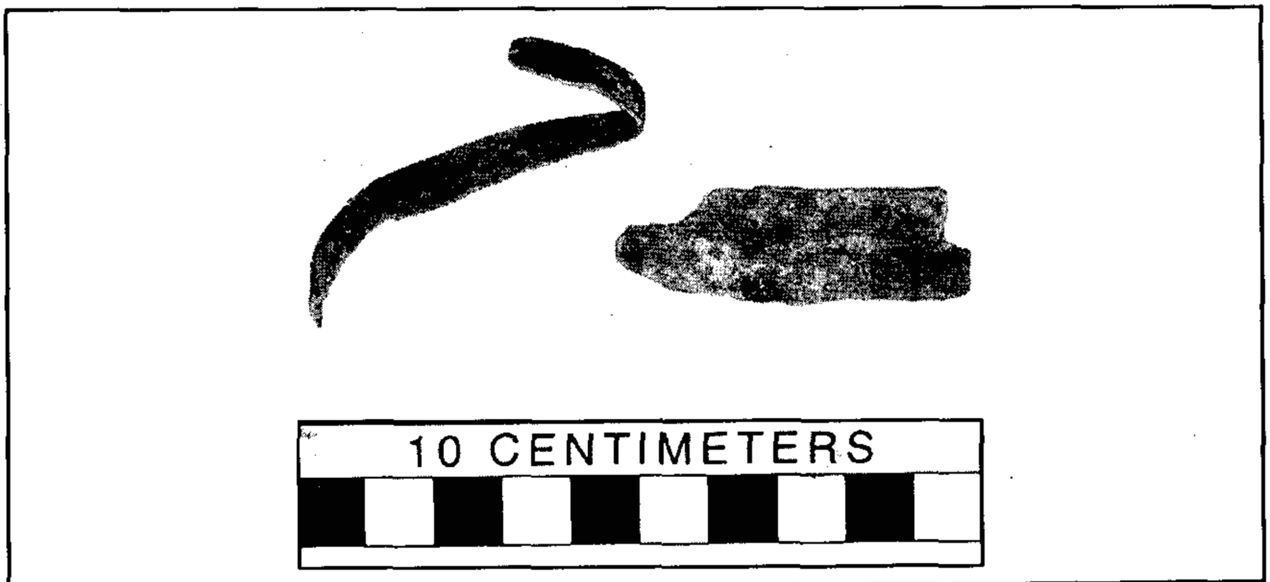
The flat rectangular piece of wood found in 1995 is similar to many of the pieces of wood that de Laguna collected from Palutat Cave, but most of the latter are worked more completely into items whose functions are readily apparent (de Laguna 1956:226, 228-229).

A knife handle from Palutat is similar to the ulu handle found at SEW-488 in that it has a whittled shoulder to hold lashing in place (de Laguna 1956:192).

De Laguna (1956:257) suggested that the extant limited prehistoric artifact assemblages from Prince William Sound reflect a rich wood working tradition which has been lost through deterioration as a result of site preservation conditions. The woodworking tools from SEW-488 and few preserved wooden artifacts seem to confirm the knowledge and skills of the prehistoric inhabitants who apparently used wood resources for daily items.

<u>Copper knives (Figure 32)</u>

Two beaten copper implements were recovered from late prehistoric deposits. One, from unit N18E23, is a complete, bent elongated lanceolate blade. It may have been a hafted knife. Measuring 70.8 mm long, 10.5 mm wide and 1.3 mm thick, it is tanged at one end, bluntly pointed at the other, and has convex slightly scalloped edges. It is not uniform in thickness and one face exhibits a folded edge. It was found only a few cm below a charcoal sample



L.J. Evans, 1996

Figure 31. Copper knives (9.18, 7.27).

radiocarbon dated to 360±60 BP (calibrated AD 1435-1660, Beta 89040).

Another knife was found in unit N21E24. This folded and hammered copper artifact is 58.2 mm long, 16.7 mm wide, and 2.5 mm thick. It appears to have been pointed at one end. The opposite end is broken. Its lateral edges are rounded in places and flat in others. The edges at the bent tip are sharp. Charcoal samples above and below this specimen have been dated to 520±50 BP (calibrated AD 1315-1345 or 1390-1455, Beta 89046) and 560±70 BP (calibrated AD 1290-1455, Beta 89047) respectively, placing this implement in a late prehistoric context.

Although copper artifacts are not numerous, tools made from this native metal have been found in late prehistoric deposits in other sites in Prince William Sound. Copper arrow and harpoon heads were recovered from Palugvik and sites on Montague and Elrington Islands; Palugvik has also yielded a copper blade and several bipointed pins (de Laguna 1956, L. Yarborough 1996). A copper bipoint was also found in a late prehistoric level at Uqciuvit (Yarborough and Yarborough 1996).

Not unique to the sound, copper implements are prevalent in late prehistoric sites around the North Gulf of Alaska, as well as in interior Alaska and southwest Yukon Territory. Items found at sites in Kachemak Bay include a bracelet, blades, and two conical beads (de Laguna 1975). A copper blade was recovered from a site at Rolling Bay on Kodiak Island (Clark 1974a:99). Three double-pointed pins were found during excavations at "Old Town", near Yakutat (de Laguna *et al.* 1964). These pieces appear in the material culture of the coast about the same time that raw copper nuggets begin to be worked extensively by the ancestral Ahtna of the Copper River. Workman (1978:344) has noted the close similarities in copper artifact types throughout these areas and suggests that they represent a "horizon technology."

<u>Ochre/paint stone</u>

Four pieces of red ochre and several stones coated with ochre dust were recovered from early to mid second millennium AD deposits in four different units. Some very friable bits of dark, brick red, grainy ochre were found in unit N22E22 near a radiocarbon sample which dates to 810±50 BP (calibrated AD 1165-1290, Beta 78766). Two crumbling chunks of grainy, brick red ochre measuring 8.0 mm by 6.0 mm by 5.0 mm, and 13.5 mm by 8.0 mm by 5.4 mm were recovered in unit N19E23. They were found in the vicinity of a radiocarbon sample dated to 350±50 BP (calibrated AD 1450-1665, Beta 78761). Several gravel clasts coated with grainy dark red brown ochre were collected from the same unit. A relatively large, 34.6 mm by 25.2 mm by 14.9 mm, rounded chunk of dark orange/red ochre with a lighter orange interior was recovered from unit N21/E23. This chunk has radiocarbon samples below and above dated 460±60 BP (calibrated AD 1410-1640, Beta 78767) and 380±50 BP (calibrated AD 1435-1650, Beta 78768), respectively. A piece of fire-cracked andesite with bits of red ochre on it was recovered toward the bottom of the forest duff preserved in unit N22E23. This irregularly shaped piece measures 58.8 mm by 32.9 mm by 25.1 mm. It is heat fractured and has pockets of very fine homogenous bright rosy red/pink clay-like material scattered in and adhering to depressions on its uneven surface. This piece is from a portion of the deposit between two radiocarbon samples with dates of 700±60 BP (calibrated AD 1235-1400, Beta 89051) and 610±60 BP (calibrated AD 1290-1435, Beta 78762).

Historic accounts from the late eighteenth and early nineteenth centuries record the use of red paint for body decoration by the inhabitants of Prince William Sound (Beaglehole 1967, Meares, 1791:lxi). According to Makari, a Chugach elder interviewed in the early 1930s, the iron oxide was crushed, then mixed with water and stale urine to produce paint (de Laguna 1956:251). Paint was used to color wooden bowls, grass baskets, arrowshafts, harpoon heads, clothing, and to paint pictographs (de Laguna 1956:252). A number of traditional sources for red ochre have been reported for the sound, including a bluff near Johnstone Point on Hihchinbrook Island and a vein above English Bay (de Laguna 1956:5). Although none of the whetstones found during testing are ochre stained, whetstones used for grinding and mixing paint have been found at Uqciuvit (Yarborough and Yarborough 1996) and Palugvik (de Laguna 1956).

Drilled slate

A slate disk with a hole drilled in the middle of it was recovered from 43 cmbd in unit N22E23. The thin, smooth, rounded piece is 43.9 mm long, 43.8 mm wide, and 4.4 mm thick. Holes drilled from each face meet as a central 4.4 mm diameter perforation. One face has marked parallel grinding striations, while the opposite has fine impact scars around the perforation. The edges have been rounded by grinding, with the ground areas extending onto each face. It is possible that this item was worn as a pendant, although though there are no obvious indications of wear from such use.

Fauna

Faunal preservation at SEW-488 is generally poor. This may be due to several factors, including, but not limited to, the nature of the past activities, erosion of the southeastern coastal portion of the site, and the soil conditions at the site. Ten bird bones, three harbor seal bones, 103 deer bones, two rodent bones and one rockfish bone were recovered from the historic portion of the site. One unidentified bird bone and a few mammal bones were found in prehistoric layers. Several hundred bivalve shells and fragments were recovered in the upper meter of the deposit, with the majority occurring in the historic, upper 40 cm. One tiny shell fragment was found below 150 cmbd. A few fish bones were recovered between 80 and 90 cmbd in the northern part of the site. Bivalve periostraca and fragments, at least some of which appear to be mussel, were recovered from deposits as shallow as 33 cmbd, but were increasingly common with greater depth, such that over 100 pieces were recovered below 100 cmbd. The site is generally damp, and is water-logged below 100 cmbd. It appears that while the anaerobic conditions have enhanced the preservation of wood and botanical remains, the acidic soil has contributed to the dissolving of shell and bone.

Mammals

Portions of two Sitka deer skeletons were present on the surface and within the forest duff layer of unit N15E23. One is adult, as indicated by the fused long bone epiphyses and full set of permanent teeth. The other is a subadult, similar in size to the first, but with only unfused and partially fused epiphyses, and partially erupted molars. One deer vertebra was also found in the duff layer of unit N17E22. As noted above in the discussion of fauna at SEW-440, Sitka deer were introduced to Prince William Sound in the twentieth century.

The early twentieth century hunting of harbor seal is represented by the presence of a left humerus, a right tibia shaft, and an unfused right tibia proximal epiphysis. Harbor seals were taken by both native and non-native hunters during the first half of the twentieth century, especially during the period when the U.S. government offered a bounty on them.

Two sea mammal fragments from late prehistoric deposits, both probably seal, indicate at least an occasional use of this resource. Harbor seals generally prefer sheltered harbors and bays. They inhabit much of the north Pacific coast and are more dispersed than other pinnipeds species in Prince William Sound. They occasionally venture into, and may winter over in, fresh water lakes. Unlike many other seals, harbor seals do not migrate and are usually found individually or in small groups within 16 km of the shore (Banfield 1974:370). They prefer haul-out areas that are not too steep sided, such as glacial ice, rocks, reefs, or beaches within the tide zone, and may change their haul-out places frequently. Because of these preferences, during the second half of the twentieth century large numbers of these seals have been found north of Knight Island on the islands of the Dutch group, and to the northeast in Columbia and Icy Bays (Dennis McAllister, personal communication 1990). Further to the south, large concentrations of harbor seals are also historically known from occur on Applegate Rocks, Smith Island, Green Island, and the inner coast of Montague Island. Fewer seals are found in the northwestern part of the sound, probably because of the steep nature of much of the coast (Lloyd Lowerie, personal communication 1990).

Both recently and ethnohistorically, harbor seals of varying stages of maturity have been valued for their skin, meat, intestines, and fat (Stratton and Chisum 1986). In historic times, and probably prehistoric as well, rendered seal oil was both consumed and used as lamp fuel. Chugach Eskimos of the 1930s recalled that in earlier times, the "innermost garment of men as well as women was an apron made of the skin of a new born seal and tied with a string round the neck and another round the waist" (Birket-Smith 1953:64). Seal skin was also used in making boots, bags for holding tools, cradles for infants, drum heads, and knapsacks. Additionally, seal skin provided the fabric for both umiaks and kayaks (Beaglehole 1967:344-346). Six adult skins were needed for a one-hole kayak, nine for a two-hole kayak, and as many as 20 for a large open umiak (Birket-Smith 1953:47, 49, 63, 85, 109).

Seals were taken year-round in early historic times. They were harpooned in the water or on ice-floes, then killed with a wooden club (Birket-Smith 1953:25). The Koniag used a similar method, while the Eyak were observed to hunt seals with harpoons and floats (Birket-Smith and de Laguna 1938:107-109; Davydov 1977:222). The Chugach, the Eyak, and the Koniag also hunted seals on land. A third method employed by the Chugach and the Koniag was to capture seals by driving them into nets placed in the water (Black 1977:98; Davydov 1977:222).

An incisor and maxilla from either a large marmot (*Marmota caligata*) or a small beaver (*Castor canadensis*) were found in unit N15E23, apparently associated with late prehistoric deposits. Marmots occur throughout southern Alaska, inhabiting burrows dug into the ground or dens in rock slides. Because they hibernate for four to eight months of the year, marmots are easily available to hunters or trappers only in late spring, summer, and early fall. It is in the fall, however, just prior to hibernation, that marmots are at their fattest and their fur is in prime condition (Hall and Kelson 1959:321, 329; Lobdell 1980:125). Beavers generally inhabit areas with fresh flowing water, and are found primarily on the mainland of the sound.

The Chugach reportedly ate marmot meat and used their skins for clothing (Birket-Smith 1953:17). Carl Merck (1980:111), who visited the sound in 1790, observed clothing made of marmot skins. Although the hunting techniques of the Chugach were not recorded, their methods may have been similar to those of the Tanaina of Cook Inlet, who both shot marmots, and also took them in deadfalls (Osgood 1976:35-36). Although beaver were also a food source, and their fur was used for clothing, there is likewise little ethnographic information on how they were obtained. They appear to have been a comparatively less important subsistence species than marmot (Birket-Smith 1953:18). Both beavers and marmot were taken prehistorically by the inhabitants of Palugvik, and their teeth were sometimes used as chisels (de Laguna 1956:50, 52).

Shell

Shell fragments are fairly well preserved in the early twentieth century historic component. These include 85 smooth Washington clams (*Saxidomus giganteus*), 13 Pacific littlenecks (*Protothaca staminea*), 9 mussel (*Mytilus trossulus*) fragments, and 1 cockle (family *Cardiidae*) fragment. A total of 126 shell fragments were identifiable only to *Veneridae* family, and 5 fragments only identifiable as mollusc. These remains seem to indicate that there are clam beds in the general area of the site, although none were noticed in the immediate vicinity during the course of project work. Shellfish have been historically gathered by both native and non-native inhabitants of the sound.

Only twelve fragments of clams were recovered from late prehistoric contexts. Eleven were only identifiable to family *Veneridae*, and one was only identifiable as mollusc. Three were just below the historic component, one in unit N22E22 and two in N15E23. Eight were preserved at greater depths, an unusual situation for this site. One was found between 83 and 93 cmbd in unit N21E24, and eight, including the one mollusc fragment, were located between 60 and 80 cmbd in unit N22E22. Although none of these were identifiable to species, it is likely that at least some of them represent smooth Washington clam and/or Pacific littleneck, the species most commonly recovered from prehistoric sites in the sound.

The prehistoric remains of common blue mussel consist of periostraca only. A few of these are whole, but the majority are in fragments, so it is difficult to estimate the number of shells represented. As noted above, common blue, or bay, mussels were desirable both for food and for their shells.

An unusual shell, a California mussel (*Mytilus californianus*), was found in the ITZ at SEW-488. It was found near a whetstone and is presumed to be prehistoric in nature. Although this species occurs in the North Pacific, they are only found on open, high energy coasts, and are rare in the northern Gulf of Alaska (Nora Foster, personal communication 1994). They are, however, found in large colonies in northern British Columbia (Ellis and Wilson 1981). This shell fragment is 73.0 mm wide and 117.5 mm from its edge to the point where it is broken midshell. The umbo half is missing. It is 9.4 mm thick at one edge, and 4.6 mm thick in the center. The original length of the shell is estimated to have been as much as 200 mm, a large shell even for this species. The entire piece is slightly waterworn. A squared portion, 15.4 mm by 28.4 mm in size, is missing from the edge of the shell. As all the other edges are naturally smoothly rounded, this section may have been deliberately removed.

Whether this specimen was brought to SEW-488 from an area such as the outer coast of Kodiak or Montague Island, or from an area further to the southeast where the species is more common, it is nevertheless highly unlikely that the specimen would have been collected live from the vicinity of the relatively sheltered area in which it was found. There is no historic or ethnohistoric record of use of this shellfish species in Prince William Sound. Because of its lack of context, it is not possible to associate the presence of this shell with any particular time period or activity.

Cultural Material Distribution and Relationships

SEW-488 is a small site within a constrained space. The restoration test excavations here were designed to yield information regarding the nature of the site between units #1 and #2 excavated in 1991 in the upland and ITZ portions of the site. Tests excavated during the 1994 and 1995 field seasons explored an area about 20 m long between those two 1991 tests.

The spatial distribution of artifacts which represent occupations from the late first millennium AD to shortly after the middle of the second millennium AD was fairly regular. Units N22E22 and N17E22 yielded the majority of artifacts, but the other units were not devoid of cultural remains. Because the units were laid out in a simple north-south pattern, rather than randomly across the site, definition of activity areas was not really feasible. Woodworking tools are found across the area. All of the complete adzes were found in northern units N22E22 and N21E24, although adze flakes, and the crystal graver and chisel, which also may have been used for wood work, were found in more southerly units. Knives, whetstones and projectile points, often associated with food procurement and processing, were likewise found across the site. Of some interest is the occurrence of ochre and ochre-stained stones in more northerly units and absence to the south, although this may be a result of sampling error rather than denoting an actual restriction of the use or deposition of ochre.

Historic artifacts display a similarly even distribution over the site. However, because of information regarding manufacturing periods, it is possible to say that the majority of the cultural material from the first half of the twentieth century occurs in the more northern portion of the site, while the material from the second half of the twentieth century occurs closer to the modern shore. The presence of fishing equipment, in the form of net weights and a float, suggest that the early twentieth century inhabitants were at least practicing subsistence fishing, and may have been involved in commercial fishing as well.

Only one tool fragment was found in a context earlier than the first millennium AD, however, only one unit was excavated to a depth which allowed this deposit to be sampled.

Summary of Archaeological Data

The evidence of occupation of SEW-488 before 2000 years ago is minimal, but the upland portion of the site seems to have been occasionally used during the first millennium BC. The difference in the apparent intensity of use between the earliest occupation period and that of the first and second millennium AD may be related to geological subsidence. If, 4000 years ago, the site area was 4 m higher in relation to the shore than it is today, then evidence of occupation from that time should surely be sought in the upper to lower ITZ. The fragment of information from the first millennium BC, from the northern part of the site, coupled with the admittedly dubious information from the ITZ , leads to the conclusion that evidence of human use of this part of the sound between 4000 and 2000 years ago is likely to be present at SEW-488. It may, however, be closer to or in the ITZ, and carefully planned work may be necessary to reveal it. The climate during the earliest period of site occupation was probably similar to the climate during the recent Little Ice Age. Forest resources may have been less abundant than at present, as pollen evidence indicates that the modern spruce hemlock forest only began to colonize the sound during the first millennium BC. The increase in fire-cracked rock after 1000 AD suggests the use of sweat-baths, but also indicates that sufficient wood resources were present to fuel the fires necessary to heat large quantities of rock.

Despite the presence of at least three distinct tephras, the various ashfalls represented by these deposits do not appear to have significantly restricted human use of the site over the past several thousand years. It may be that the ashfalls occurred during seasons when the site was not occupied, or were so minimal as to have been unimportant.

The isthmus or tombolo location of the site provided two boat landings to its inhabitants. The beach bordering the southeast side of the site is the more protected, but the northwest beach would have offered escape in another direction given an enemy approach.

The artifacts recovered represent a wider variety of types than found at SEW-440. In comparison with the Uqciuvit and Palugvik collections, only a few lithic artifact types are missing. Stone implements which are found elsewhere in the sound, but are not represented at SEW-488 include picks, mauls, strike-a-lights, incised plaques, mortars and pestles, labrets, nose pins and stone beads. No bone tools were recovered, probably as a result of adverse soil conditions. Only a few wooden tools are represented at the site, despite the demonstrated preservation of wooden materials in some waterlogged situations. The broken condition of many of the discarded lithic tools, and the lack of easily portable and complete lithic, bone and wood tools suggests planned abandonment. The presence of three still functional splitting adzes together in the northern part of the site suggests that their owner cached these heavy tools with the intention of returning to retrieve or use them, but, for some now unknowable reason, was unable to do so.

The woodworking tools present in the site–adzes, gravers, a chisel–suggest that splitting and carving wood were frequent activities. It is also probable that the few wood artifacts found do not reflect all the end-products of this manufacturing process.

Although there is plenty of evidence of fire, through the presence of charcoal and burned rocks, no hearths were found, in contrast to the box and pit hearths present at both Uqciuvit and Palugvik. Post-holes, closely spaced rock and fire-cracked rock "floors" and gravel lenses and soil discolorations with straight edges suggest particular living or activity areas.

Travel and/or trade during late prehistoric times is evident in the presence of felsic tuff whetstones from east of Prince William Sound; beaten copper artifacts, probably from the Copper River area; and California mussel, from at least the Gulf of Alaska coast, if not further east and south. Procurement of these items would have required travel of up to 80 or 100 km or more, through territories occupied by other people, or trade. Lithic materials, adzes, wedges, food, furs, baskets, snowshoes and boats were also early historic units of exchange (Birket-Smith 1953: 100-101), so it is possible that some or all of the adzes and some of the lithic artifacts are also the result of trade. Unfortunately there has not been enough study of quarry sites and materials in the sound to recognize which materials would have been received through trade, and subsequently made into artifacts.

Both Palugvik and Chugach phases are viewed as having a modified maritime subsistence base, and the few Uqciuvit phase cultural remains from SEW-488 do not challenge the suggestion of a maritime base for that phase (Yarborough and Yarborough 1996). It is not possible to say much about the prehistoric subsistence practices at this site due to the minimal faunal remains. Fishing and bivalve collection are represented. However, the site is not particularly close to a stream with an anadromous fish run, and it is impossible to infer the type of fish which might be represented by the unidentifiable remains. The number of knives and ulus recovered suggest that even though few bone remains were found, fishing and probably hunting were important subsistence pursuits.

The results of the tephra analysis, when compared with the date of 30±50 BP from a charcoal sample at 17-21 cmbd in square N22E22 (Beta 78764) and the general association of the lapilli with early twentieth century historic remains, reinforces the conclusion that the historic occupation at SEW-488 is limited to the period between 1900 and 1950 AD. Although a variety of commercial food products would have been available to twentieth century campers, the people who temporarily stayed at the site did leave evidence of modern hunting and gathering. The presence of fishing equipment but lack of fish remains from the historic stratum lends strength to the premise that the occupants were involved in commercial fishing. A variety of fish bones could be expected as a result of subsistence fish processing, while commercial fishing, in which fish were sold whole to canneries, might result in few, if any, remains.

Site Condition

Damage to SEW-488 consisted of oiling, disturbance of the ITZ through hot-water washing, furrowing by a landing craft, and digging in the upper and middle ITZ. Oil was still present in the underlying gravel in 1990 (Gallison *et al.* 1990). While no oil was present in the Hanby sample taken in 1995, it is possible that oil may still exist in some parts of the ITZ. However, extensive testing to determine its presence or absence is not recommended, due to the presence of intact cultural deposits.

Although the ITZ component continues to erode, the number of artifacts found during the project implementation period was dramatically lower than the quantity discovered during the oil spill and subsequent cleanup years. The protected location of this site suggests that natural erosion may be associated mainly with severe storms or tsunamis.

Erosion of upland areas appears to be currently limited to tree falls and animal trails. Historic use of the site associated with hunting and fishing does not appear to have caused significant erosion or other damage. The test units, all backfilled, are revegetating.

CHAPTER 6: REGIONAL CONTEXT OF SEW-440 AND SEW-488

Over 400 prehistoric archaeological sites have been recorded for Prince William Sound, 127 of them in the western and central portion of the sound surveyed during the Exxon Cultural Resource Program (Haggarty *et al.* 1991). However, testing to define the nature of particular sites, answer research questions, or determine eligibility for the National Register of Historic Places had only been previously conducted at three locations. The data collected during the restoration project testing of SEW-440 and SEW-488 allows these sites to be examined within the known context of other tested sites, and also considered in light of regional research questions.

Northern Maritime Adaptations

The data from SEW-440 and SEW-488 suggest that their prehistoric inhabitants were well adapted to the maritime ecology of the region. A modified maritime subsistence strategy has been postulated for the sound, in which both terrestrial and marine resources were used, with an emphasis on the latter (Haggarty *et al.* 1991:206, L. Yarborough 1995:74). However, the faunal remains from these sites indicate an almost exclusive reliance on marine fish, birds, mammals, and molluscs. In the instance of SEW-440, this may be due to the seasonality of the site and its intermittent use. The deterioration of bone and shell at SEW-488 biases the understanding of the inhabitants' prehistoric subsistence strategies, and makes it impossible to determine the seasonality of the site. The most that can be said at this point is that marine resources were used, as there is no indication of the extent of prehistoric utilization of terrestrial animals.

The artifact categories and activities represented suggest that SEW-488 may have been occupied on a semi-permanent basis in at least late prehistoric times. While proportions are different, the artifact assemblage is technologically very similar to those of Uqciuvit and Palugvik, with very few unrepresented lithic artifact categories. SEW-440 is more likely to have been intermittently inhabited.

Technological similarities to other sites in Prince William Sound place both SEW-440 and SEW-488 well within the Uqciuvit, Palugvik and Chugach cultural phases. Artifact similarities and differences which affirm connections with Kodiak and Cook Inlet, yet simultaneously place Prince William Sound sites outside the Kachemak cultural phase (Workman 1988, M. Yarborough 1991), are also corroborated by the remains from SEW-440 and SEW-488.

Similarities between the late prehistoric Koniag material culture and the Chugach phase include artifacts such as slate end blades, splitting adzes, stone axes, stone chisels, slate "awls", quartz crystal gravers, stone saws, slate splinters, and basic forms of both ground and flaked ulus (M. Yarborough 1991), all of which are present at SEW-488. Although no fishing related artifacts *per se* are present in the Chugach phase component of SEW-440, the almost exclusive use of fish resources is remarkably reminiscent of the Koniag subsistence focus on fish (Amorosi 1986; Knecht 1995).

However, the inhabitants of Prince William Sound were not only in contact with people to the west. De Laguna noted that "the cultural lines between Aleut-Pacific Eskimo and Eyak-Yakutat are much less sharply drawn than are the linguistic boundaries" (de Laguna *et al.* 1964:209). and that there is a particularly strong relationship between Prince William Sound and the Yakutat region:

"There is hardly a single trait of Yakutat archeology that cannot be duplicated

Dale Vinson, USFS 1995

Figure 32. Excavations in progress at SEW-488, 1995.

> or at least matched by something similar from Prince William Sound, and the trends noted with respect to the use of copper, of woodworking tools, and so forth, are the same in both areas. Many of these points of similarity apply to traits that are narrowly defined and that appear only in late prehistoric times, but others apply to traits that are very much older" (de Laguna *et al.* 1964:209).

The presence of certain artifacts and the absence of others in the collections of SEW-440 and SEW-488 also corroborates de Laguna's observations regarding cultural connections to the southeast. The few boulder spalls at these sites are typical of other collections from the sound, as well as from the Yakutat area (de Laguna *et al.* 1964:108). Like other lamps recovered from Prince William Sound and Yakutat, those from SEW-488 are undecorated (Davis 1996:490-495; de Laguna *et al.* 145-146), although undecorated lamps may also be typical of the late prehistoric Koniag phase on Kodiak Island (Clark 1974a:114-115). Despite the large amounts of fish recovered from SEW-440, no notched sinker stones are present at the site. Although notched stones are known from a site on Montague Island to the south, their general lack from other sites in the sound is in keeping with the use of unshaped stones for sinkers among the late prehistoric and early historic Chugach and Eyak, and a general paucity of notched and grooved stones on the Northwest Coast (de Laguna 1964:151).

The artifact collections and general site sample from SEW-488 and SEW-440 are probably too small to substantiate regional chronological trends in decreasing or increasing numbers of artifacts such as splitting and planing adzes. However, the presence of copper artifacts and quartz crystal gravers in late prehistoric deposits further confirm changes in north Pacific coast technology, and possibly trading patterns, in the centuries before European contact. The large amounts of fire-cracked rock in the first and second millennium deposits at SEW-440 and SEW-488 coincide with regional evidence of the introduction of sweat baths into the north Pacific during the first millennium (Clark 1974a:140-141; Knecht 1995; de Laguna 1972:305-306; de Laguna *et al.* 1964:40; Yarborough and Yarborough 1996).

Defensive considerations, as postulated by de Laguna (1956:11), may have been important in determining the locations of both SEW-440 and SEW-488. Ethnohistorically, the Chugach had a tradition of warfare between villages, and with their Eskimo and Indian neighbors (Birket-Smith 1953:101; de Laguna 1956:9). Although protection from wind and surf, and access to food and water were considerations, "good conditions for landing and look-out" were among the main factors influencing settlement location (Birket-Smith 1953:53), and the heads of bays, "dead ends from which no escape by water would be possible in the event of an attack," were avoided (de Laguna 1956:11).

Neither site today is particularly close to a salmon stream or a bird rookery, although excellent deep sea fishing is possible within a 5 km radius of each site. Given the general subsidence of the area over the past 4000 years, notwithstanding the uplift that occurred during the 1964 earthquake, resource availability in the vicinity of each site may have changed. However, if twentieth century biological habitat is considered, it seems likely that some other site location determinants may have been more important than proximity of subsistence resources.

Both SEW-440 and SEW-488 were occupied during the late prehistoric period, a time of suggested increases in social complexity along the north Pacific coast, but there are no special features which would distinguish either site from others in the sound in terms of distinct territoriality. Habitation of both sites appears to have ceased in late prehistoric or protohistoric times; artifacts such as glass beads or iron objects, which are generally typical of protohistoric or early historic settlement, were not recovered. Although unique personal ornamentation is believed to have distinguished inhabitants of Kodiak Island by village and rank (Knecht 1995), evidence of similar singular embellishments are not present from these two sites. SEW-488 and SEW-440 were within the territory of the Shuqlurmiut of north Montague and eastern Knight Islands (Birket-Smith 1953:20-22), but none of the materials recovered necessarily separate them from the Kangirtlurmiut, as represented by the cultural remains from Uqciuvit, or the Palugvirmiut, represented by the artifacts from Palugvik.

Prehistoric Settlement Models

Two models have been proposed to explain prehistoric site settlement patterns throughout the oil spill area (Haggarty *et al.* 1991:209-211). These models include Prince William Sound, as well as the Kodiak archipelago and the Alaska Peninsula. The first is a resource distribution based model which postulates that "the distribution, density, diversity, seasonal availability, and accessibility of resources strongly influence where hunter gatherers choose to establish settlements" (Haggarty *et al.* 1991:209). This model allows for permanent and seasonal settlements, depending on the resources present within an easily accessible area. It assumes relatively stable environmental conditions over time, and a stable human population size. The second model postulates that fluctuations in human population densities over time were most important in determining the locations of settlements. This demographic model suggests that the number of settlements increased over time as populations in a given area increased. Its corollary is that settlements in areas with limited resources were either newly established or, if already in existence, occupied for increasing lengths of time as villages fissioned due to increasing pressure on available resources.

Although potential interpretive problems, arising from such factors as uneven survey intensity, historic decreases in resource abundance due to commercial harvest, and differential site preservation due to tectonic movement and erosion, were acknowledged by the formulators, these models were subjected to statistical analysis in which spatial variation in assumed site types, known site densities, temporal trends, and proximity to known modern resources were compared (Haggarty *et al.* 1991:219-233). As a result it was suggested that resource distribution and abundance had not changed during the late Holocene prior to European contact; that unequal resource distribution led to "significant variation in population density, wealth, power, trade, and overall cultural complexity," and that increasing population density over time and environmental infilling during the late prehistoric period was the source of the current known site location record (Haggarty *et al.* 1991:246-247). The statistical test basically suggested that the demographic model was more applicable than the resource distribution model to the *Exxon Valdez* oil spill area.

However, there are inherent problems in applying either model to Prince William Sound, and perhaps elsewhere in the northern Pacific. The first model assumes environmental stability and does not take into account Neoglacial climatic change or the possibility that resources may have changed in ways which could have affected settlement patterns. Advances of tidewater glaciers appear to have been more dramatic in Prince William Sound than elsewhere in the Gulf of Alaska (de Laguna 1956, Tikhmenev 1978, Wiles and Calkin 1994). Close correlations have been noted between glacial and volcanic activity in recent centuries, with volcanic activity suggested as a stimulus for climate changes between at least 5800 and 2400 BP (R. Bryson, personal communication 1993, Kutzbach 1983:276; Porter 1986). Average temperatures during glacial advances following high latitude volcanic eruptions are suggested to have been from 0.5 to 1.2 degrees Celsius lower than current temperatures (Porter 1986:44). A simulated palaeoclimatic annual rainfall history for the Cordova suggests peaks of precipitation during Neoglacial advances, not unlike the climate noted by Tikhmenev during the Little Ice Age (R. Bryson 1993 personal communication, Tikhmenev 1978). Atmospheric and oceanic circulation interact, each affecting the other's temperatures and currents, and local atmospheric forcing can have a noticeable effect on coastal currents (Mysak 1986:464).

The effect of such recorded and postulated climatic variation is likely to be changes in subsistence resource populations. Studies of sockeye and pink salmon have shown that low pressure systems, associated with increased cloudiness and lower water temperatures, may slow salmon maturity, and that decreases in water temperature seem to be associated with decreases of ocean abundance of salmon (Yeh 1987:66, 69). In contrast, El Niño and Southern Oscillation episodes, which correlate with increases in sea surface temperature and food production in the Gulf of Alaska, result in increased populations of herring, earlier return times for sockeye salmon, increases in weight of mature salmon, changes in salmon migration routes and an increase in the numbers of rare warm-water fish, birds, turtles and whales in the North Pacific (Mysak 1986:488).

While such environmental changes may have had a bearing on the abandonment of Uqciuvit during the first neoglacial episode and initial habitation of sites in the northern Knight Island group, they nevertheless do not explain the small number of known sites with remains from the Uqciuvit phase, larger number of sites with components assigned to the Palugvik phase, and apparently greatest number of sites with Chugach phase components. This situation seems to be more in tune with the demographic model, on first glance. However on closer examination, an assumption of steadily increasing population in the sound, resulting in the configuration of today's known sites, is also fallacious.

A primary variable in the statistical analysis of the models was the number of visible housepit surface features at any given site. The use of this variable is likely to have greatly skewed the analysis results for Prince William Sound, as only five known sites in the area have such surface features. In addition, the housepits present at the two partially excavated and tested "village" sites, Palugvik and Uqciuvit, have no direct ascertainable relationship to any surface features. This is most likely related to depositional factors. The spruce-hemlock forest covering these sites with its litter and fallen trees contributes to a higher natural rate of deposition than that found on the Kodiak archipelago or Alaska Peninsula. The latter were both virtually treeless until the past several centuries, and a large number of sites in these areas have highly visible housepit surface features that can be as old as several thousand years.

Given that the oldest known cultural deposits in Prince William Sound occur under up to 1.8 m of later strata, and that crustal warping associated with the 1964 earthquake lowered some parts of the sound by over a meter and uplifted others as much as 10 m, it is highly likely that late Holocene depositional circumstances, geomorphological changes, and coastal patterns of archaeological survey, rather than prehistoric demographic changes, are largely responsible for perceived prehistoric settlement patterns and our current state of knowledge regarding temporal and demographic trends. For many years it was assumed that, because of the general subduction of the continental plate into the Aleutian Trench, Prince William Sound sites greater than 2250 years old had simply subsided into the sea and had been destroyed through erosion (Clark 1984a:137, 140). While this explanation is too broad to present the full picture of geological movement in the sound, its focus on geomorphologic processes as a major factor in site preservation and location in the sound is probably correct. The subsidence of SEW-488 over the past 4000 years illustrates in some measure this traditional view of shoreline changes, although this location rose a meter or more during the 1964 earthquake. With the 1988 discovery of the earlier Uqciuvit component at SEW-056, physically located in a portion of the site which is 3 m above the current shoreline, and the 1989 discovery of related material at SEW-430, about 10 m above the current shoreline, it is apparent that the question of early site existence and location is closely tied to understanding degradational and depositional events, and complex vertical shoreline changes which vary greatly from one locality to another.

The resource and demographic models were partially tested in the Kodiak archipelago through excavations and surveys in the late 1980s and early 1990s. In contrast to the expectation that Neoglacial environmental changes would have been so slight that most resources would not have been affected (Haggarty *et al.* 1991:213), Amorosi (1986) and Knecht (1995) have demonstrated that changes in artifacts, fire-cracked rock abundance, and subsistence resources on Kodiak Island correlate with the onset of the Little Ice Age. Additionally, during surveys on Kodiak and Sitkalidak Islands, a number of 6000 to 8000 year old sites have been discovered as much as a mile inland from the current shoreline, and at elevations 6-10 m above current sea level (Carver and Gilpin 1993, Ben Fitzhugh 1996:269-277). These newly discovered sites have resulted in reassessment of assumptions regarding site locations, resource use, and demographics. The Kodiak archipelago has undergone tectonic processes similar to those at work in Prince William Sound, and provides an example of archaeological sites associated with old shorelines. In addition, the faunal evidence from Kodiak and other parts of Alaska (Ackerman 1988) suggests that changes in resource distribution, population abundance, and subsistence strategies associated with Neoglacial environmental changes should be expected in Prince William Sound.

The resource and demographic models discussed above undoubtedly seemed theoretically reasonable when they were proposed. However, research results which had begun to be presented and published even at the time that these models were put forward had already nullified the assumptions of unchanging climate and resources, and increasing population represented by sites present along the current shoreline. A more appropriate settlement model for the sound, and perhaps the Kodiak area as well, would be one which takes into consideration climate and shoreline changes in relation to available subsistence resources and site locations, and evidence of social and demographic changes.

CHAPTER 7: SUMMARY

The primary goal of the EVOS Archaeological Restoration Project was to implement the mitigation measures designed and recommended for SEW-440 and SEW-488. This involved survey of upland and intertidal zone portions of both sites by Chugach National Forest archaeologists, testing to determine the nature of the sites, and analysis of the results of those tests. This report presents the project results to the general public, as well as other archaeologists.

Evaluation of the Damaged Sites for Inclusion on the National Register of Historic Places

Both SEW-440 and SEW-488 are eligible for inclusion on the National Register of Historic Places under Criterion D, as properties which "possess integrity of location, design, setting, materials, workmanship, feeling, and association" and "have yielded, or may be likely to yield, information in prehistory or history" (36 CFR 60.4(d)). Both sites meet these requirements in that they have yielded or are likely to yield data with significant bearing on research questions such as site location, activities, seasonality of use, prehistoric subsistence, regional chronology and settlement patterns.

Restoration Goals and Project Effectiveness

The goals of the project, as specified in the mitigation measures, have been met. SEW-440 and SEW-488 are no longer perceptibly deteriorating as a result of, or in danger of destruction from, the effects of the *Exxon Valdez* oil spill. The recommended mitigation–site assessment, followed by recovery and analysis of artifacts–has been accomplished. In order to analyze the artifacts and understand the nature of each site, it has been necessary to obtain and study environmental, historical, and archaeological data, which are incorporated into this document. The scientific and cultural knowledge which has been gained through test excavations and analyses will assist in the protection and preservation of the remaining cultural deposits at these and other sites.

Fluid ITZ oil from the spill was present in samples from SEW-440 in 1994, but not in 1995. No oil was detected in samples from SEW-488, probably in large part because of the hot water hosing, which also damaged the site. Both sites will be included in future programs to monitor oil presence and vandalism.

Partly because the ITZ component at SEW-440 does not seem to be extensive, the oil spill cleanup damage at that site appears to have been minimal. No upland damage was discovered during this project. Upon visiting the site in 1995, one year after the completion of the archaeological testing program, all humanly disturbed areas, including the archaeological tests, were revegetating naturally and were almost indistinguishable from the surrounding undisturbed areas.

Damage from the cleanup process is likely to have been more extensive at SEW-488, especially in the ITZ, but has not been easy to assess. The ITZ cultural remains at this site are in a precarious, easily disturbed situation. The mixing of deposits discerned in upper ITZ unit N12E24 may simply be the result of natural wave action. The strata in ITZ test unit #1, excavated in 1991, appear to have been undisturbed by the cleanup efforts. However, it is likely that the hot water hosing, the holes dug by cleanup workers, and the furrows created by the landing craft disturbed cultural material, and may actually have exposed some of the artifacts

Figure 33., Revegetating test unit, SEW-440.

found in the ITZ in 1989 and 1990. There is probably undisturbed material left in the ITZ, but it is difficult to estimate how much. Given the subsidence since the earliest occupation at the site, the portion of the site now in the ITZ may represent the extent of the inhabited site as it existed several thousand years ago. The upland evidence of this occupation found during the course of this project was minimal. While the dates for the earliest cultural remains indicate the period of occupation, the collected remains themselves leave unanswered many other research questions. In contrast, the upland damage to the site from the oil spill appears to be minimal, and, as at SEW-440, the site appears to be revegetating well.

The effectiveness of this project is measured in large part by the knowledge gained through its implementation. Although archaeological investigations invariably lead to more research questions about a particular culture or time period, some very basic questions pertaining to site activities and cultural affiliations of these sites have been answered as a result of this work. The information gathered provides a greater understanding of the inhabitants represented by all the periods of occupation identified at each site.

Conclusions

This project would not have been necessary had the *Exxon Valdez* oil spill not occurred. Oiling and cleanup related damage occurred at both SEW-440 and SEW-488. After assessment, a panel of archaeologists prescribed mitigation measures. These have been implemented, resulting in this report of assessment and analysis.

This report described the mitigation work at each site, and presented the results of this testing. In so doing, cultural values at SEW-440 and SEW-488 have been documented and preserved. The knowledge gained from assessing damage and analyzing these cultural remains is a considerable contribution to understanding the nature of not only each site, but, in a larger context, archaeological sites in Prince William Sound. Additional analysis will undoubtedly be ongoing, as archaeological data lends itself to further examination with advances in the field.

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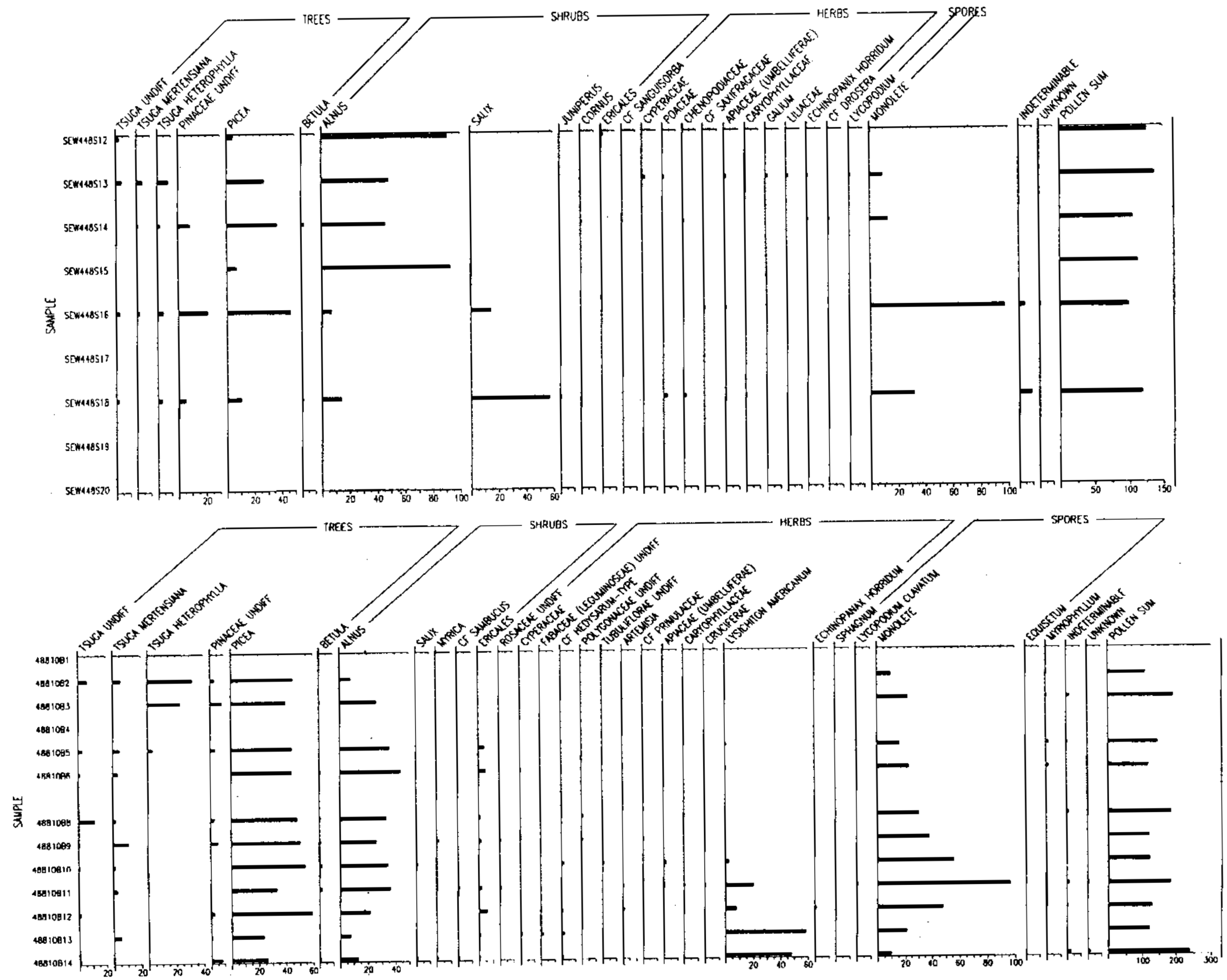

Figure A-1. Pollen diagram, Section 49SEW488.3.S (top) and49SEW488.10 B (bottom)

Appendix A:

ANALYSIS OF POLLEN SAMPLES FROM ARCHEOLOGICAL SITE SEW-488, NORTHEASTERN KNIGHT ISLAND

by Mary Edwards and Andrea Krumhardt
Department of Geology and Geophysics, University of Alaska Fairbanks

INTRODUCTION

Pollen was examined from a total of 36 samples taken in conjunction with excavations at archeological site SEW-488. Of these, 27 samples came from excavation walls or test pits associated with excavations at the archaeological site; the other 9 came from a small swale southwest of the archaeological site and above the tree line, at about 500 ft elevation. The sample series are as follows: SEW-488.3.S from the east wall of N21E23; 49SEW488.10.S and 49SEW448.10.B from N22E23 and an associated test pit, and 49SEW488.11.B from the swale.

METHODS

Approximate 2-ml samples of sediment were obtained by water displacement. Sediments were treated with conventional pollen-processing techniques (Faegri and Iversen 1989): dilute acid wash to extract carbonates, 10% KOH soak to extract humic acids, HF to remove silicates, glacial acetic washes and acetolysis. Pollen samples were stained with safranin and mounted in silicone oil. Samples were counted to 100 terrestrial grains or greater. Samples with <50 countable grains per slide were considered barren. The pollen sum consisted of all terrestrial pollen taxa, but excluded terrestrial spores. Percentages of other types were based on the count for that type plus the pollen sum. Pollen calculations were done using TILIA and diagrams plotted using TILIA.GRAPH (E. Grimm, Illinois State Museum).

RESULTS

N21E23 Sequence: section 49SEW488.3.S (7-78 cmbd)

Sample 49SEW488.3.S.12 (7 cm) is completely dominated by alder (*Alnus*) (Figure A-1). Fungal spores and blue-green algae are common, and charcoal is present in small amounts.

Samples 49SEW488.3.S.13 and 49SEW488.3.S.14 (17 and 24 cm) contain about 35% spruce (*Picea*) pollen and 50% alder pollen; conifer stomates are present in small amounts. 49SEW488.3.S.15 (30 cm) resembles the surface sample, but the next lowest sample, SEW488.3.S.16 (39 cm) is dominated by spruce and undifferentiated conifer pollen (spruce or hemlock). Alder drops to 10% and willow is >10%. Monolete spores reach 100%.

49SEW488.3.S.17 (48 cm) is barren. 49SEW488.3.S.18 (60 cm) is dominated by willow (*Salix*) pollen at 60%. 49SEW448.3.S.18 and 19 (69 and 78 cm) are barren. The material in the basal samples is dark, abundant, angular organic detritus. Although some fragments may be charcoal the majority are not. Bordered pits are visible on some fragments, suggesting that macerated wood pieces are present. Fungal spores and hyphae and bacterial filaments are common. Occasional spruce grains are present.

N22E23 East Wall Sequence: section 49SEW-488.10.B (95-1.65 cmbd)

This sequence is offset horizontally; beginning at approximately the level of the basal sample in the previous sequence and continuing downward.

49SEW488.10.B.1 (95-100 cm) contained poorly preserved (abraded and crumpled) conifer pollen (hemlock, spruce), a few conifer stomates, and occasional charcoal. There was insufficient pollen to count.

49SEW488.10.B.2 and 3 (100-110 cm) are dominated by western hemlock (*Tsuga heterophylla*) (20-30%) and spruce (35-45%). Conifer stomates and charcoal are present. Samples 49SEW488.10.B.4 through 12 (110-155 cm) are dominated by spruce and alder, with spore content increasing downwards. Spruce-type conifer stomates occur in 49SEW488.10.B.4 and 5; fungal remains are common in most samples. Charcoal is abundant in 49SEW488.10.B.6. The two lowermost samples (49SEW488.10.B.13 and 14; 155-165 cm) are dominated by pollen of skunk cabbage (*Lysichiton americanum*), and spruce, alder, and spores are reduced.

Lower deposit N22E23, section 49SEW488.10.S

These samples contained abundant pollen. The spectra are dominated by pollen of alder and mountain hemlock (*Tsuga mertensiana*), Liliaceae (skunk or deer cabbage), and large numbers of fern spores (100-500% of the pollen sum). Spruce values are extremely low. The two uppermost samples (49SEW488.10.S.21 and 22; 182-211 cm) have 15-20% mountain hemlock, 50-60% alder and 10-20% liliaceous pollen. 49SEW488.10.S.23 and 24 (211-235 cm) are dominated by alder and ferns, with lycopodium spores at ca 25%. The basal sample, 49SEW488.10.S.25 (235-244 cm), is also alder-dominated but in addition contains >10% mountain hemlock, >10% Ericales (heath) pollen, and >20% lycopodium spores.

Wet Meadow Section 49SEW488.11.B

The 40-cm sequence from the wet meadow contains well-preserved pollen. The basal sample is dominated by alder, the other samples by mountain hemlock and alder. Spruce occurs at levels of 5-20% in the uppermost 4 samples, and western hemlock values are above 5% in the uppermost 2 samples. Cyperaceae, c.f. *Sanguisorba* (burnet), sphagnum (Sphagnidae), and fern (Pteridophyta) spores occur consistently within the profile.

DISCUSSION

N21E23 Sequence: section 49SEW.3.S (7-78 cmbd)

49SEW448.3.S.12 lies close to the modern surface in forest duff and probably approximates to modern pollen rain. Alder dominates the pollen spectrum. Alder can be locally abundant, especially during the early stages of succession after disturbance. It is also common as an understory shrub in spruce-hemlock forest. As it is over-represented in pollen spectra, its cover is usually considerably less than its pollen percentages might suggest. Spectra from 17-39

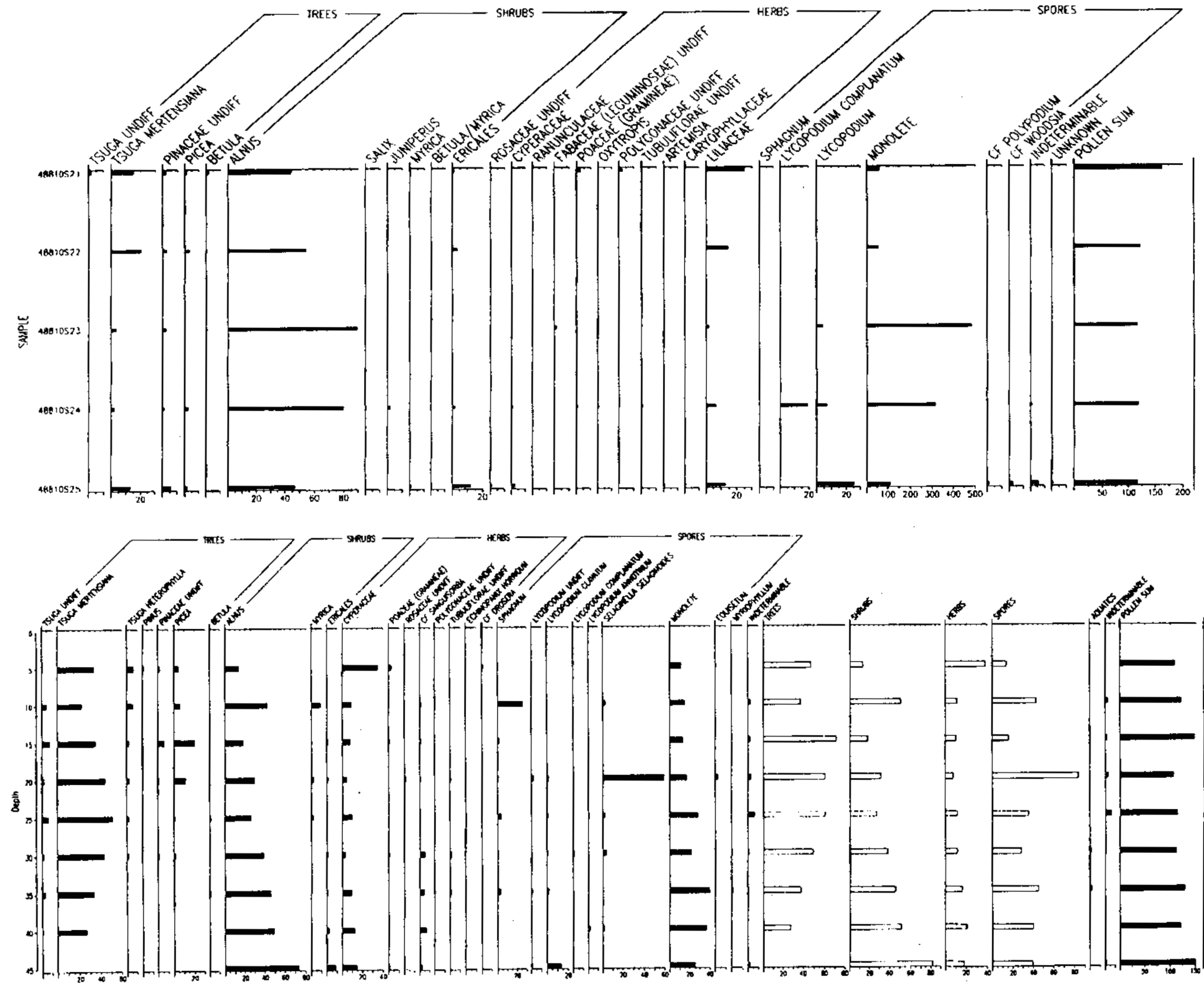

Figure A-4. Pollen Diagram, Section 49SEW488.10.S (top) and 49SEW488.11.B (bottom).

suggest a spruce forest with alder understory occupied the site during the accumulation of the uppermost 40 cm of sediment. Gravel is abundant in the sediments from 40-80 cm; pollen preservation is often poor in gravel as it allows oxidation. The sample at 60 cm suggests that willow was locally dominant. This may reflect a more disturbed substrate at this time, perhaps the result of stream action or a beach incursion. Other material in the basal samples suggests a woody, forest floor or detrital deposit largely decomposed by fungi. Basal radiocarbon samples from this square are 300-500 years BP.

N22E23 East Wall Sequence: section 49SEW488.10.B (95-1.65 cmbd)

The uppermost sample (95 cm) lies within the largely sterile gravelly unit. The suite of samples below to 155 cm provide a fairly consistent set of pollen spectra that suggest a spruce forest occupied the site. The forest duff between 100 and 110 cm contains abundant western hemlock pollen, and this species may have been locally present during the time represented by these sediments. The high levels of skunk cabbage pollen in the basal spectra (145-165 cm) probably indicate local abundance of this species on the site, and the high counts probably artificially reduce the percentages of spruce and alder. Skunk cabbage commonly occurs in seeps and wet areas but is also found more generally in damp, more open areas of forest. Overall, the sequence from ca 100-165 cm, which is sampled from a fairly continuous forest duff, suggests spruce forest present throughout. The suite of radiocarbon samples from this square (upper section) range to 1290±50 near the base.

Lower deposit N22E23, section SEW448.10.S

This suite of samples suggests the local presence of mountain hemlock forest, again with alder. Ferns and lycopods were probably locally abundant throughout the accumulation of the deposit.

Spectra of all three sections contain occasional grains of herbs: grass, sedge, Rosaceae, Fabaceae, Apiaceae, Caryophyllaceae, etc., and some pollen of heaths. However, total herb pollen values are extremely low, suggesting woody vegetation dominated the sites during the time represented by the sediments. The herb pollen spectrum is consistent with a forest flora or flora of small openings and forest edges.

Dates for this section range from 2680±60 at the top to ca. 5000 years BP near the base. The rise in mountain hemlock values from <5% to about 20% seen in sample 488.10.s.22, which according to the dates occurs after about 5000 years BP but before about 2700 Years B.P, is.consistent with the regional *Tsuga mertensiana* rise of about 4000 years BP. However, the basal sample, which is presumably ca. 5000 years BP or older, has intermediate values of *T. Mertensiana* (10-15%), suggesting this taxon may have been in the vicinity of the sampling locality as early as 5000 years BP. No very firm conclusions can be drawn here because of the preliminary nature of the pollen data (one sample, a ca 100-grain count), and possible reworking of basal material indicated by two indistinguishable dates.

Wet Meadow Section 49SEW488.11.B

The wet meadow section records the presence close to the site of a mountain hemlock forest with alder understory, with increasing spruce and western hemlock in the upper part of the record. The latter reflects either establishment of a few trees near the site or a change in the forest composition in the adjacent area. Throughout the record herb pollen is between 10 and

40%, suggesting the immediate area where the section was dug has remained treeless. The dominant herbs (sedges, burnet) and the consistent presence of sphagnum suggest locally boggy conditions.

The radiocarbon dates show that the spruce rise, after ca. 4000 but before 600 years BP, and a recent, ca. 1000 years BP, western hemlock rise are consistent with existing data (Ager 1983, Heusser 1983). The mountain hemlock rise occurs after ca. 6500 but before ca 3500 years BP. This is not inconsistent with the regional rise at 4000 years BP (Ager 1983). However, if sedimentation rates are relatively consistent, interpolation between the dates would place the mountain hemlock rise ca. 5000-5500 years BP, which is older than other dates from the region and quite consistent with the basal sample in the lower section 49SEW488.10.s.

CONCLUSION

The dates raise an interesting question about the first arrival of mountain hemlock on Knight Island. Preliminary pollen data indicate this taxon may have been present 1000 years earlier than at mainland sites in central Prince William Sound (PWS). Although the data are not sufficient to place any weight on this conclusion, as further dates and pollen analyses would be required to confirm the pattern, it appears that mountain hemlock reached Knight Island earlier than it reached central and western PWS. Two lines of evidence suggest that this is not an unreasonable history. First, forest tree taxa migrated up the coast of Alaska from the south, and the route from Cordova via Hawkins, Hinchinbrook and Montague Islands to Knight Island may have been a faster migration corridor than the fiord and glacier dominated mainland coast. Second, neoglacial activity of mainland glaciers over the past 2000-3000 years prevented conifer forest migration and/or erased evidence of earlier forest incursions into western PWS (Heusser 1983), whereas Knight Island did not experience neoglacial activity.

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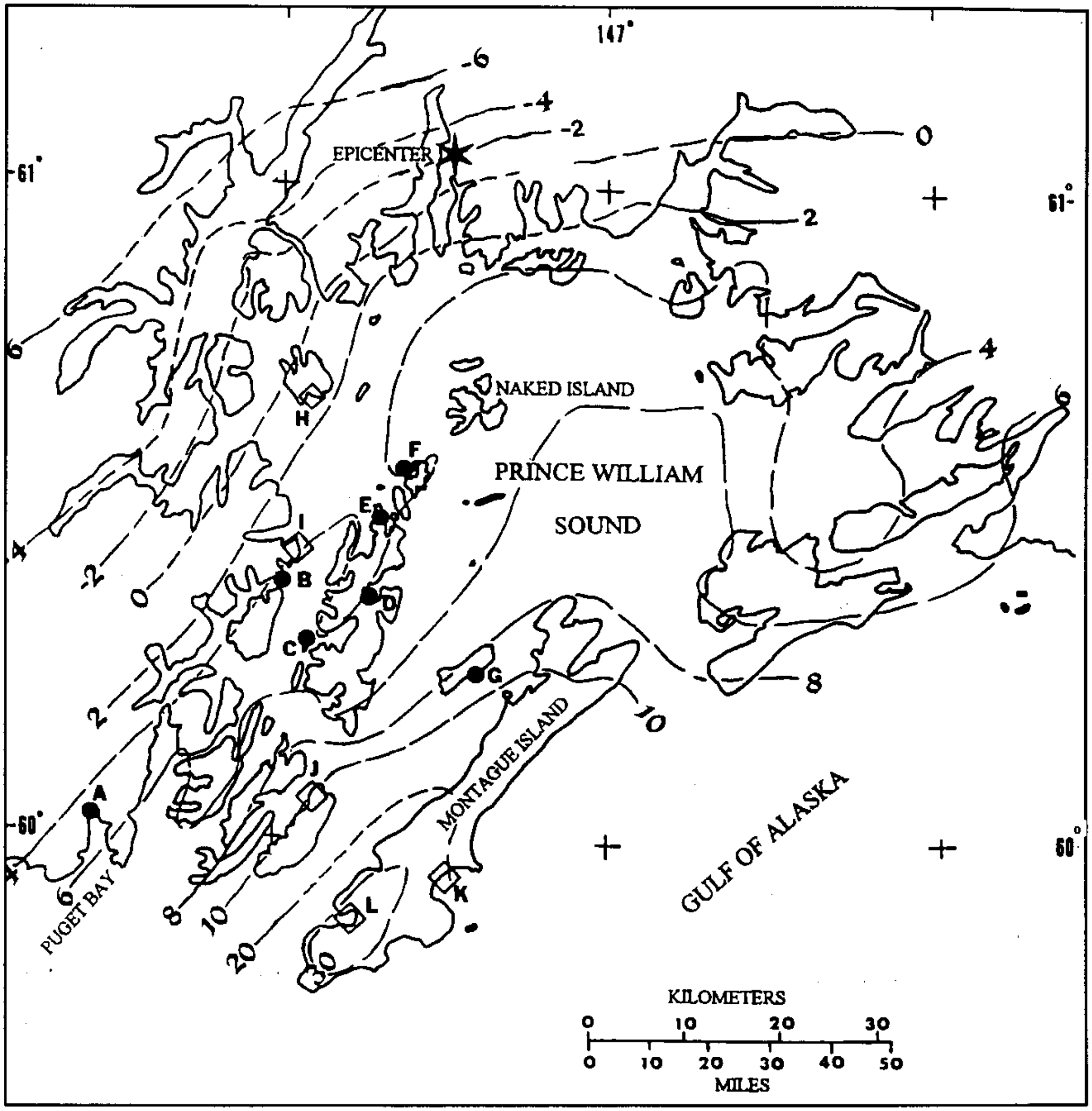


Figure B-1. Location map of Prince William sound. Contour lines show the amount of episodic elevation change (scale in feet) which occurred as a result of the 1964 earthquake (Plafker and Mayo 1965:7). Sample sites visited in 1994: A) Puget Bay; B) Junction Island; C) Mummy Island; D) bay of Isles; E) SEW-488; F) SEW-440; G) Green Island. Locations samples during earlier studies: H) Perry Island; I) Nowell Point; J) Latouche Island; K) Patton Bay; L) MacLeod Harbor.

Appendix B:

OBSERVATIONS CONCERNING HOLOCENE TECTONISM AND ASSOCIATED SHORELINE CHANGES IN PRINCE WILLIAM SOUND, ALASKA

by Greg Chaney

INTRODUCTION

This report briefly describes tectonic and shoreline history in the vicinity of archaeological sites SEW-440 and SEW-488. The two sites, and six dispersed sampling locations, were visited and 30 samples were collected for radiocarbon dating (20 of which were submitted.) The results of this field work have combined to provide significant new insights into the nature of shoreline dynamics in the EVOS region of Prince William Sound. As with all preliminary investigations, more research remains to be done, however these data provide a better framework from which future projects may proceed.

BRIEF LITERATURE REVIEW

There is general agreement that sea level has risen globally in the last 8,000 years. However the extent, timing, and magnitude of this increase is extensively debated. It is generally accepted that sea level changes have been minor or non-existent for the last 2,000 years (Komar, 1976). In recently deglaciated and seismically inactive regions, emergence of land from the ocean has been attributed to unloading of glacial ice. Glacial rebound is the expected response to the melting of large glacial ice sheets (Hicks and Shofnos, 1965). On the southwestern coast of the Kenai Peninsula glacial cirques of Wisconsin age are found below sea level. Long term subsidence of this recently deglaciated region has been attributed to diastrophic deformation of a magnitude greater than glacial rebound mechanisms (Plafker and Rubin, 1967:64-5).

Changing Holocene land levels in the northern Gulf of Alaska seem to have been dominated by pulses of movement resulting from the subduction of the Pacific Plate by the North American Plate. Due to the shallow 5 ° to 15 ° angle of subduction, the leading edge of the North American Plate is relatively thin and is dragged downward with the Pacific Plate until a threshold is reached and the two plates slip past each other. This slippage generates large seismic disturbances such as the 1964 Alaska earthquake (Plafker 1965). While the western Kenai Peninsula has been sinking since deglaciation, Montague and Middleton Islands have been rising for approximately 4,500 years (Plafker and Rubin 1967). Land level changes which resulted from the 1964 earthquake were well documented (Plafker 1965, Plafker and Mayo 1965, Plafker and Rubin 1967). The region along the axis of Montague Island was uplifted at least 10 m while north western Prince William Sound experienced subsidence of over 2 m.

Regional subsidence of the area affected by the 1964 earthquake was noted historically as early as 1794 on Montague Island by Vancouver (1801:335-6) who stated:

The shores are in general low, and as has been already observed, very swampy in many places, on which the sea appears to be making more rapid encroachments than I ever before saw or heard of. Many trees have been cut down since these regions had been first visited by Europeans; this was evident by the visible effects of the axe and saw; which we concluded had been produced whilst Messrs. Portlock and Dixon were here, seven years before our arrival; as the stumps of the trees were still remaining on the earth where they had originally grown, but were even now many feet below the high water mark, even of neap tides. A low projecting point of land behind which we rode, had not long since afforded support to some of the largest pine trees in the neighborhood, but it was now overflowed by every tide; and excepting two of the trees, which still put forth a few leaves, the whole were reduced to naked, dead white stumps of trees, with their roots still fast in the ground, and were also found in no very advanced state of decay nearly as low down as the low water of spring tides. [Low water of spring tides is about 5.5 m (18 ft) below the reach of high water in that area (Thompson's Tide Tables 1994).]

Many radiocarbon dates from submerged stumps in growth position collected during previous studies revealed that the entire region which experienced land level changes resulting from the 1964 earthquake had subsided up to 5 m during the previous 700 years. In most of Prince William Sound, this gradual subsidence was reversed by sudden uplift during the earthquake. Therefore, while net Holocene land level change has been positive in the Montague and Middleton Island regions, prior to the earthquake these regions were being depressed by diastrophic forces. In the region of Prince William Sound, sudden uplifts are thought to have been proceeded by slow subsidence. This lurching pulsating motion has been preserved on five pre-quake marine terraces found on Middleton Island. The oldest of these is located 41.5 m above present sea level and dates from 4,470$\pm$250 years BP.. Actual uplift is greater due to the gradual increase in sea level during this period (Plafker and Rubin 1967:56,64-5).

Although the 1964 Alaskan earthquake is the best documented earthquake in south central Alaska, seismic disturbances are common in this region. The seismological record is extremely biased toward modern events because reliable instrumentation has not been available for more than 80 years. The most common sources for early data are eyewitness reports. These are often subject to error especially when observations are made under conditions of mental stress, surprise and fear. In the early period most of south central Alaska was not settled by literate people making it difficult to locate early earthquake reports. In many cases it is probable that no reports were received from the region of greatest intensity. Between the years 1896 and 1980, 78 earthquakes were recorded within 200 km of western Prince William Sound. An earthquake which was recorded on October 9, 1900 with an epicenter east of Prince William Sound may have had as great a magnitude as the 1964 earthquake (U.S Department of Commerce and the Interior 1982). The large number of earthquakes recorded in the historical record provides ample evidence that significant seismic events probably have been far more frequent than just five earthquakes in the last 4,500 years that the wave cut terraces on Middleton Island imply.

FIELD DATA

Due to time constraints, only a few sites were visited for sampling during the 1994 field season. These locations are indicated on Figure B-1. The most thoroughly investigated location was on northern Knight Island around archaeological site SEW-488 which was being archaeologically tested while this field work was conducted.

Field Methodology

Locating, documenting, and collecting datable organics from vertically offset landforms were the highest priorities of the sampling strategy employed in areas visited during this survey. Documenting the context of these finds was vital to construction of a tectonic/shoreline chronology. Considering that long term regional subsidence and episodic uplift had been previously documented in adjacent regions, it was necessary to establish the elevation of each sampling site as accurately as possible. Considering that during 1964 land levels were vertically offset to various degrees within the study area, a variety of datums could be selected to describe the elevation of samples collected. All absolute elevations were collected by measuring the elevation of a sample above tide level at the time the sample was collected. This method provided elevations above Mean Lower Low Water (MLLW) which is the datum used by NOAA in publishing tidal predictions. This datum is particularly useful in coastal Alaska, however it is important to note that the USGS measures elevations above Mean High Water (MHW). When discussing relative elevation change it is common practice to compare pre- and post- earthquake elevations for a given location. These were determined soon after the 1964 earthquake by comparison of bands of sessile intertidal organisms which are restricted to particular tide ranges. This methodology can no longer be used because all traces of pre-1964 intertidal life has disappeared (except in a few uplifted intertidal caves). Currently elevations of pre-1964 mature forests and post 1964 immature forests can still be reliably compared. This is done by comparing the reach of storm waves (Extreme High Water) at particular locations which varies depending on wave exposure. All intertidal stumps and peat formerly grew above the reach of storm waves so their elevation below Extreme High Water is most meaningful. All of these methods use different datums and it is important to be aware of which method was used when making comparisons between the results of different research projects.

The Knight Island region of Prince William Sound experiences high tides of 4.6 m (15.1 ft) above MLLW and low tides to -1.1 m (-3.6 ft) below MLLW providing a predicted maximum tide range of 5.7 m (18.8 ft). This is 0.27 m (0.9 ft) less than published Cordova tide predictions (Thompson's Tide Tables 1994). Storm waves reach elevations of 5.5 m (18 ft) above MLLW along most of the locations observed near Knight Island.

The method employed to survey the elevation of samples and beach profiles was by necessity very simple. A 2x magnification "Davis White Hand Level" and stadia rod were used to measure elevation above current tide level. In most cases a person was not available to hold the stadia rod so the rod had to be held upright in a small rock cairn or lashed to a stake. Tide levels were derived by interpolating tidal curves between predicted tide stands employing the rule of twelfths. This method has an accuracy of about 0.3 m (1 ft). Due to the inaccuracies of this methodology, elevations are only provided to the nearest 0.3 m (1 ft). All elevations were measured using a stadia rod imprinted in feet and added to tidal predictions published in feet. These elevations were then converted to meters for this report.

Datable carbon was sought in an attempt to establish a chronology of shoreline elevation changes. All organic material collected in the field was wrapped in aluminum foil and sent to Beta Analytic Inc. for analysis. A total of 30 samples were collected however due to budgetary constraints only the 20 judged to be the most informative were submitted for analysis. Sediment samples were also collected in order to establish the presence of marine or freshwater diatoms. These samples were not submitted to a laboratory for analysis because a laboratory could not be located which would conduct this analysis. One sediment sample collected was bracketed by radiocarbon dates (#22 & #23) was suspected to be a tephra. This sample was analyzed by Jim Beget at the tephrachronology laboratory at the University of Alaska, Fairbanks. The analysis results indicated it was composed of non-volcanic fine sand and so no tephra deposits are discussed in this report.

SEW-488

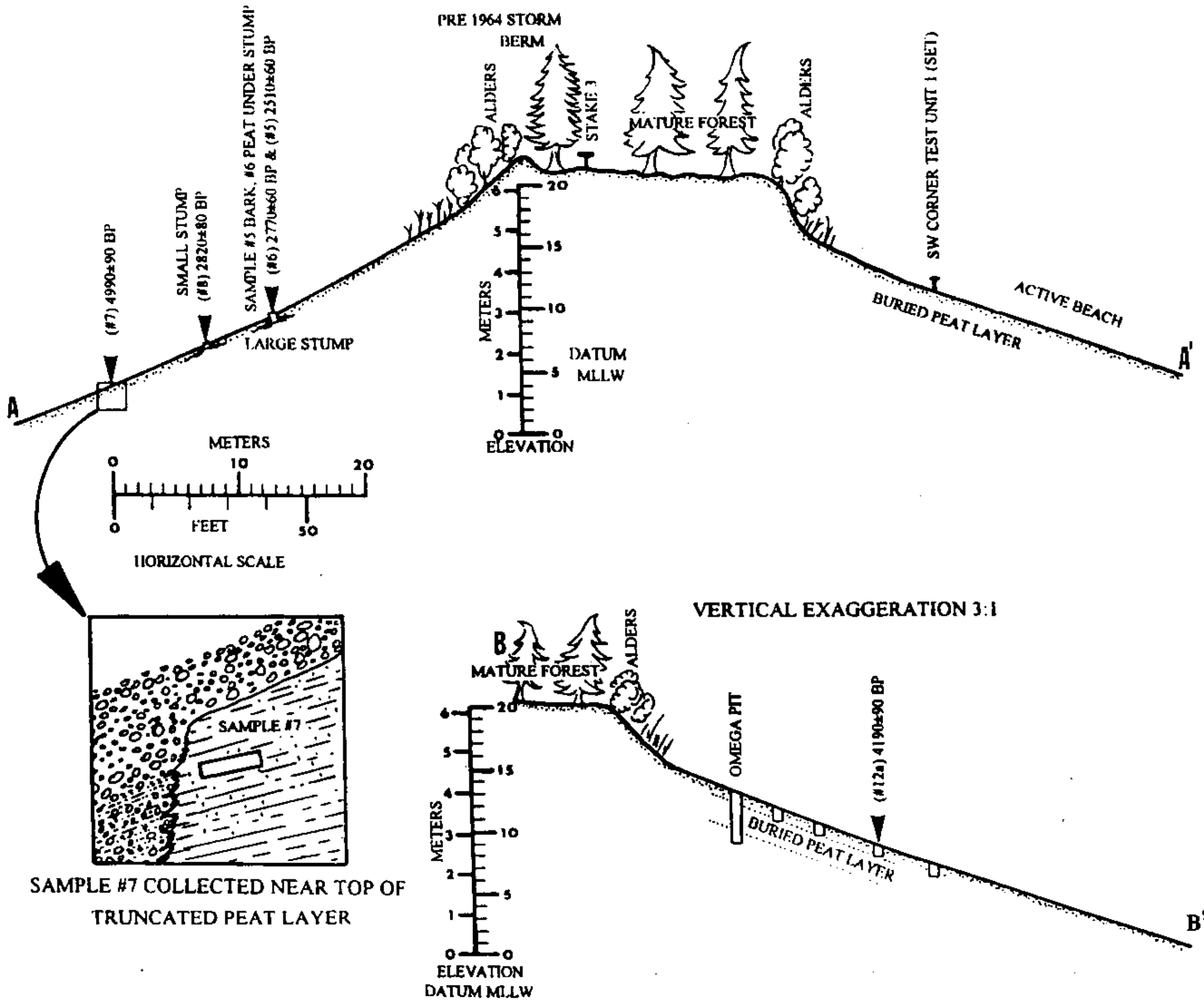
Several short visits were made to SEW 488 due to its proximity to the support vessel's nightly anchorage. This afforded the opportunity to follow up leads uncovered during previous visits. Therefore SEW 488 was the most thoroughly investigated location during the 1994 field study. However, due to time constraints, further investigation will be necessary to provide a thorough treatment of vertical shoreline chronology in this location.

The geomorphology of the site appears to consist of an uplifted tombolo which connects a former small round bedrock island with Knight Island (Figure 18). Cross sectional transects of the site were compiled along the lines A-A' and B-B' (Figure B-2). Several radiocarbon samples were collected along these profiles. No excavations or sampling were conducted in the uplands or on the beach adjacent to Exxon test unit #1. Samples were collected from the beach facing Prince William Sound and to the south along the B-B' transect. The only deep excavation was conducted at the ITZ location designated as the Omega Pit.

Intertidal stumps in growth position were observed along the northern beach face. Samples were taken from two of these stumps located along transect A-A'. The higher stump was larger and a its bark was collected and designated sample #5. Sample #6 was taken from the peat in which the large stump was rooted. The extent of the buried peat layer on the northern beach was traced down the beach and appeared to abruptly end at the location of sample #7. The peat layer at this point had the appearance of having been eroded by wave action in the past. Sample #8 was collected from a small stump located lower in the ITZ adjacent to the stump which yielded sample #5.

An attempt was made to define the extent of the peat layer on the beach between B-B'. Sample #12a was collected from the surface of the lowest peat layer observed. This peat layer was covered with a deeper accumulation of beach pebbles than observed along transect A-A' and the lower extreme of the peat layer was not established.

In order to establish the depth of the peat bed an excavation to its base was conducted and designated the "Omega Pit". The stratigraphic profile was observed and samples were collected from various layers in order to establish a chronology of land morphogenesis (Figure B-3). Six samples were collected for radiocarbon analysis. The surface of the beach at this level was approximately 4 m (13.5 ft) above MLLW. Peat was observed at a depth of 30 cm below the surface. A sample (#18) of this surficial peat was collected. A bed of fine sand, which had the appearance of tephra in the field, was observed at 50 cm below the surface. Two samples (#22 & #23) were collected above and below this layer. A layer of coarse cobbles and pebbles was observed 70 cm below the surface. These rocks were covered with a fine gray clay and the deposit appeared to be glacial marine in nature. Two samples (#19 & #20) were collected which bracketed this layer. Below the angular cobble layer, peat continued down to 90 cm below the surface. At this point a granule layer was observed which was also associated with gray clay



SAMPLE #7 COLLECTED NEAR TOP OF TRUNCATED PEAT LAYER

Figure B-2. Profiles from SEW-488. Sample locations and standard radiocarbon dates are provided.

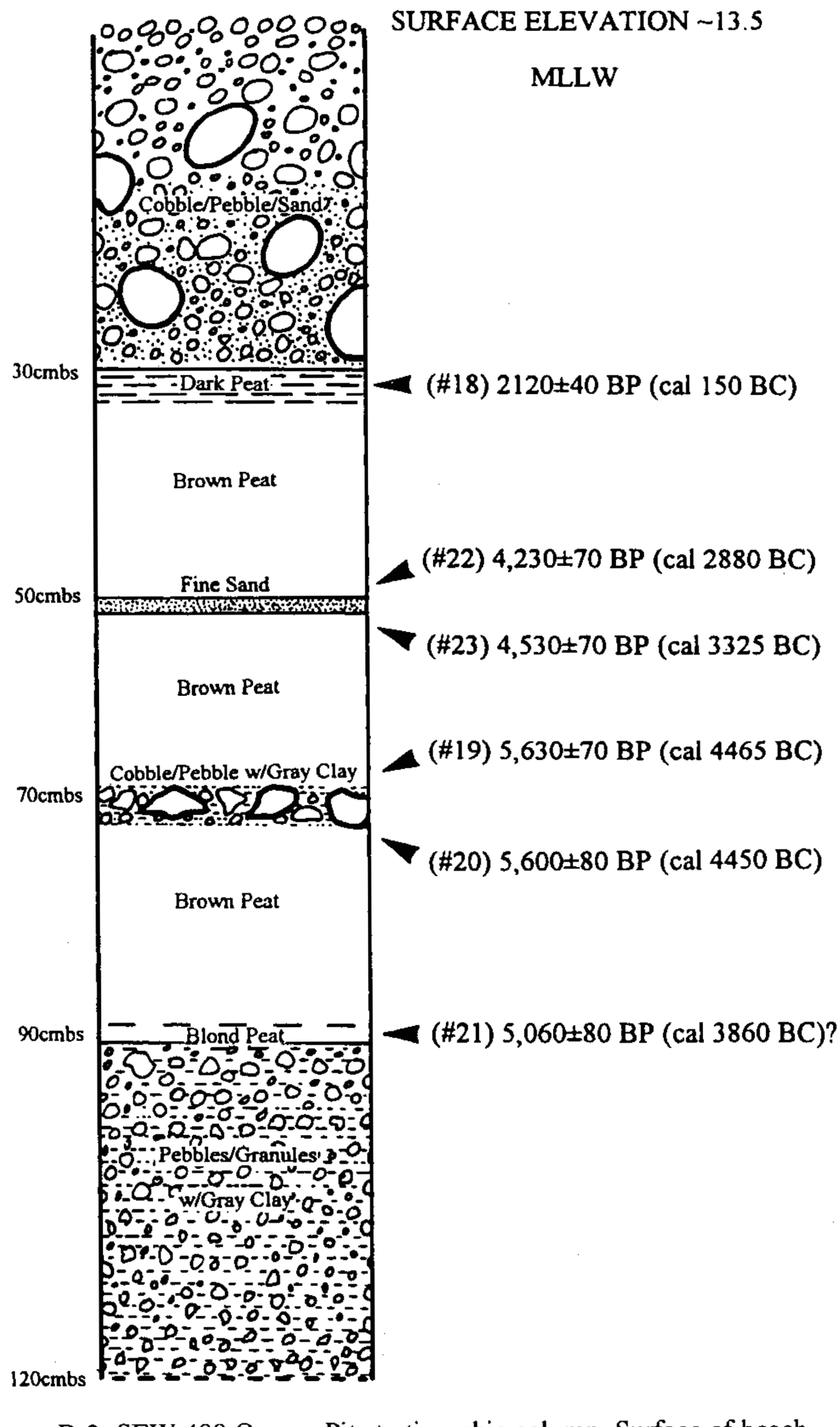


Figure B-3. SEW 488 Omega Pit stratigraphic column. Surface of beach approximately 4 m (13.5 ft) above MLLW.

and appeared to be a glacial marine deposit. A sample, #21, was collected of the blond peat layer at the bottom of the pit.

The calibrated results of the samples collected from SEW-488 were plotted on a graph with their corresponding elevations (Figure B-4). A reconstruction of events derived from this compilation follows.

The tombolo which composes SEW-488 was probably originally formed as the Wisconsin ice sheet receded and the isostatically depressed crust rebounded. The glacial marine sediments were reworked to some degree as the site was exposed to intertidal wave action. The rate of rebound was probably relatively rapid and the site was lifted beyond the reach of storm waves. Based on thickness of the peat column at the base of the "Omega" pit, it seems that this area was uplifted some time before 7000 BC. Since radiocarbon sample #21 from this level appeared to have been contaminated, the 7000 BC date is based on the depth of the peat column and its estimated rate of accumulation.

From about 7000 BC to 4500 BC the tombolo was uplifted at least 2.4 m (8 ft) above its current elevation. Peat development does not appear to have been interrupted during this time span. Approximately 4500 BC, for a relatively brief period, glacial influence reached at least to the 3.4 m (11 ft) MLLW elevation. This episode is not well understood but may have resulted from local submergence and ice rafting of glacial sediments. Alternatively the area may have been over-ridden by Knight Island glaciers. A third possibility is that icebergs bearing glacial sediment may have been washed ashore by a tsunami and melted, leaving the shallow deposit. Whatever the cause, the period was short lived, and did not erode the peat beds which had grown at this location. It is interesting to note that the peat beds on Junction Island appeared to be continuous throughout this time frame and do not display evidence of this event.

From about 4500 to 3325 BC, peat development appears to have continued uninterrupted. Peat sample #7, recovered from the middle ITZ, indicates that the site was elevated at least 4.3 m (14 ft) above its current elevation at about 3775 BC. This elevated period lasted for an undetermined period of time before this date, indicated by the peat column which extended deeper into the substrate below the sample location. Any further sampling at this elevation will have to be conducted during low spring tides to allow enough time to excavate deeper into the sediments.

Between ca 3325 and 2880 BC marine influences may have reached at least to the 3.7 m (12 foot) elevation MLLW. Evidence for this elevated marine influence is preserved as a thin bed of sand. Alternatively, this sand bed may have been deposited by the meandering channel of the ephemeral drainage adjacent to the "Omega" pit and therefore further research is recommended before this evidence of local land level depression is accepted. Stratigraphy spanning this era was not observed at other locations during this investigation so the evidence remains inconclusive.

From about 2880 to 150 BC, marine influences did not reach the 3.7 m (12 ft) elevation MLLW. In fact during 2795 BC storm waves did not reach the 2.7 m (9 ft) elevation MLLW. It is probable that the four major earthquakes known to have occurred during this period resulted in episodic land level changes at this location however the maximum range of uplift which took place during this period is unknown. It is interesting to note that the area became forested at least as early as 2,820$\pm$80 BP (cal. 940 BC). At that time marine influences did not reach above the 2.1 m (7 ft) elevation MLLW.

The period between ca 150 BC and AD 1964 was a period of net subsidence. The exact

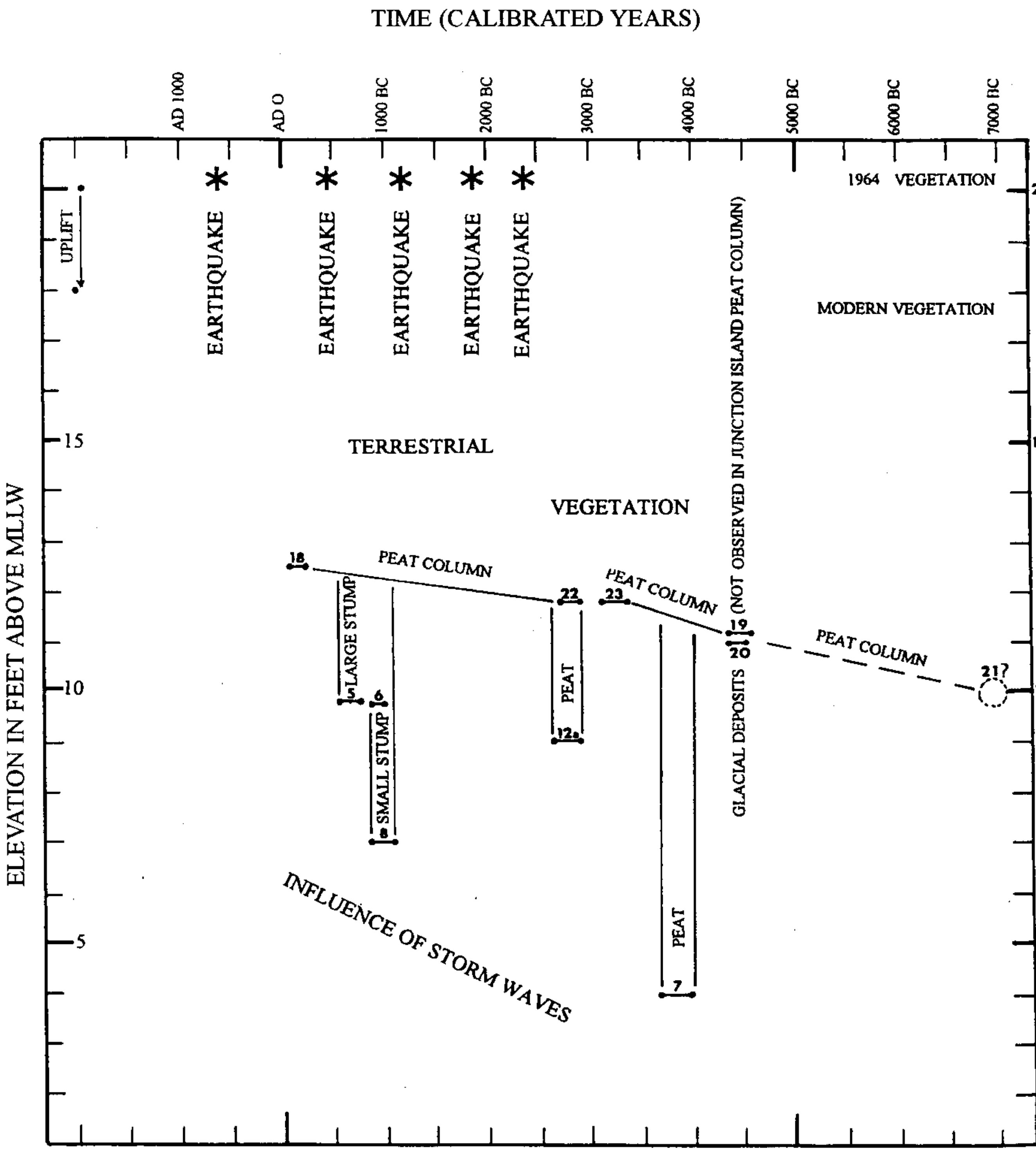


Figure B-4. Data collected from SEW-488. Stars represent earthquake events associated with episodic uplift derived from observations at Middleton Island (Plafker and Rubin 1978).

nature of this subsidence is unknown. Intertidal peat or stumps were not collected from this time frame at SEW-488. It is interesting to note that an intertidal stump from Junction Island dated from 730±50 BP (cal. AD 1285). This may indicate that subsidence occurred primarily in the later portion of this period. It is possible that the tombolo at SEW-488 may have been reached by storm waves at some point during these two millennia. The presence of gravel beds in many of the upland archaeological excavations may date from this period. Further analysis of these deposits may yield additional information about the maximum reach of storm waves in this area. It appears that the surface of the intertidal peat beds were eroded during this period.

SEW-440

SEW-440 was briefly visited during the evening of August 23, 1994. This visit took place between 8:00 pm and 9:15 pm. This time corresponded to a 0.1 m (0.4 foot) MLLW low tide which afforded a good opportunity to observe the lower beach in this area. Unfortunately overcast skies and the late hour combined to create dim ambient light conditions. By 9:15 pm lighting was so poor that the investigation was terminated.

The morphology of this site was strikingly similar to that observed at SEW-488 suggesting a similar morphogenesis (Figure 3). SEW-488 appears to rest on an uplifted tombolo between Eleanor Island and a former small bedrock island. The tombolo was probably created as the Wisconsin ice sheet receded and associated isostatic rebound occurred. As the area was subjected to wave energy, the glacial marine deposits were reworked forming the tombolo. Isostatic adjustment was probably relatively rapid and as regional uplift continued, the location emerged beyond the influence of storm waves.

During the brief survey, intertidal peat was not observed. The archaeology crew which had been excavating this site had not previously noticed intertidal stumps in this location and none were observed during this brief visit. A test pit was excavated at the center of the southeast beach on the Northwest Bay side of the site. This pit was excavated to a depth of 45cm. Several spruce needles were mixed with beach pebbles. Due to slumping of the pit walls, exact stratigraphic location of these needles was difficult to establish but they generally seemed have been associated with depths below 24 cm. A chip of wood, sample #2, was recovered from this level for subsequent radiocarbon dating. Due to budget constraints and the possibility that this chip may have been transported into position from another location, this sample was not submitted for analysis. No peat was observed in the pit. Due to time constraints, poor light conditions and respect for the integrity of the adjacent archaeological site, no sampling pits were excavated higher in the ITZ. It is possible that intertidal peat beds exist at this location and further research is recommended.

The southwest wall of archaeological Unit SEW-440 N12E23 was still open and available for viewing. Lighting conditions in this hole under the forest canopy were quite poor. The upper 75 cm of this profile appeared to have been composed of clast free terrestrial soil. There was no indication of an intervening marine phase. This terrestrial soil column rested on what appeared to be a layer of glacial marine cobbles and pebbles. Gray clay was also associated with the cobble and pebble layer. The lowest portion of the terrestrial soil column consisted of a 15-20 cm peat bed. A piece of driftwood had been nearly encased within this peat bed. This driftwood had been removed during the archaeological excavation. A sample (#1) of this driftwood was collected for radiocarbon analysis. It was not submitted for analysis due to budget constraints and the uncertainty of when it was deposited relative to the peat bed. It may have been deposited quite early and the peat could have grown around it. Alternatively the driftwood may have been carried to the location and pressed down into the soft peat layer. This site was visited within the first hours of reaching the field in 1994. At that time it was uncertain what information would be obtained from other locations and the best sampling strategy had not yet been devised. With the benefit of hind sight, a basal peat sample should have been collected. This could have shed light on the time frame when this location was lifted above marine influences. If this site is visited again, it is recommended that a basal peat sample be collected and both the peat and driftwood sample #1 should be submitted for radiocarbon analysis. These dates could be compared to establish when this site was uplifted beyond marine influences.

Junction Island

Field work at Junction Island was conducted on August 27 1994 between 10:30 am and 4:00 pm. During this period, beaches along the northern half of the island were surveyed. The southern portion of the island had been previously visited by the author and did not appear to retain intertidal peat or submerged stumps therefore it was not investigated during this survey.

Junction Island is a bedrock island surrounded by numerous rocks and small islets (Figure B-5). Intertidal peat and stumps were only preserved in the vicinity of the small pocket beaches located between bedrock projections, therefore the preserved record of the island's uplifted past is fragmentary. Only those areas protected by bedrock outcrops have retained this fragile record. The pocket beaches along the northeast side of the island did not appear to retain any intertidal stumps in growth position or peat beds however the sediments in the these beaches do retain traces of a terrestrial paleosol. The best preserved peat beds are located in a broad salt marsh on the east side of the island.

The elevations of the samples collected were plotted on a graph corresponding to their calibrated radiocarbon ages (Figure B-6). An interpretation of these findings follows:

Since the continental crust along the Gulf of Alaska was depressed by the weight of glacial ice, Junction Island was probably below sea level when the Wisconsin Glaciation ended. Peat sample #13 taken at the base of a continuous 90 cm (3 ft) peat column at an elevation of 2.4 m (8 ft) MLLW yielded a radiocarbon date of 9,350$\pm$60 BP (cal. 8395 BC). This peat was resting in direct contact with a bed of sand, indicating that the island emerged from marine influences before ca. 10,400 years ago (8395 BC). At that time the island was at least 4 m (13 ft) higher in elevation relative to storm waves than the pre 1964 forest in this area.

From 9,350$\pm$60 BP (cal. 8395 BC) to 4,710$\pm$70 BP (cal. 3410 BC) a continuous peat column indicates the island remained free from marine influences above the elevation of 2.4 m (8 ft) above MLLW. A basal peat sample dating from 6,940$\pm$90 BP (cal. 5750 BC) collected at an elevation of 1.8 m (6 ft) above MLLW indicates that storm waves did not reach this elevation. Since this sample was collected at the base of a 21 cm peat column, an additional approximately 1,100 year time span, to 4600 BC, above the influence of storm waves is indicated.

No datable material from the period between about 3410 BC and 185 BC was gathered from Junction Island. Additional peat beds remain which could be sampled during future research projects which might fill in this time gap. A stump in growth position was observed at an elevation of 2.7 m (8.8) ft above MLLW. This is 3.7 m (12 ft) below the elevation of the pre-1964 earthquake forest in this area. This stump yielded a date of 2,160$\pm$40 BP (cal. 185 BC) indicating the region was forested and elevated relative to current sea level at that time.

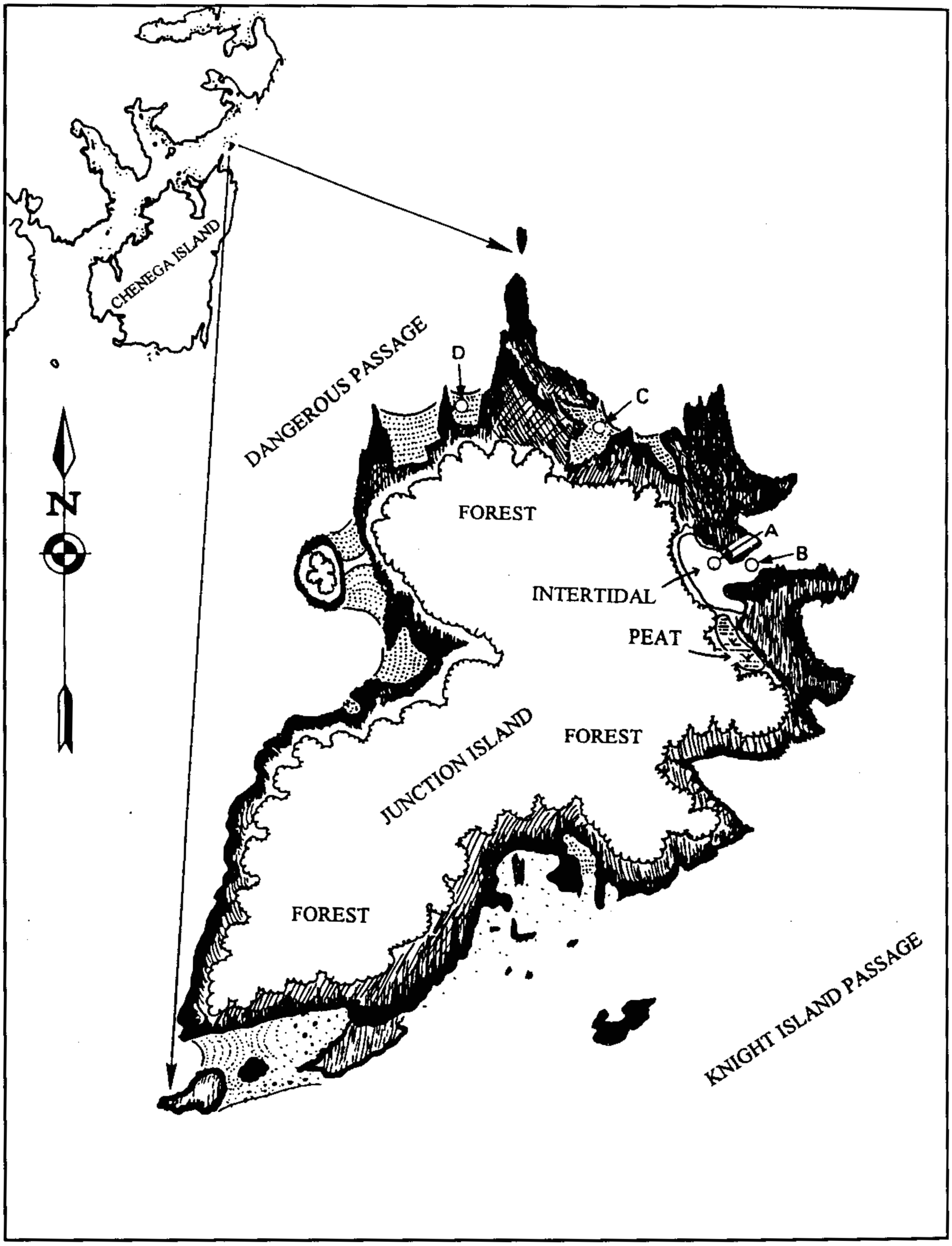


Figure B-5. Junction Island location map. A: Peat Samples (#13 and #14), B: Peat Sample (#12b), C: Intertidal Stump Sample (#15), D: Intertidal Stump Sample (#16).

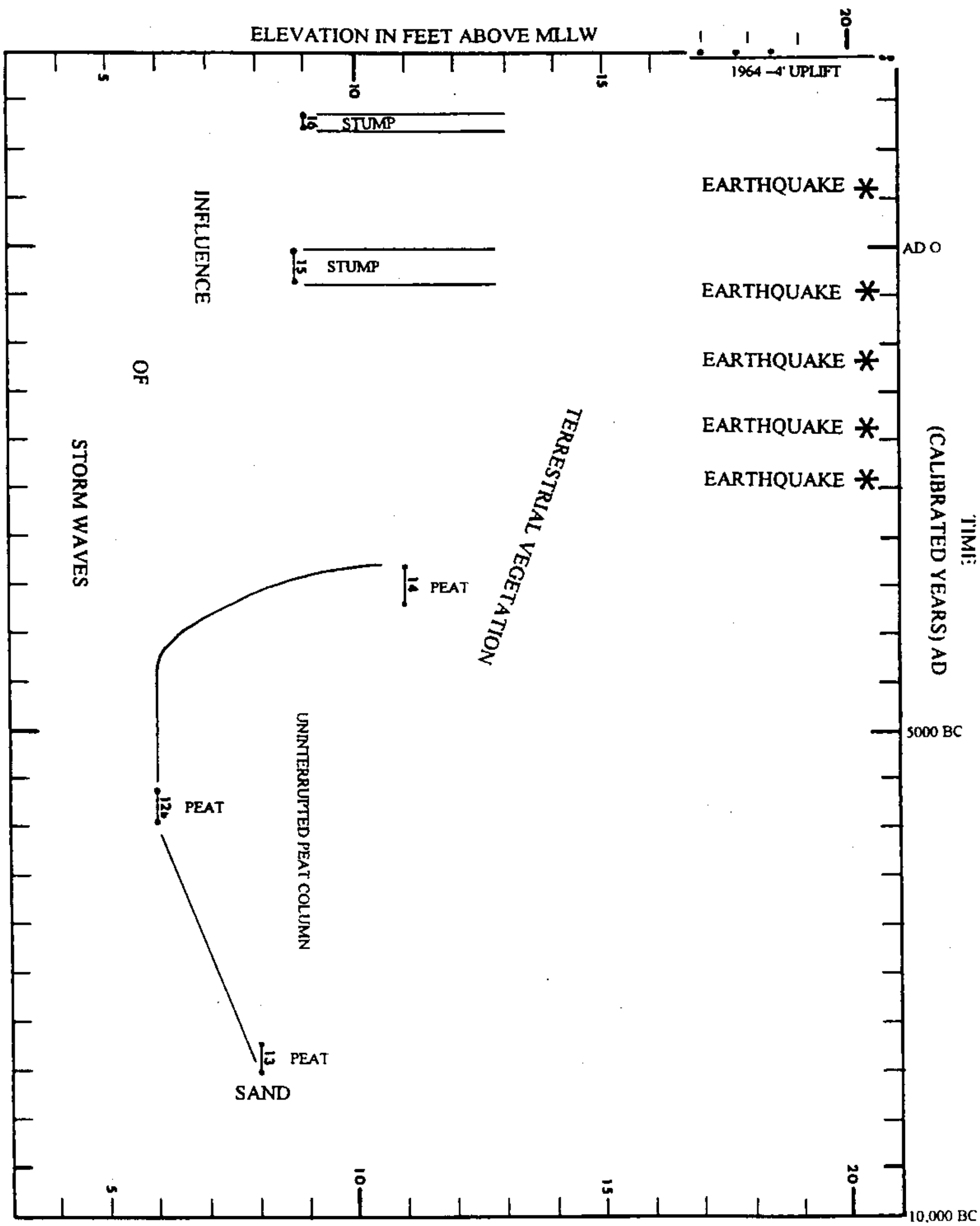


Figure B-6. Data collected from Junction Island. Stars represent earthquake events associated with episodic uplift derived from observations at Middleton Island (Plafker and Rubin 1978).

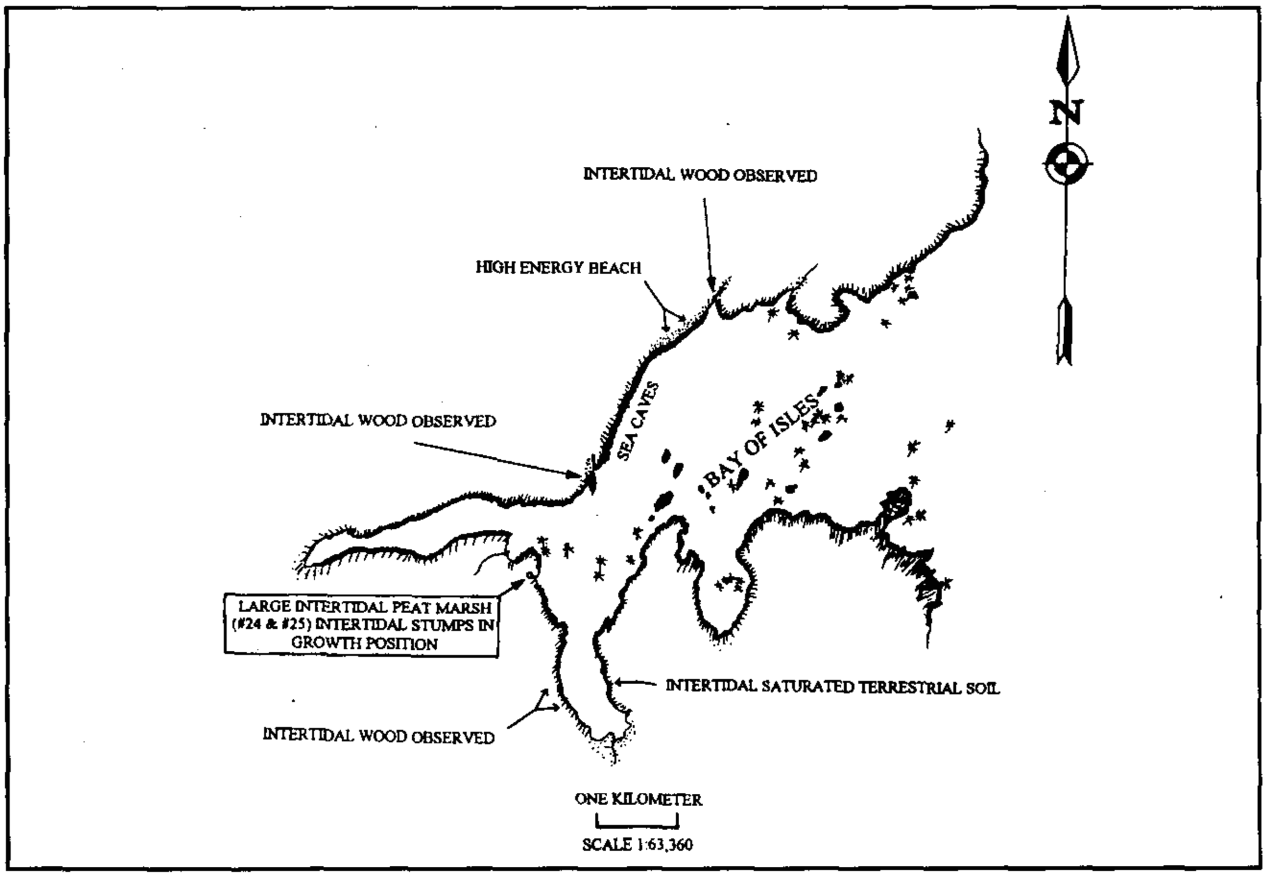


Figure B-7. Areas where intertidal wood and peat were observed in growth position along the shore of the Bay of Isles, Knight Island. Intertidal stump samples (#24 and #25) were collected from a large intertidal peat marsh.

An additional stump was sampled which was located at approximately 2.7 m (9 ft) above MLLW. This stump dated from 730±50 3P (cal. AD 1285). It is possible that these two stumps represent a continuous forest occupation however it is also possible that they represent two separate periods when forests reached a lower elevation than today. The younger stump was rooted in a degraded terrestrial paleosol which was not as cohesive as peat. The older stump was rooted in peat. The younger stump appeared to have been rooted in a soil which was not well developed indicating that the location may have been available for forestation for a relatively short interval before 730±50 BP (cal. AD 1285).

Between 730±50 BP (cal. AD 1285) and AD 1964 the island subsided 3.7 m (12 ft), amounting to 0.54 cm/yr. This rate of submergence agrees well with previously calculated rates of submergence published for Prince William Sound during this interval (Plafker 1969:Table 5).

Bay of Isles

The Bay of Isles shoreline was explored by skiff on August 28, 1994 for about five hours in an attempt to locate protected areas which might retain intertidal peat and stumps in growth position. Several locations were observed where wood projected from the beach but few areas were identified which yielded stumps in growth position (Figure B-7). It is probable that additional growth position stumps might be located if more detailed surveys are conducted. Limited digging was conducted due to the large number of spawning salmon in the rivers during the time of the survey. The southern reach of South Arm was not investigated due to bears seen feeding on salmon in the area.

A small cove which drains at mid to low tide was located which contained growth position intertidal stumps and peat. Peat samples were not collected because the salt marsh had been heavily oiled as a result of the 1989 EXXON VALDEZ oil spill. Asphalt pavement was commonly observed and oily sheen spread out from the peat when it was disturbed. It seemed that the risk of sample contamination was too great to warrant peat sampling. The intertidal stumps were easier to evaluate. The two lowest in growth position were sampled, #24 & #25. The outer layers of wood were scraped off to avoid oil contamination. Forest debris appeared to reach down to at least 2.1 m (7 ft) above MLLW. In this protected location, forest debris appeared to have remained relatively undisturbed indicating that stumps sampled elsewhere might not represent the forest's lowest growth limit. A sample, #24, was collected from a stump at an elevation of 2.4 m (8 ft) above MLLW but it was not submitted due to budget constraints. Another stump was sampled (#25) which was located at an elevation of 2.9 m (9.4 ft) above MLLW. Sample #25 yielded a radiocarbon date of 2940$\pm$50 BP (cal. 1130 BC) which makes it the oldest stump dated during this survey. These stumps were located at approximately the same vertical distance below the pre 1964 earthquake forest line as intertidal stumps observed on Junction Island and SEW-488. This implies a similar shoreline elevation chronology is shared between these regions.

Mummy Island

A rock overhang on Mummy Island was briefly visited on August 26, 1994 along with archaeologists. The rock shelter consisted of a massive wall of pillow basalt which overhung a less resistant lithology which had eroded more rapidly. The agent of erosion may have been glacial plucking although this was probably aided by wave driven erosion. The overhang was approximately 5.8 m above current storm waves, approximately 11.3 m above MLLW. The author was not present when a small area was excavated, however it was reported that beneath the well packed soil of the rock shelter's floor, a layer of water worn pebbles and small cobbles were observed. This deposit may represent a time when sea level was substantially higher than modern times. Some carbon material was recovered during the grave's excavation and, if dated, it could provide a minimum limiting date for this higher stand of sea level. In the absence of any other data, it appears that this elevation was last reached by storm waves at some time before ca. 10,400 years ago when Junction Island emerged from marine influences.

After the rock shelter was located, a swift one hour tour of the shoreline around Mummy Island was conducted in an attempt to locate submerged stumps and datable peat deposits. The tide level was approximately 2.7 m (9 ft) above MLLW. Although several small pocket beaches were visited, no evidence of intertidal stumps or peat was observed. Some limited digging was done but no peat was observed at depth. The small pocket beaches contained very angular deposits indicating little reworking by wave action. In some locations poorly preserved terrestrial paleosols appeared to be present. This may be an indication that lower stands of sea level existed in this area. It should be noted that it was near the 2.7 m (9 foot) tide level MLLW when this rapid survey was conducted so intertidal stumps could have been missed.

Puget Bay

The evolution of the coastal geomorphology of Puget Bay from 1909 to 1986 was investigated in detail by this author (Chaney 1987). During the Puget Bay geomorphology study, submerged stumps and uplifted beach ridges were observed but not dated (Figure B-8). As a portion of the current study, Puget Bay was visited on August 29, 1994 in order to obtain datable material from these landforms.

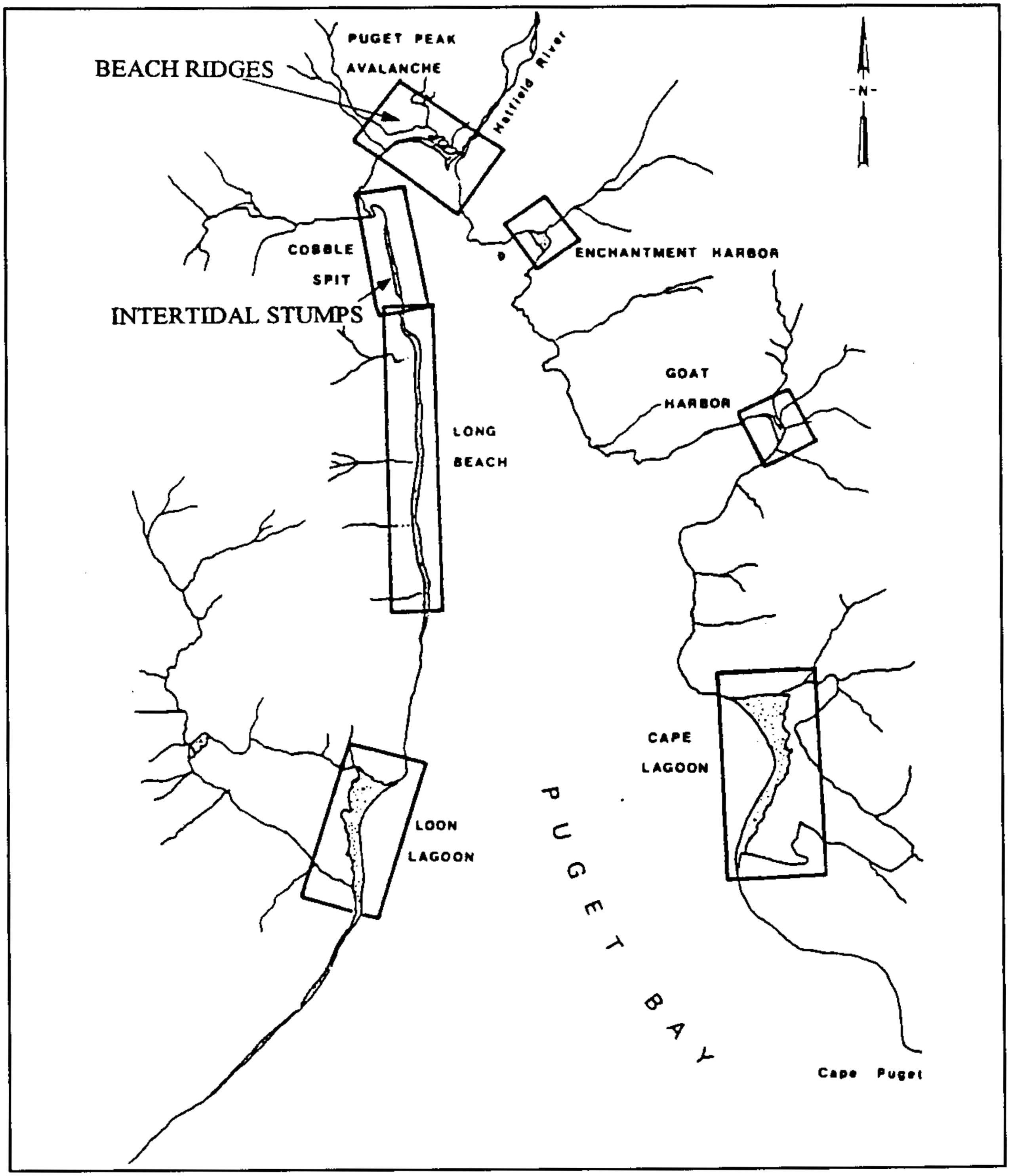


Figure B-8. Location of intertidal stumps and uplifted beach ridges in Puget Bay, Alaska. Scale 1:65,000. (Chaney 1987:65).

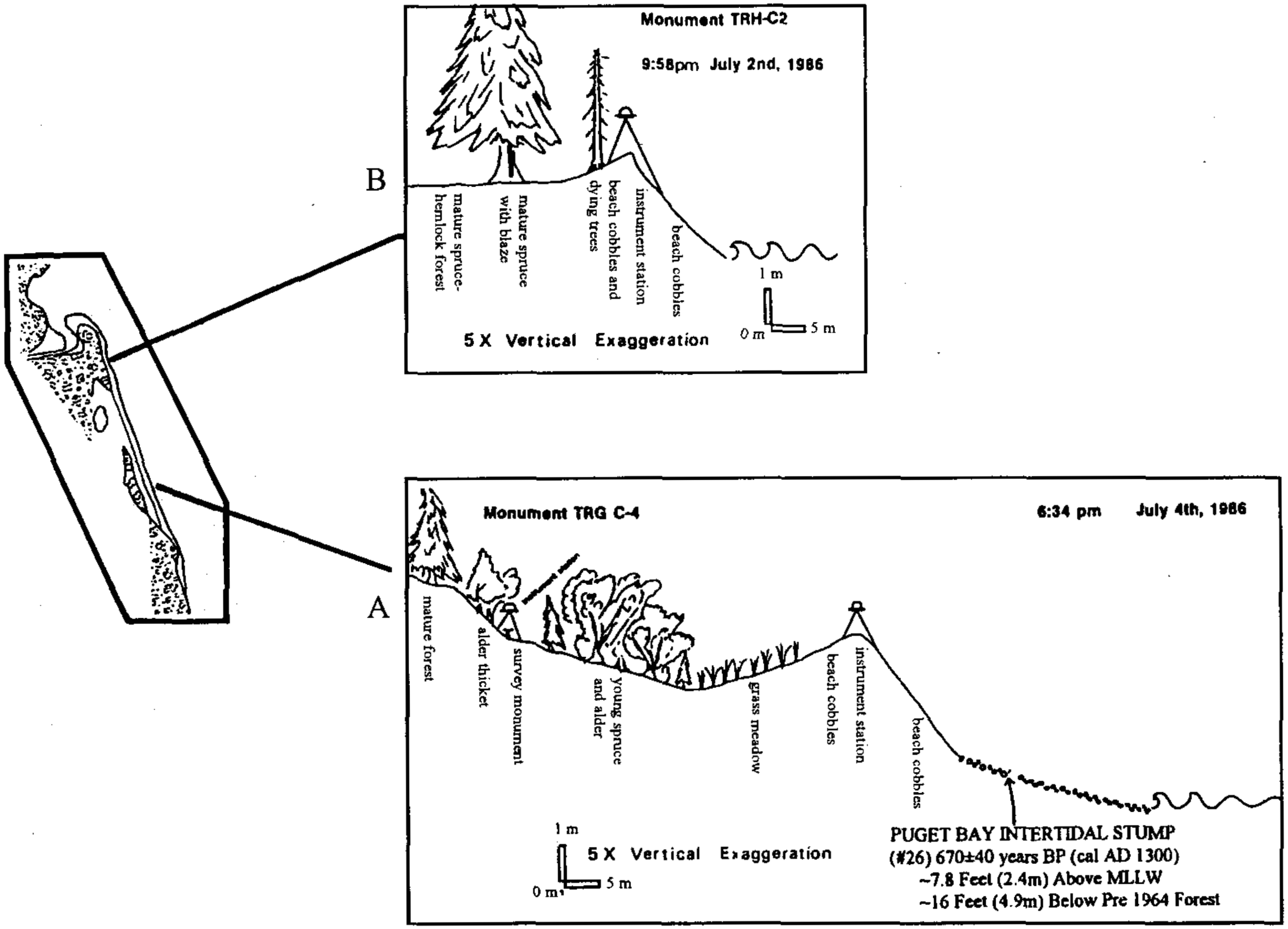


Figure B-9. Location: "Cobble Spit" area shown on Figure B-8. A: Uplifted beach profile, young spruce and alder established on old beach face, new storm berm built seaward of beach, submerged stumps 7 m south of transect; grain size long axis mean: 18.5 cm. B: Depressed beach profile, survey monument destroyed by littoral erosion, trees being killed by storm waves and salt water; grain size long axis mean: 18.6 cm.

Intertidal Stumps

During the 1986 field study, a group of three intertidal stumps had been observed in the Cobble Spit study unit (Figure B-9). They were located in the ITZ adjacent to survey monument TRG C-4 at the elevation of 2.4 m (8 ft) above MLLW. This was approximately 4.9 m (16 ft) below the elevation of the pre-1964 mature forest (Chaney 1987:125,149). A sample from one of these stumps was submitted as part of the current investigation and yielded a radiocarbon date of 670±40 BP (cal. AD 1300). This corresponds with the intertidal stump collected from the same tide level on Junction Island which dated from 730±50 BP (cal. AD 1285). The death of these trees could have been caused by regional episodic subsidence.

In the eight years since the 1986 field work, the surface of the beach surrounding the intertidal stumps had eroded. Approximately .5 m of beach sediment surrounding the stumps had been washed away leaving portions of the roots exposed. It seems probable that these stumps will soon be lost to erosion. In 1994 portions of the relic forest floor surrounding the stumps were observed eroding from the beach face which provides further evidence that these stumps were in growth position.

Although previous studies of crustal movement in response to the 1964 earthquake have painted a picture of uniform gradients between areas of greatest uplift and subsidence, localized differential movement was also observed (Plafker 1969). The beach profile below survey monument TRG C-4 shows a marked contrast with the profile below survey monument TRH-C2 compiled only 763 m to the north. The beach adjacent to TRH-C2 shows a very short and steep drop to Puget Bay. In fact the profile was taken from a blazed tree because survey monument TRH-C2 had been eroded away by littoral activity. This beach exhibits the traits characteristic of beaches which were subjected to diastrophic subsidence during the 1964 earthquake (Stanley 1968). This is particularly surprising because 1. 7 m (5.5 ft) of uplift was measured only 650 m to the north in 1966 (personal communication M.C. Hoyer). The floor of the pre-1964 forest at survey monument TRG C-4 is approximately 7.6 m (25 ft) above MLLW while the floor of the mature forest at TRH-C2 is only 4.6 m (15 ft) above MLLW. The difference in elevation is 3 m of uplift in less than 763 linear m. This differential uplift provides evidence that uplift resulting from past earthquakes may not have been uniform over large regions such as Prince William Sound.

Uplifted Beaches

Since episodic diastrophic uplift on low gradient beaches is primarily expressed as lateral offset, the horizontal spacing of uplifted bay head beaches observed in Puget Bay provides a geomorphic record of sudden past land level changes (Figure B-10). For the purposes of this reconstruction the low ridge designated "X" is assumed to represent an uplifted beach. These ridges suggest four distinct pulses of sudden uplift prior to the 1964 earthquake. Since these ridges are offset from each other a similar horizontal distance, they probably represent similar magnitudes of uplift. Therefore if the geomorphic evidence from Puget Bay is correlated with Middleton Island, Puget Bay experienced at least four distinct episodes of uplift beginning approximately 2,500 BC. Unlike Middleton Island however, episodic uplift in Puget Bay does not appear to have resulted in significant net vertical movement.

The bay head beach ridges of Puget Bay were visited on August 29, 1994 in an effort to obtain radiocarbon dates from these features (Figure B-11). Unfortunately it proved to be very difficult to find old drift wood embedded in the beach ridges because the ground was covered with roots, moss and fallen logs, making it impossible to locate driftwood without extensive digging. The active beach "V" retained little driftwood with large sections devoid of drift logs. This may be why it proved to be so difficult to find old drift logs in the relic ridges. Development of the uplifted beach ridge "U" was documented to have been created as a result of the 1964 earthquake (Figure B-12).

In order to establish a minimum limiting date for the time when beach ridge "W" was uplifted, a section of root from a decayed stump in growth position on the seaward edge of the ridge was collected and submitted for radiocarbon analysis. This sample, #30, yielded a calibrated radiocarbon ranging from AD 1695 to AD 1920. This recent age was supported by the relatively immature soil development observed on the leading edge of this feature. Terrestrial clast free soil was only 1-2 cm deep along the leading edge of this uplifted beach ridge. It appears that this ridge accreted seaward over a span of time because terrestrial clast free soil depth on the trailing edge was 10 to 12 cm deep. A drift wood log was observed deeply embedded in the seaward face of beach ridge "W". A sample of the outer growth rings from this log was collected and submitted for radiocarbon analysis, yielding a radiocarbon date of 480±60 BP (cal. AD 1435). These two dates bracket what appears to have been an episodic uplift event of equal or greater magnitude than the 1964 earthquake.

The uplift event which created beach ridge "W" has not previously been reported therefore it may not represent an extensive regional uplift event. The prehistoric record of earthquake activity in Prince William Sound is fragmentary and has primarily been derived by extrapolation of observations from Middleton Island (Plafker and Rubin 1978). Therefore it seems probable that ridge "W" may have been uplifted by an earthquake which occurred soon after 480±60 BP (cal. AD 1435). Alternatively it is possible that the log was deposited during a period of over bank flow by the small stream adjacent to the face of the ridge. However the drift log (sample #29) was deposited before the tree (sample #30) began to grow because the tree's roots grew over the sediment in which the drift log was encased. Field observations strongly suggested that the log had been deposited by waves along an active beach but further evidence must be collected before the hypothesis of a ca. 1435 AD earthquake resulting in episodic uplift is accepted.

Drift logs were not observed embedded in relic beach ridge "Y". In order to establish a minimum limiting date for this feature, a sample of root from a very decayed stump was collected from this ridge for radiocarbon analysis. This sample (#28) yielded a radiocarbon date of 790±60 BP (cal. AD 1260). The close coordination of this date with the radiocarbon date of 670±40 BP (cal. AD 1300) derived from the Puget Bay intertidal stump indicates that this ridge was forested when the region was elevated about 4.9 m (16 ft) above the pre-1964 relative sea level. The radiocarbon date (#28) from the stump collected from relic ridge "Y" indicates that this ridge was formed before AD 1260. Unfortunately no maximum date of formation is available.

The low ridge designated "Z" was the farthest from the ocean and therefore the oldest relic beach ridge observed in Puget Bay. A line of weathered stumps were observed along the crest of this ridge. All of the stumps exhibited the same degree of extreme decay. No rotten logs were observed on the ground associated with these stumps implying that these logs had floated away during high water. It appeared that these trees had grown at some point in the past and were all killed at the same time by an elevated water table. Radiocarbon sample #27 was collected from the root of one of these stumps in order to date when these trees were killed. This radiocarbon

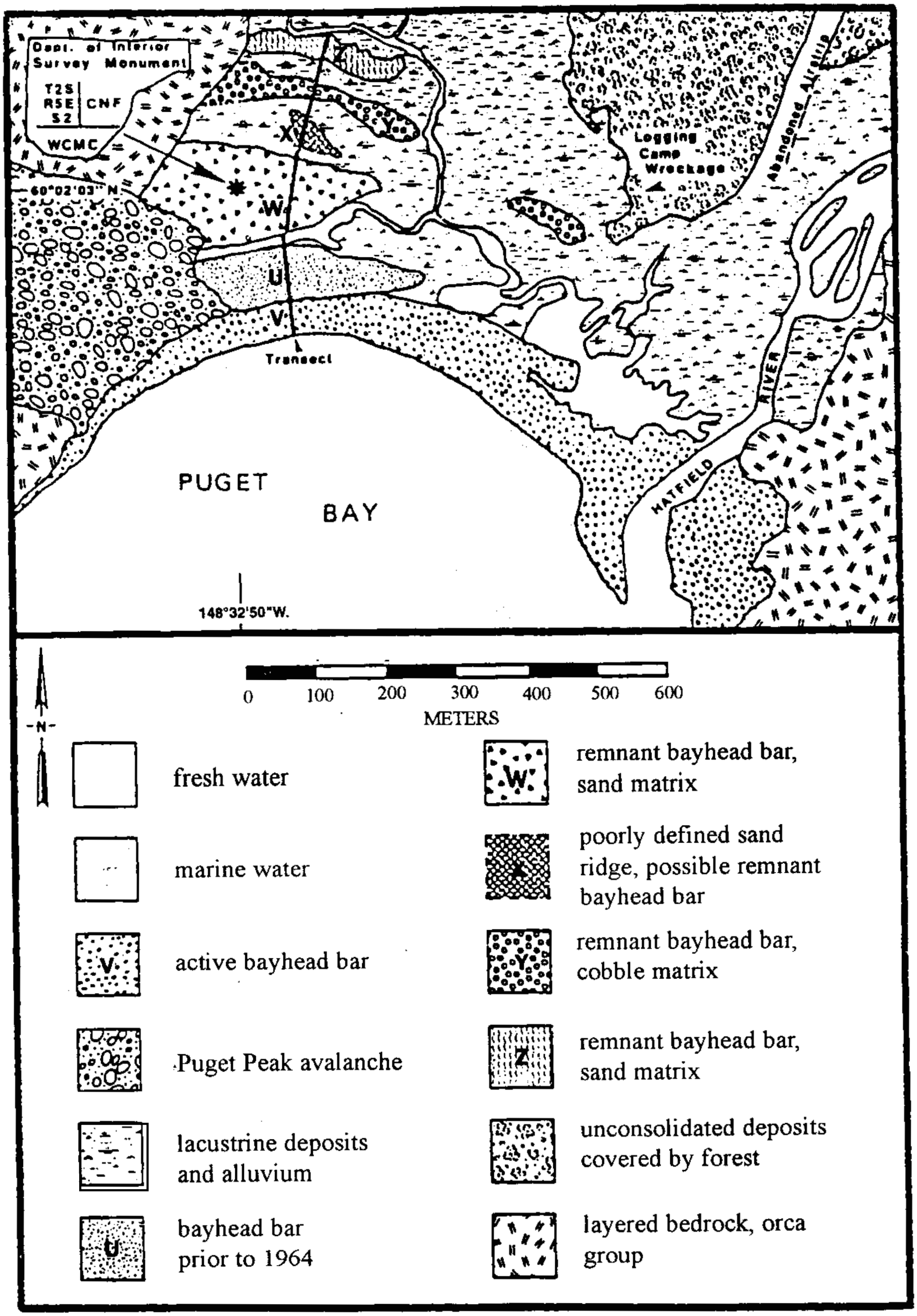
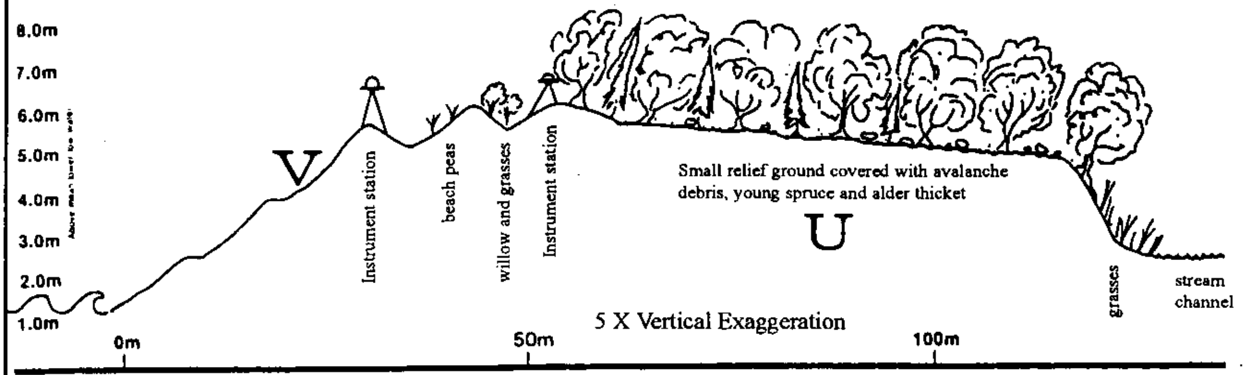
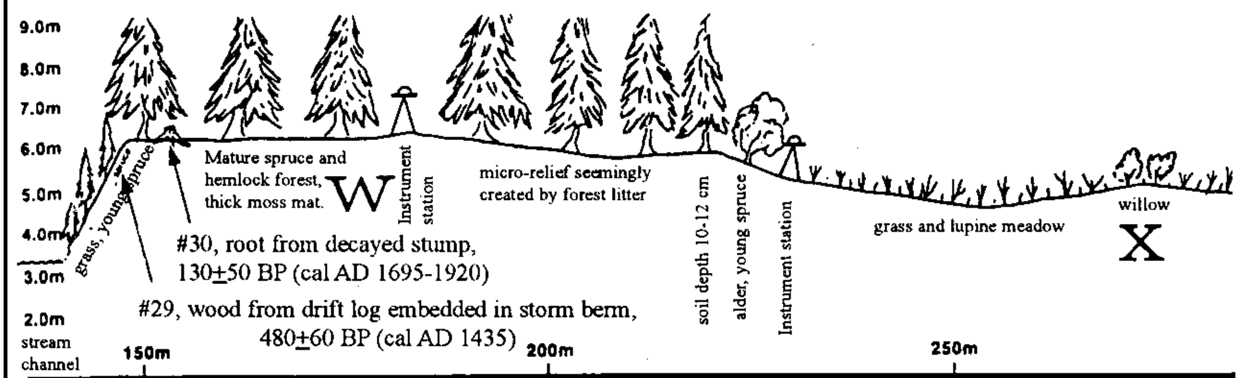


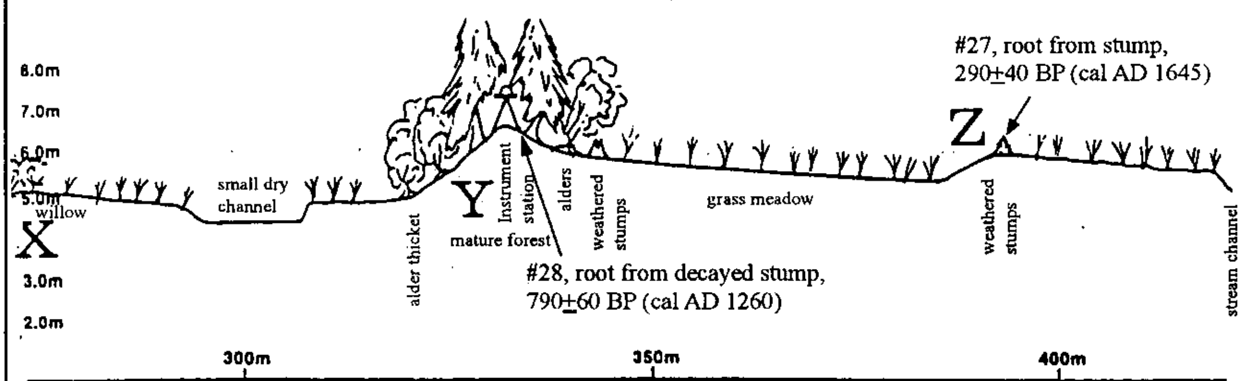
Figure B-10. Surficial deposits of Puget Peak avalanche study region. Location of Figure B-11 transect shown (Chaney 1987:133).



A: Active beach face and most recently uplifted beach. Note young vegetation and veneer of avalanche debris.

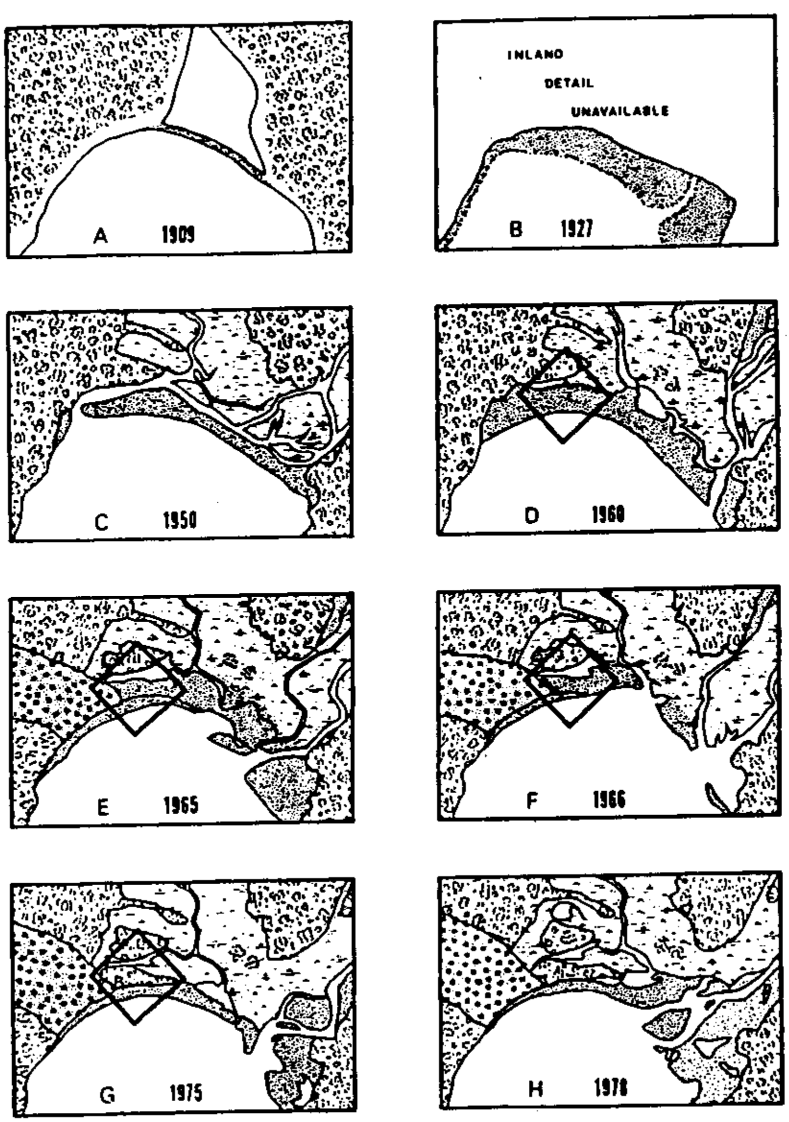


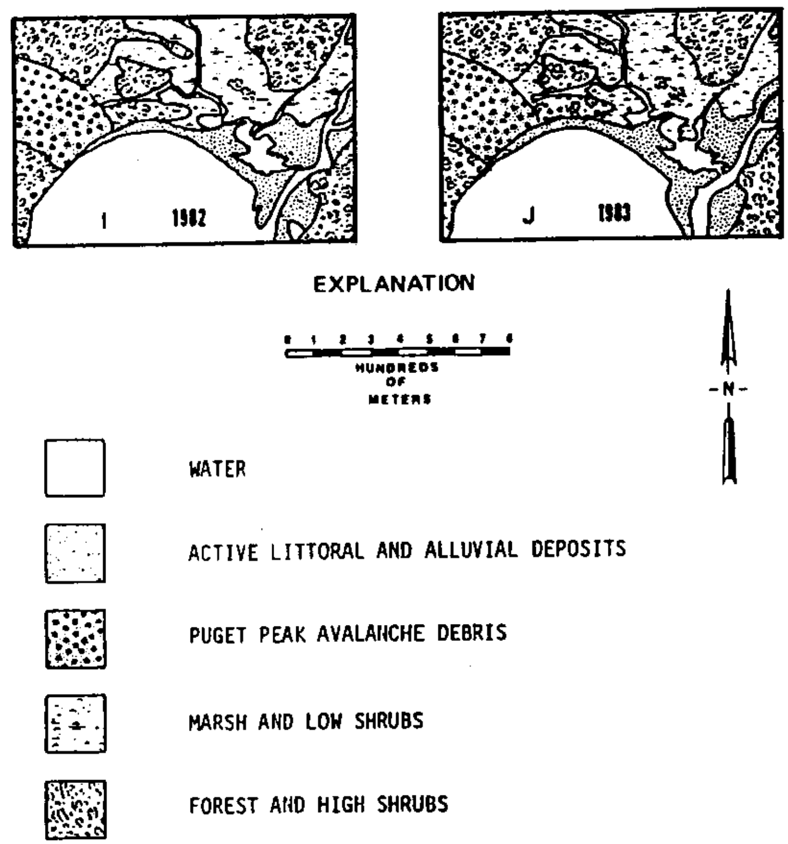
B: Second remnant bayhead bar. Composed of sand matrix; soil depth increases from 1-2 cm on the seaward edge to 10-12 cm on the trailing edge. Remnant bayhead bar covered with mature forest. Note low ridge covered with willow behind well defined bayhead bar. Transect is 125.5 m east of DOI Survey Monument T2S R5E 2S CNF WCMC at this point.



C: Third well-defined remnant bayhead bar. Cobble matrix implies it may have been associated with a major Puget Peak Avalanche Event. Fourth remnant bayhead bar has a row of dead stumps along the top. This implies past changes in water table. Sand matrix may be responsible for its relatively low profile.

Figure B-11. Transect of uplifted beach ridges, Puget Bay, samples collected 1994 (from figure compiled in Chaney 1987:Plate III).





IMAGERY USED

YEAR	IMAGE NO.	TIDE	YEAR	IMAGE NO.	TIDE
1909	-	-	1966	66-257	9.9'
1927	H-4693	-	1975	875-81	7.6'
1950	171 VV	6.5'	1978	6753	2.7'
1960	EEV-36-5	?	1982	1653	4.0'
1965	471	5.2'	1983	4374	1.8'

Figure B-12. Evolution of Puget Peak Avalanche study region, 1909 to 1983. Note development of uplifted beach within diamond, 1960 to 1975 (Chaney 1987:80).

sample yielded a date of 290±40 BP (cal. AD 1645). This is known to have been a time of regional subsidence as observed by Vancouver, above. The band of trees which lined the crest of this low ridge are interpreted to have been killed by a rising water table which resulted from regional crustal subsidence. The maximum age of this ridge is unknown but if these ridges can be correlated with the uplifted terraces of Middleton Island, then ridge "Z" dates from 2500 BC.

Reconstructing the chronology of past elevation changes in an environment like these beaches at the head of Puget Bay is especially challenging because of the associated sedimentation and erosion of the Hatfield River. Further complicating this reconstruction is the fact that areas of unconsolidated sediments settled as a result of the 1964 earthquake. The center of the Puget Bay valley actually subsided during the 1964 earthquake even though adjacent bedrock areas were uplifted. This subsidence may account for the fact that relic beach ridges have only been preserved along the margins of the valley adjacent to bedrock walls.

Green Island

The south central portion of Green Island was visited on August 25, 1994 for 3 hours (Figure B-13). This region was selected because of the large number of well defined beach

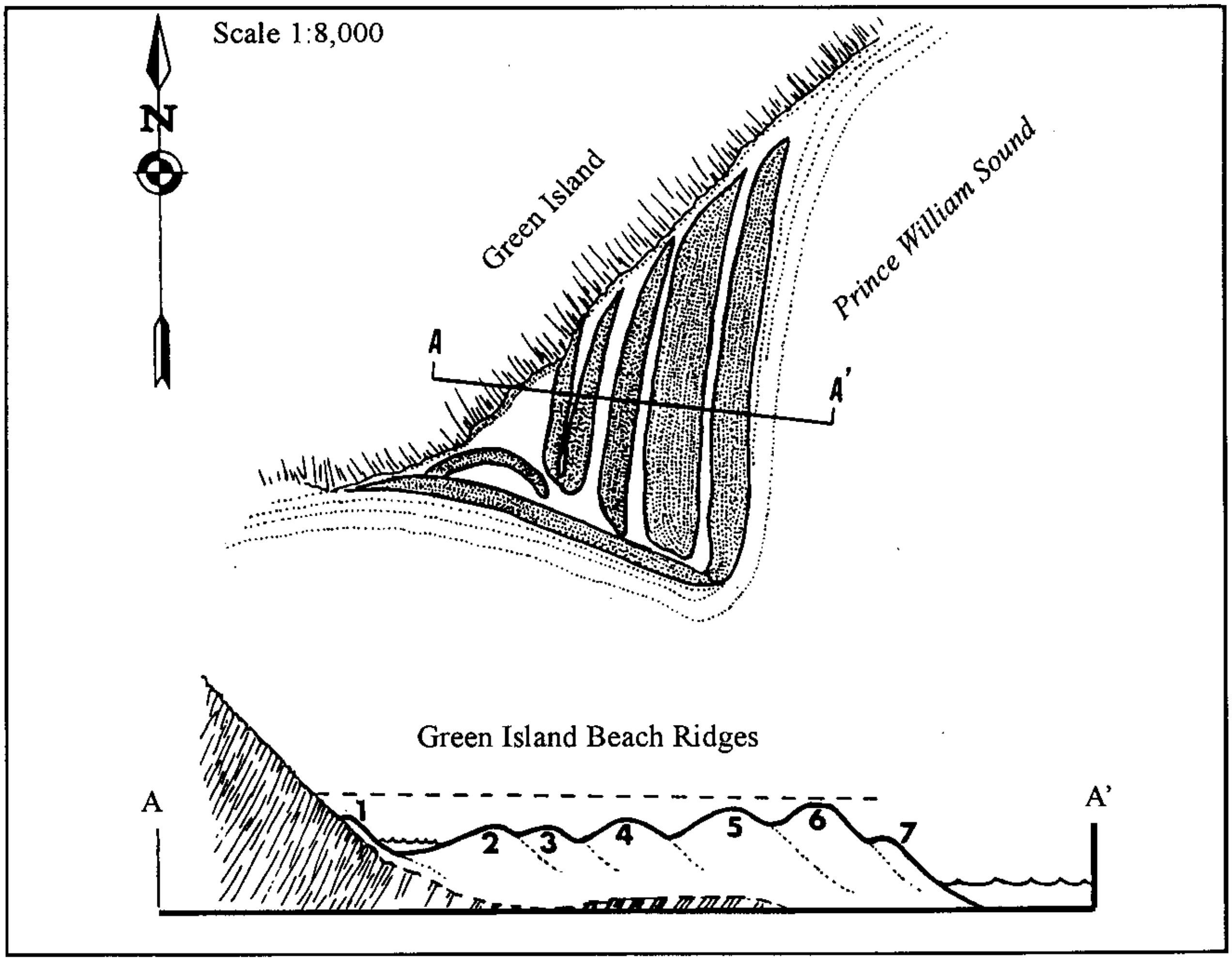


Figure B-13. Sketch of relative beach height on southern Green Island derived from qualitative observations made on August 25, 1994.

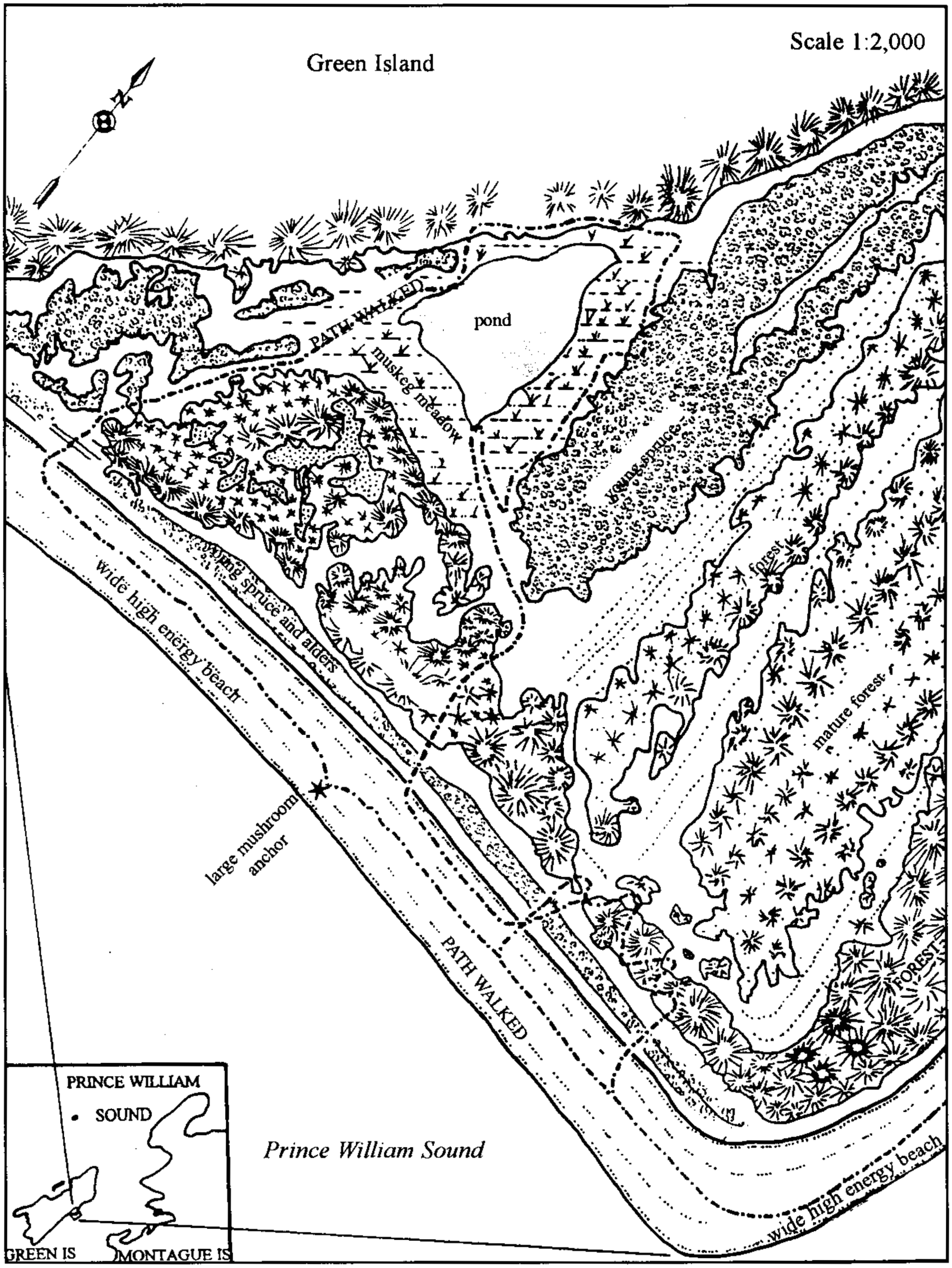


Figure B-14. Location of beach ridge development observed on south central Green Island. Dot and dash line indicates areas walked during this study, August 25, 1994.

ridges visible from aerial photography. These ridges shared a similar morphology with those observed at the head of Puget Bay. These ridges were not associated with an adjacent river so they had not been subjected to the level of sedimentation and scouring observed in Puget Bay. A profile of the beach ridges was desired however this undertaking was soon abandoned because of the dense brush, lack of a second person to hold the leveling rod, and time constraints. Therefore qualitative observations of the relative elevations of these ridges were collected (Figure B-14).

The ridges at this location on Green Island appear to consist of at least seven different beach building regimes. The oldest deposit is represented as a collection of water rounded pebbles and cobbles found below terrestrial soils at the base of a bedrock cored slope. These deposits were mixed with angular cobbles which may have had a short residence time in the intertidal or may have rolled down slope from the adjacent uplands. These deposits are relatively thin compared to the ridges which compose the bulk of this site.

A large pond was located adjacent to the bedrock slope. August 1994 had been unusually dry and the pond was relatively low. The low water revealed a ring of drowned stumps below the average pond level. This drowned forest appeared to have dated from a time when this area was elevated and better drained. These stumps had the same general appearance as intertidal stumps dating from over 2,000 years ago. A bark sample (#9) from one of these stumps was collected for radiocarbon dating. This sample was not submitted for analysis because of budget constraints, lack of elevation data and need for additional research to put these stumps in context. It is assumed that the forest represented by these stumps was drowned by the same subsidence event which preserved intertidal stumps observed in other locations in Prince William Sound.

The second and third beach ridges had relatively low relief. These ridges were covered with a young spruce and alder forest which appears to have become established after the 1964 earthquake. A 30 cm pit was excavated on this ridge. Fine loam was observed to a depth of 30 cm. Below this soil the remains of a remnant forest were encountered. It seems that this forest was probably associated with the stumps observed along the rim of the pond. Since no stumps projected above the surface, it appears that this ridge experienced submergence near the same time as the stumps located along the pond. A bark sample from a buried log was collected for radiocarbon dating (#10) however it was not submitted for analysis due to budget constraints, lack of elevation data and the need for additional research to put this forest layer into context.

The fourth, fifth and sixth ridges appeared to have more relief. These ridges supported mature forests but between these ridges tall grass and thick brush made walking difficult. Future researchers attempting to conduct leveling surveys should attempt to do this work while the leaves are down. These large ridges are actually composed of several smaller ridges which were probably constructed during storms.

The seventh ridge was the active storm berm. It was actually composed of several small ridges at different elevations. It appears that this ridge is still in its infancy. If sea level remains relatively consistent, this ridge will build seaward and form another ridge of a similar magnitude to those located inland.

It is difficult to say why these ridges are present on an otherwise linear coast line. It seems that these ridges were formed originally as a pair of tombolos connecting Green Island to a small low rock shelf or island which was subsequently covered by beach ridges.

The height of these beach ridges was not measured accurately however it is clear that these

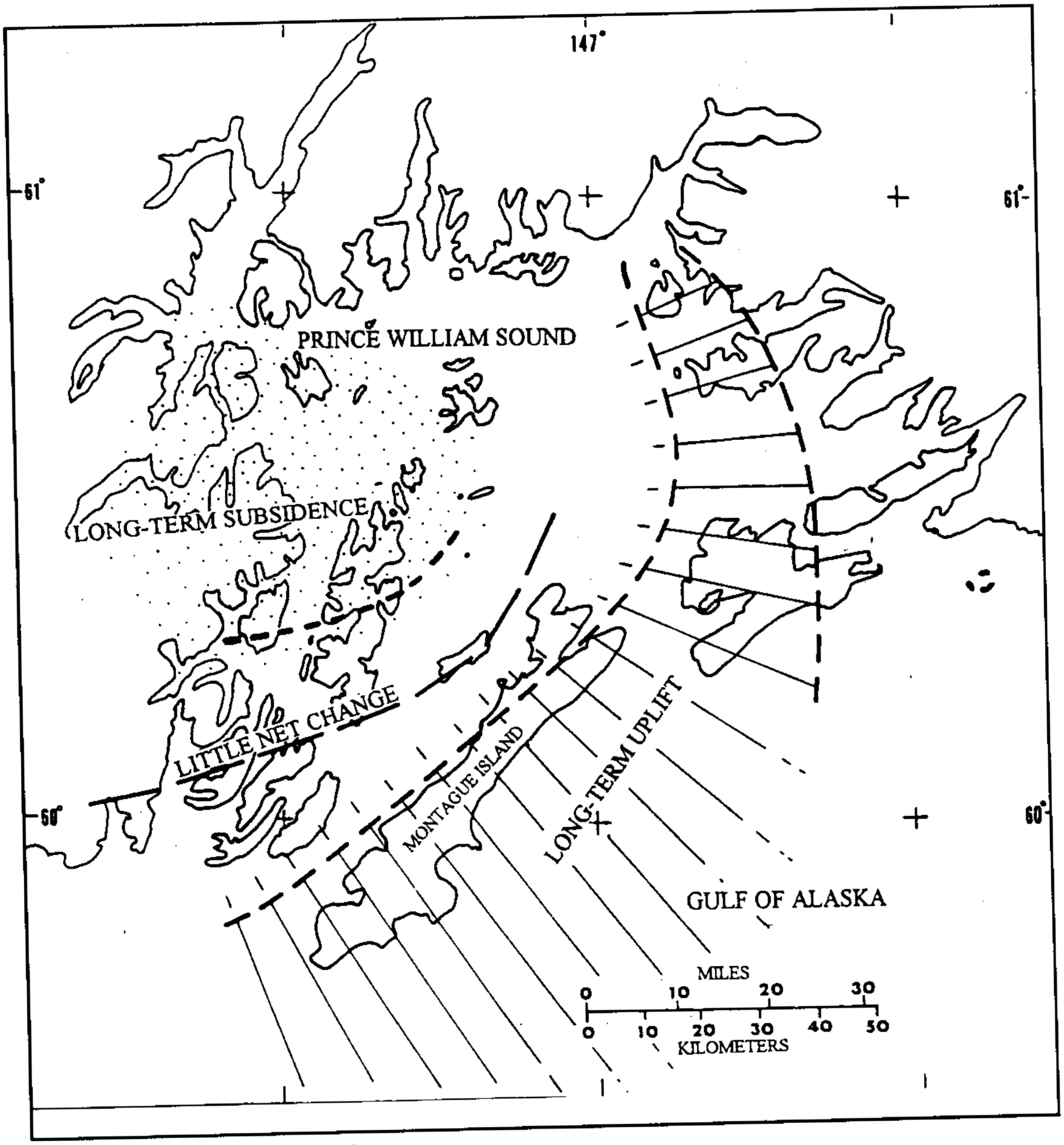


Figure B-15. From observed coastal geomorphology, Prince William Sound is classified into three broad categories: 1) the region surrounding northern Knight Island, which has experienced pulsating diastrophically induced subsidence; 2) a linear band which trends between Puget Bay and southern Green Island which has experienced similar pulsating episodic land level changes, however with little resultant net elevation change; and 3) the broad region encompassing most of Montague Island, Hinchinbrook Island and eastern Prince William Sound which has been subjected to the same pulsating vertical elevation change and seems to have been experiencing net long term uplift.

ridges are near the same elevation. These ridges appear to have been formed from a series of episodic uplift and subsidence events which have created the distinctive laterally offset ridges with little net long term elevation change. If these ridges can be correlated with the uplifted terraces on Middleton Island, beach ridge #2 may be about 4,500 years old.

During the course of shoreline surveys a large mushroom mooring anchor was observed. This anchor was over 2.1 m (7 ft) long, laying on its side and half buried in the rounded pebbles and cobbles of this high energy beach. When this artifact was observed from a distance, one of it's flukes resembled a shark fin projecting from the beach. Anchors of this type are known to have been used for anchoring commercial fish traps and there may be an associated historical upland installation. The anchor was covered by a 0.9 m (3 foot) tide MLLW. A GPS reading taken at this location was N60 °15'18.2" W147 °23'36.2". Due to Department of Defense selective availability, this reading is only accurate to within 100 m of it's actual position.

CONCLUSIONS

From the geomorphology observed at sites visited during this investigation and examined from aerial photography, Prince William Sound can be classified into three broad categories (Figure B-15). It appears that the region encompassing northern Knight Island, Eleanor Island, Bay of Isles and Junction Island experienced rapid uplift following the retreat of the Wisconsin ice sheet. This uplift was then reversed by pulsating diastrophically induced subsidence. A linear band which trends between Puget Bay and southern Green Island has experienced similar pulsating episodic land level changes however little net elevation change has resulted in the last 4,500 years. Although vertical offset has been measured of at least 4.8 m (16 ft) in less than 670 years, the elevation trend for the last 4,500 years has remained relatively stable. A broad region encompassing most of Montague Island, Hinchinbrook Island and eastern Prince William Sound has been subjected to the same pulsating vertical elevation change however this area seems to have been experiencing net long term uplift.

The implication of this model for the distribution of archaeological deposits is significant. In the area of net subsidence, coastal settlements beyond a certain age would be subtidal. The band of little net elevation change might retain older sites near modern sea level. The best opportunity for older sites to exist above sea level is likely to be found in the band of net uplift. Unfortunately these sites are likely to be found relatively far inland and may be difficult to locate.

In an attempt to reconstruct the chronology of vertical land movement in the region of net Holocene subsidence, radiocarbon dates and elevations of samples collected from SEW-488, Junction Island and Bay of Isles were plotted on a single graph (Figure B-16). Radiocarbon dates from Puget Bay and observations from Green Island were not included on this graph because these regions appear to have experienced different net vertical movement. All the data points on this graph represent terrestrial vegetation preserved in growth position below the reach of high tides. Therefore elevations above the plotted data points would have been above the reach of storm waves. Unfortunately the relationship of these locations to paleo storm tide levels is unknown because the peat and stumps which were preserved might not have been growing along the beach prior to subsidence. It is possible that the peat and stumps which were preserved may have grown inland from the beach and following subsidence, the plants which

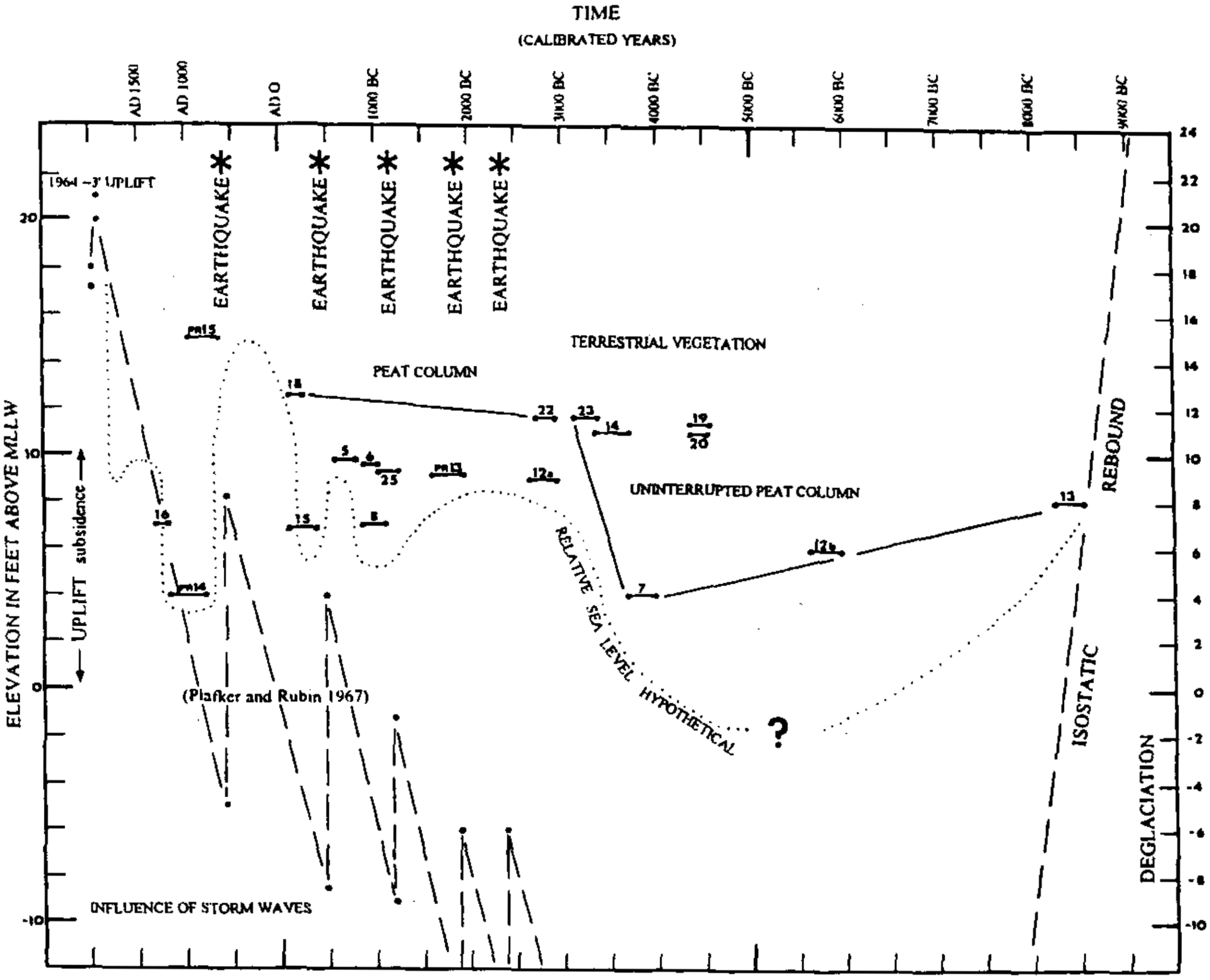


Figure B-16. Radiocarbon analysis and elevations collected from SEW-488, Junction Island and Bay of Isles. Elevations above the plotted data points would have been above the reach of storm waves. The data points connected by solid lines represent continuous peat columns which demonstrate marine influences did not reach those elevations during the connected periods. The dotted line below the solid data points represents an estimated maximum reach of storm waves derived from the data obtained from this survey. The dashed line represents a hypothetical vertical movement reconstruction based on observations gathered from uplifted marine terraces preserved on Middleton Island (Plafker and Rubin 1978).

were lowered into the mid intertidal and subject to the most wave energy might have been destroyed while only those buried in the storm berm would have been preserved.

The data points connected by solid lines represent continuous peat columns which demonstrate that marine influences did not reach those elevations during the connected periods. The nature of vertical shoreline movement below these solid lines is unknown. Tree stumps provide individual data points, however multiple stumps need to be dated to provide a continuous record comparable to peat layers. Data points obtained from stumps have not been connected because episodic inundation could have occurred between the lives of these trees.

The dotted line below the solid data points represents an estimated maximum reach of storm waves derived from the data obtained from this survey. Since large gaps in the data set are present and no information is available below these points, this line is likely to be revised when new information becomes available. The deviation of the dotted line after AD 1500 represents the uplift event implied by evidence gathered in Puget Bay.

The dashed line represents a hypothetical vertical movement reconstruction based on observations gathered from uplifted marine terraces preserved on Middleton Island. These terraces are thought to represent past large magnitude earthquakes which resulted in episodic net vertical uplift. The timing of these earthquakes was indicated by radiocarbon dating of drift logs found on these terraces. These dates are represented by star symbols on the graph. Regional subsidence is thought to have preceded these earthquake events. In the region of Knight, Chenega, Perry and Eleanor Islands subsidence is thought to have been of a greater magnitude than the episodic uplift events. This resulted in a pulsating motion with widely fluctuation land levels occurring over periods of a few hundred years. The actual magnitude of these fluctuations is generally unknown, however sample (#16) from and intertidal stump on Junction Island demonstrated that elevation changes of 4.8 m (16 ft) can occur less than 700 years.

Perhaps the most significant finding of this modest research project is that the radiocarbon data collected up to 2000 BC provides a relative sea level curve which generally mirrors the episodic uplift and subsidence predicted by the Plafker and Rubin (1967) model. Beyond this date the data becomes more uniform, indicating general regional elevation but little evidence is provided concerning possible episodic land level change. The field data does not indicate the degree of subsidence predicted by the Plafker and Rubin model however this may be due to preferential preservation and biased sampling. Only those deposits which were preserved and are now exposed could be sampled, these undoubtedly represent a fragment of the deposits which are available. As more thorough research is conducted in the future, the paleo sea level curve should become more clearly defined. As a result of that process, it is likely that evidence of more earthquakes will be discovered and a more complex chronology of episodic land level change will result.

FURTHER RESEARCH

As with all research projects, more remains to be done. However, the results of this field work have combined to provide significant new insights into the nature of shoreline dynamics in the EVOS region of Prince William Sound provided a more detailed framework from which future projects may proceed.

SITE SPECIFIC RESEARCH

This project was requested in order to assist USDAFS archaeological projects in areas impacted by the Exxon Valdez Oil Spill in Prince William Sound. Therefore this report attempted to encompass the entire area in order establish regional trends. However, as shorelines result from the complex interaction of a series of natural processes, research for specific sites is recommended. This was attempted to some degree for SEW 488 but additional information is required from this site to construct a more complete vertical shoreline chronology. It is especially important that sampling from the uplands be incorporated into future research designs in order to explore the nature of marine influences above the pre 1964 Extreme High Water line. Data collected from any previous archaeological excavations should be incorporated if possible.

REGIONAL SHORELINE CHRONOLOGY

The regional vertical shoreline chronology is still fragmentary and additional data is need to establish the magnitude and timing of past events. Evidence was collected during this investigation which suggests that an episodic uplift event occurred between 130±50 BP (cal. AD 1815) and 480±60 BP (cal. AD 1435). Further data needs to be collected to see if this happened or if the evidence suggesting the uplift event was created by site specific conditions.

Additional dating of terrestrial plant deposits located in the intertidal zone needs to be conducted in order to establish a more complete chronology of regional subsidence. There are considerable gaps in the current record which need to be filled in. Subtidal sampling may be required to reach the oldest peat beds in some areas. If dendrochronology could be developed for this region, exact growth and death dates could be established for intertidal stumps. If this could be done, then the exact timing and nature of regional subsidence events could be deciphered.

Uplifted marine deposits require further consideration. Marine terraces have been described in a few locations, however little region wide research has been done in this regard. Uplifted marine sediments and diatoms also need to be analyzed for further insight into marine transgressions. Regional correlation of laterally accreted beach ridges also may provide evidence for episodic land level change. A potentially rich region for this research falls along the axis of little net horizontal change depicted on the regional trends map (Figure B-16).

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Table B-1. Results of Radiocarbon sample analysis
(Samples collected this survey)

No.	Beta No.	Sample Type	Location	Years BP	Comments
5	79453	bark	near SEW-488	2510±60	Intertidal stump
6	79454	peat	near SEW-488	2770±60	Under Sample #5
7	79455	peat	near SEW-488	4990±90	Low in ITZ
8	79456	wood	near SEW-488	2820±80	ITZ Stump
12A	79457	peat	near SEW-488	4190±90	Low in ITZ
12B	79458	peat	Junction Island	6940±90	Low in ITZ
13	79459	peat	Junction Island	9350±60	Base of 3' column
14	79460	peat	Junction Island	4710±70	Top of 3' column
15	79461	wood	Junction Island	2160±40	ITZ stump
16	79462	wood	Junction Island	730±50	ITZ Stump
18	79463	peat	near SEW-488	2120±40	Top Omega Profile
19	79464	peat	near SEW-488	5630±70	Above C/P layer
20	79465	peat	near SEW-488	5600±80	Below C/P layer
21	79466	peat	near SEW-488	5060±80	Base Omega Profile
22	79467	peat	near SEW-488	4230±70	Above sand layer
23	79468	peat	near SEW-488	4530±70	Below sand layer
25	79469	wood	Bay of Isles	2940±50	ITZ stump
26	79470	wood	Puget Bay	670±40	ITZ stump
27	79471	wood	Puget Bay	290±40	Uplifted beach stump
28	79472	wood	Puget Bay	790±60	Uplifted beach stump
29	79473	wood	Puget Bay	480±60	Uplifted beach driftwood
30	79474	wood	Puget Bay	130±50	Uplifted beach stump

Table B-2. Previously Collected C14 Data
(Consolidated by Plafker and Rubin 1967:56)

No.	Lab No.	Sample Type	Location	Years BP	Comments
PR12	W-1720	wood	Seward	>200	Rooted stump on delta
PR13	W-1589	wood	Perry Island	3680±300	Rooted stump on beach
PR14	W-1588	wood	Nowell Point	930±200	Wood fragment from peat
PR15	W-1592	wood	Columbia Bay	1140±250	Rooted stump on beach
PR16	W-1591	wood	Latouche Island	230±200	Rooted stump on beach
PR17	W-1590	wood	MacLeod Harbor	560±200	Rooted stump on beach
PR18	W-1764	wood	MacLeod Harbor	380±200	Rooted stump on delta
PR19	W-1766	wood	Patton Bay	600±200	Wood fragment from peat
PR20	W-1770	peat	Patton Bay	2070±200	Uplifted beach deposits
PR31	W-1724	wood	Middleton Island	1350±200	Driftwood 6.7m terrace
PR32	W-1401	wood	Middleton Island	2390±200	Driftwood 17.7m terrace
PR33	W-1405	wood	Middleton Island	4470±250	Driftwood 41.5m terrace