Exxon Valdez Oil Spill
State/Federal Natural Resource Damage Assessment
Annual Report

Geographical Extent and Recovery Monitoring of Intertidal Oiled Mussel Beds in the Gulf of Alaska Affected by the *Exxon Valdez* Oil Spill

Restoration Study Number 103-4
Annual Report

This annual report has been prepared for peer review as part of the *Exxon Valdez* Oil Spill Trustee Council restoration program for the purposes of assessing project progress. Peer review comments have not been addressed in this annual report

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Geographical Extent and Recovery Monitoring of Intertidal Oiled Mussel Beds in the Gulf of Alaska affected by the *Exxon Valdez* Oil Spill

Restoration Study Number 103-4
Annual Report

Study History: Project R103-4 was initiated in 1992.

Abstract: The purpose of this project was to determine the geographical extent and intensity of petroleum hydrocarbon contamination of mussel beds outside of Prince William Sound, along the Kenai and Alaska Peninsulas and in the Kodiak Archipelago. To this end, available oiling information was evaluated to prioritize sites for investigation. In 1992, 41 sites along the Gulf of Alaska were examined: 27 along the Kenai Peninsula (including 4 in Kenai Fjords National Park), 8 along the Alaska Peninsula (all within Katmai National Park and Preserve), and 6 sites in the Kodiak Archipelago. Thirteen sites were sampled (12 from the Kenai Peninsula and 1 from Katmai National Park and Preserve). Hydrocarbon analyses of samples are being conducted by NOAA's Auke Bay Laboratory. Some preliminary chemical analyses are included in this report.

Key Words: Alaska, *Exxon Valdez*, Gulf of Alaska, mussels, *Mytilus*, national parks, oil, persistence, petroleum hydrocarbons

Project Data: The data collected by this project include: 1) descriptions of oiling at sites visited along the Gulf of Alaska, and 2) samples of mussels and underlying sediments for hydrocarbon analyses. Preliminary chemical analyses (uv fluorescence) for selected samples are presented. We are awaiting further chemical analyses of samples sent to the Auke Bay Laboratory. Descriptions of oiling and results of the preliminary chemical analyses are presented in the text and tables of the report; Gail Irvine is the custodian of these data (U.S.G.S.-B.R.D., Alaska Biological Science Center, 1011 East Tudor Road, Anchorage, Alaska 99503, phone 907/786-3653, fax 907/786-3636, E-mail gail_irvine@usgs.gov). The hydrocarbon data are held as part of a larger database, The Exxon Valdez Oil Spill of 1989: State-Federal Trustee Council Hydrocarbon Database (EVTHD), 1989-1995. This database is housed at the Auke Bay Labs with Bonita Nelson as custodian (11305 Glacier Highway, Juneau, Alaska 99801-8626, phone 907/789-6071, fax 907/789-6094, E-mail bnelson@abl.afsc.noaa.gov). Data are available on diskette in multiple formats.

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GEOGRAPHICAL EXTENT AND RECOVERY MONITORING OF INTERTIDAL OILED MUSSEL BEDS IN THE GULF OF ALASKA AFFECTED BY THE EXXON VALDEZ OIL SPILL

Recovery Monitoring Study Number 103
Part Two

Draft Interim Status Report
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ABSTRACT

Oil-contaminated mussel beds have been documented within Prince William Sound (Babcock, status report, 1991). Based on concerns regarding the continued contamination of these mussels and the implications for trophic transfer of oil to other consumers, including birds and mammals, the National Park Service received Restoration funding from the Trustee Council to: 1) investigate the geographical extent of oiled mussel beds (specifically, outside of Prince William Sound), and 2) determine the degree of hydrocarbon contamination of the beds. These issues relate, not only to the extent of continued injury to mussel beds, but to the rate of recovery of these beds. Additionally, some sense of the magnitude of risk to higher-order consumers may be gained.

In order to determine the geographical extent and intensity of petroleum hydrocarbon contamination of mussel (Mytilus trossulus) beds at sites outside of Prince William Sound, along the Kenai and Alaska Peninsulas, and in the Kodiak Archipelago, available information on oiled sites was evaluated and sites were prioritized for investigation. Forty-one sites were visited in the summer of 1992 in the Gulf of Alaska. Twenty-seven of these sites were located along the Kenai Peninsula, including four sites within Kenai Fjords National Park. Another eight sites were located along the Alaska Peninsula (all within Katmai National Park and Preserve), and 6 sites in the Kodiak Archipelago. Based on observations made during these visits, 13 sites were sampled (12 from the Kenai Peninsula and 1 from Katmai National Park and Preserve). At some sites we sampled more than one mussel bed. Sampling protocols used were those established by National Oceanic and Atmospheric Administration (NOAA).

The field work is now completed and all samples have been shipped to the NOAA, National Marine Fisheries Laboratory at Auke Bay for chemical analysis. Upon receipt of the chemical analyses, the final report will be written in conjunction with the NOAA Auke Bay Laboratory. Preliminary chemical analyses have been included.

INTRODUCTION

The oil spill that resulted from the March, 1989 grounding of the oil tanker Exxon Valdez affected a large geographic area that included, not only the Prince William Sound area, but a large section of the Gulf of Alaska. A study conducted in Prince William Sound (PWS) indicated that within the marine environment, the highest oil concentrations in animals or sediments in 1991 were found in mussels and underlying substrates from oiled mussel beds (Babcock, status report, 1991). State and federal scientists and managers proposed the following theories to explain these findings:

A) The hydrodynamic regime created by mussel beds allows for the creation of a sediment layer beneath the mussels, as well as entrapment of oil within that sediment. Original oiling of the bed may persist because the overlying mussel bed protects crude oil from physical weathering and thus slows degradation rates and allows mussels to be continually exposed to oil.

B) Subsequent oiling of an originally non-oiled bed may result from existing oil migrating down from the upper intertidal zone and then becoming trapped under mussel beds, exposing mussels to oiling (Fultz, draft manuscript, 1991).

Mussels can be one of the predominant species in the rocky intertidal, and when present, play an important role in structuring the community. They can be a key prey item for a number of invertebrate consumers, as well as various bird and mammal species. The continuing contamination of mussel beds provides an avenue through which other consumers may be exposed to oil. If this oil remains unweathered, then the consequences are of even greater importance, since the more toxic fractions occur in unweathered oil. Observed effects on higher order consumers, for example, continued reproductive failure of harlequin ducks in the western PWS, injury to the American Black Oystercatcher and river otter, and higher than normal mortalities of juvenile sea otters, suggest that consumption of contaminated mussels or contact with these contaminated beds may be the cause.

Oil-contaminated mussel beds have been documented in PWS, but the geographical extent of the contamination had not been addressed prior to this study. Oiled coastlines in the Gulf of Alaska west of PWS were the focus of this part of the oiled mussel project. Surveys conducted in 1991 indicated that oil continued to persist along the outer Kenai Peninsula including Kenai Fjords National Park, along the Alaska Peninsula including Katmai National Park and Preserve, and within the Kodiak Archipelago. Fresh-looking mousse and sheening were observed in many locations, despite the predictions that this would not occur beyond the first year after the oil spill (Irvine, 1992).

The presence of oiled mussel beds outside of Prince William Sound and the implication of their presence (through the continual oiling of mussel beds and the trophic linkage to mammals and birds) is of great concern to state and federal resource agencies, including the National Park Service (NPS). In concert with the examination of contaminated mussel beds inside PWS by NOAA, the National Park Service undertook, as the lead agency, to investigate the geographical extent and intensity of petroleum hydrocarbon contamination of oiled mussel beds in the Gulf of Alaska along the Kenai and Alaska Peninsulas and in the Kodiak Archipelago. The main objectives of this study were to:

A. Evaluate and investigate the geographical extent of mussel bed oiling.

B. Determine via chemical analysis the degree of hydrocarbon contamination of these beds.

The main criteria for choosing to sample a bed were the presence of oil, either in the substrate underlying the mussels or immediately upslope from mussel beds; and, the presence of a moderately to densely packed mussel bed.

Study Area

One of this study's main tasks was to determine the geographic extent of oiled mussels within the Gulf of Alaska. This massive area was categorized geographically to facilitate operations and data recording (Figure 1). From east to west the regions were as follows:

1. Kenai Fjords National Park: This area includes 430 miles of shoreline with all lands managed by the National Park Service. Boundaries extend from Bear Glacier on the Aialik Peninsula in Resurrection Bay, to the southwestern tip of Nuka Bay (Figure 2).

2. Outer coast of the Kenai Peninsula and associated islands: The "outer coast" is a name used to describe the Gulf of Alaska coastline from Blying Sound near Seward to the mouth of Cook Inlet. For this study the definition of "Outer Coast Kenai Peninsula and Associated Islands" will include the winding coastline from the western boundary of Kenai Fjords National Park to Koyuktokik Bay. Associated islands include those of the Alaska Maritime National Wildlife Refuge and Nuka Island. The Kenai Peninsula land managers include Alaska Department of Natural Resources (ADNR) representing the Kachemak Bay State Park and Kachemak Bay State Wilderness Park, Port Graham Corporation and United States Fish and Wildlife Service (USFWS) representing the Alaska Maritime National Wildlife Refuge in the Chiswell and Pye Islands (Figure 2).

3. Alaska Peninsula: This study area includes: Katmai National Park and Preserve administered by the National Park Service and the Becharof Unit of the Alaska Peninsula/Becharof National Wildlife Refuge, administered by the USFWS. For the purposes of this study, the Alaska Peninsula was subdivided into these two geographic units:

    a. Katmai National Park and Preserve encompassing the eastern portion of the Alaska Peninsula, bounded on the north by Kamishak Bay and on the east by Shelikof Strait. The most southwestern border of the park is Cape Kubugakli. The 385 miles of shoreline is irregular and broken by numerous indentations (Figure 3).

    b. The Becharof Unit of the Alaska Peninsula/Becharof National Wildlife Refuge which includes the westernmost portion of the study area along the Alaska Peninsula. This unit encompasses an irregular coastline extending about 100 miles from Cape Kubugakli west to Cape Igvak (Figure 3).

Figure 1. Overview of the five geographic regions within the Gulf of Alaska study area - Kenai Fjords National Park, outer coast of the Kenai Peninsula, Katmai National Park and Preserve, Becharof Unit of the Alaska Peninsula/Becharof National Wildlife Refuge and the Kodiak Archipelago.

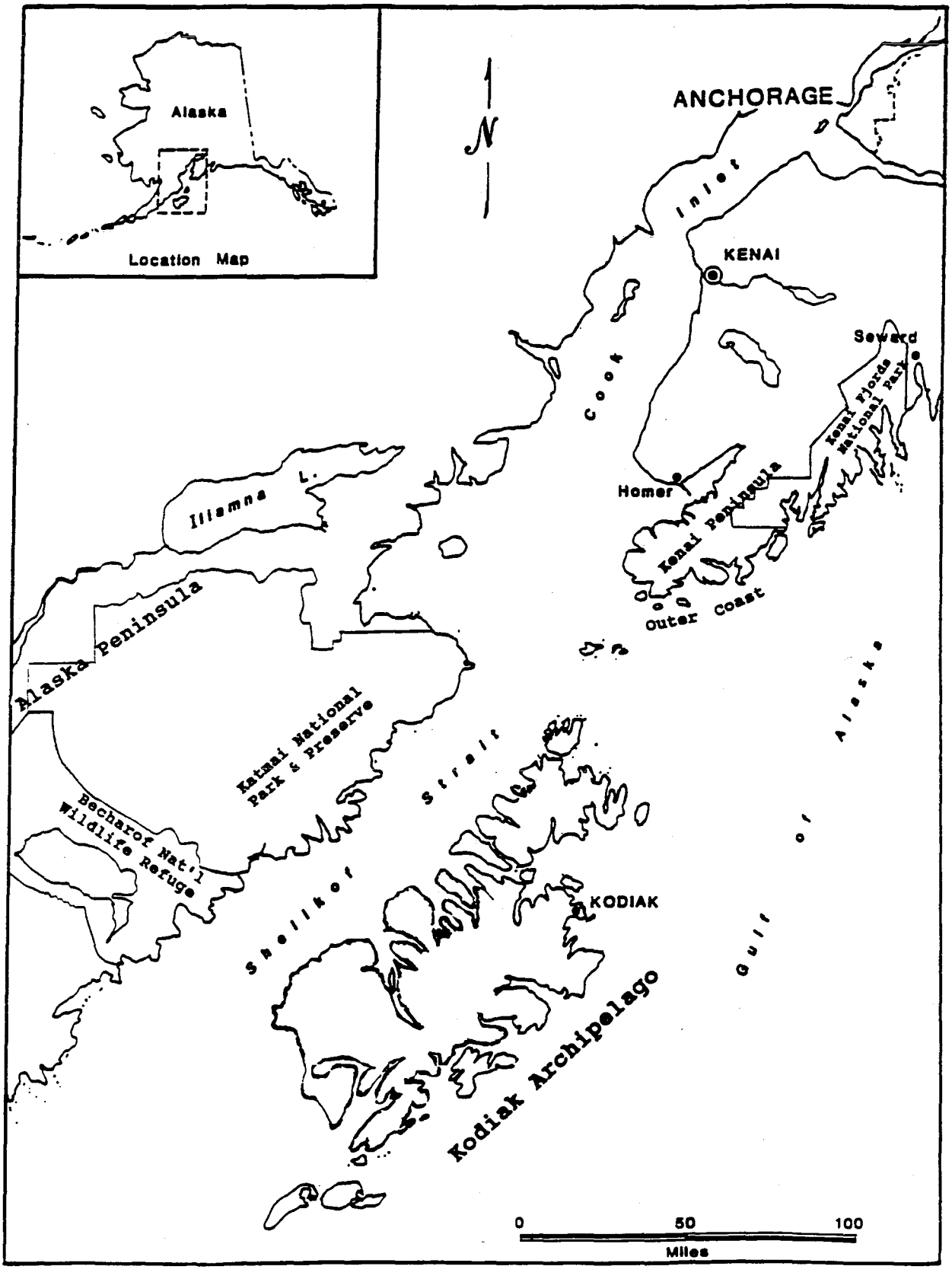


Figure 2. Location of the two geographic regions within the Kenai Peninsula - Kenai Fjords National Park and the outer coast of the Kenai Peninsula and associated Islands.

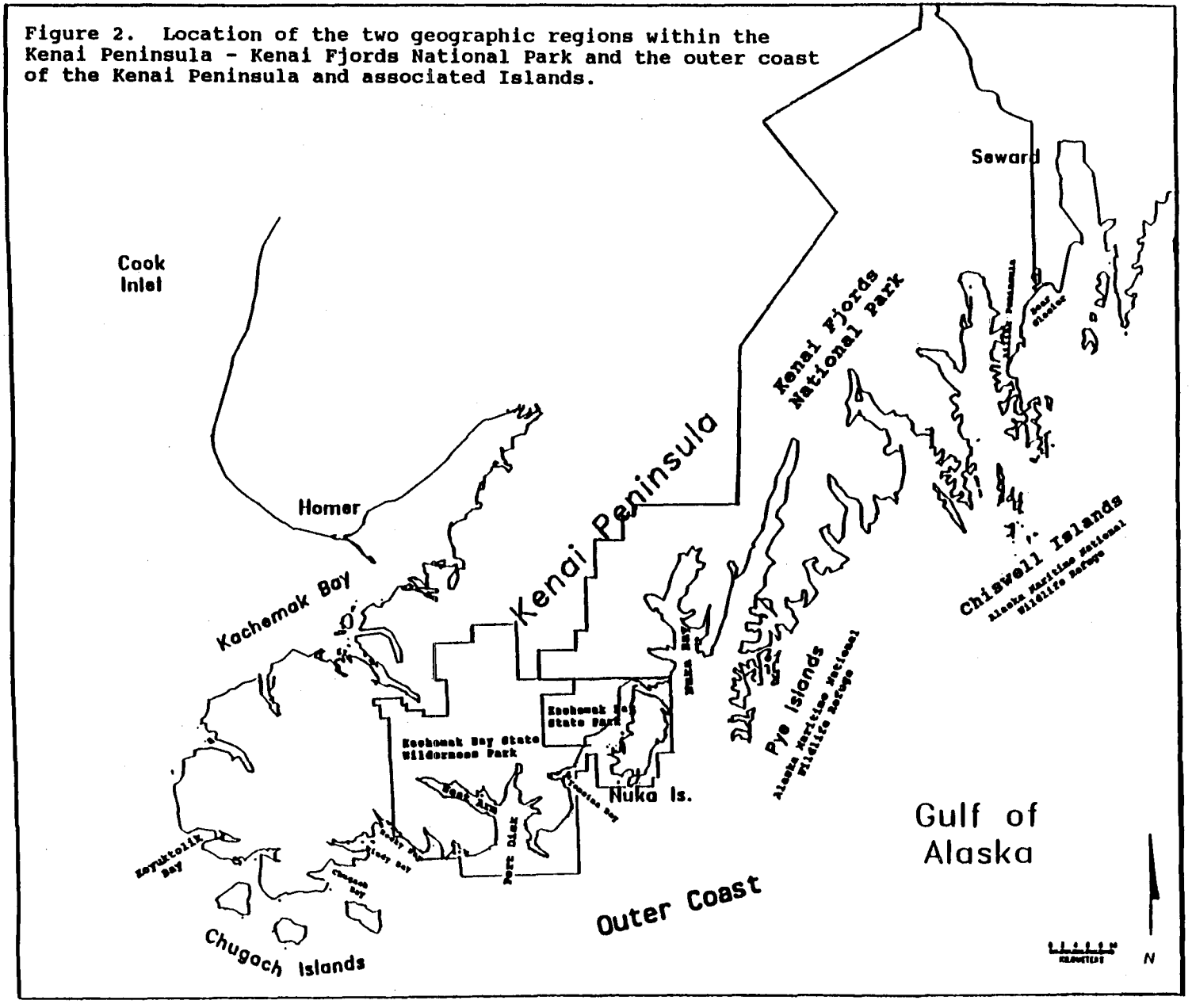
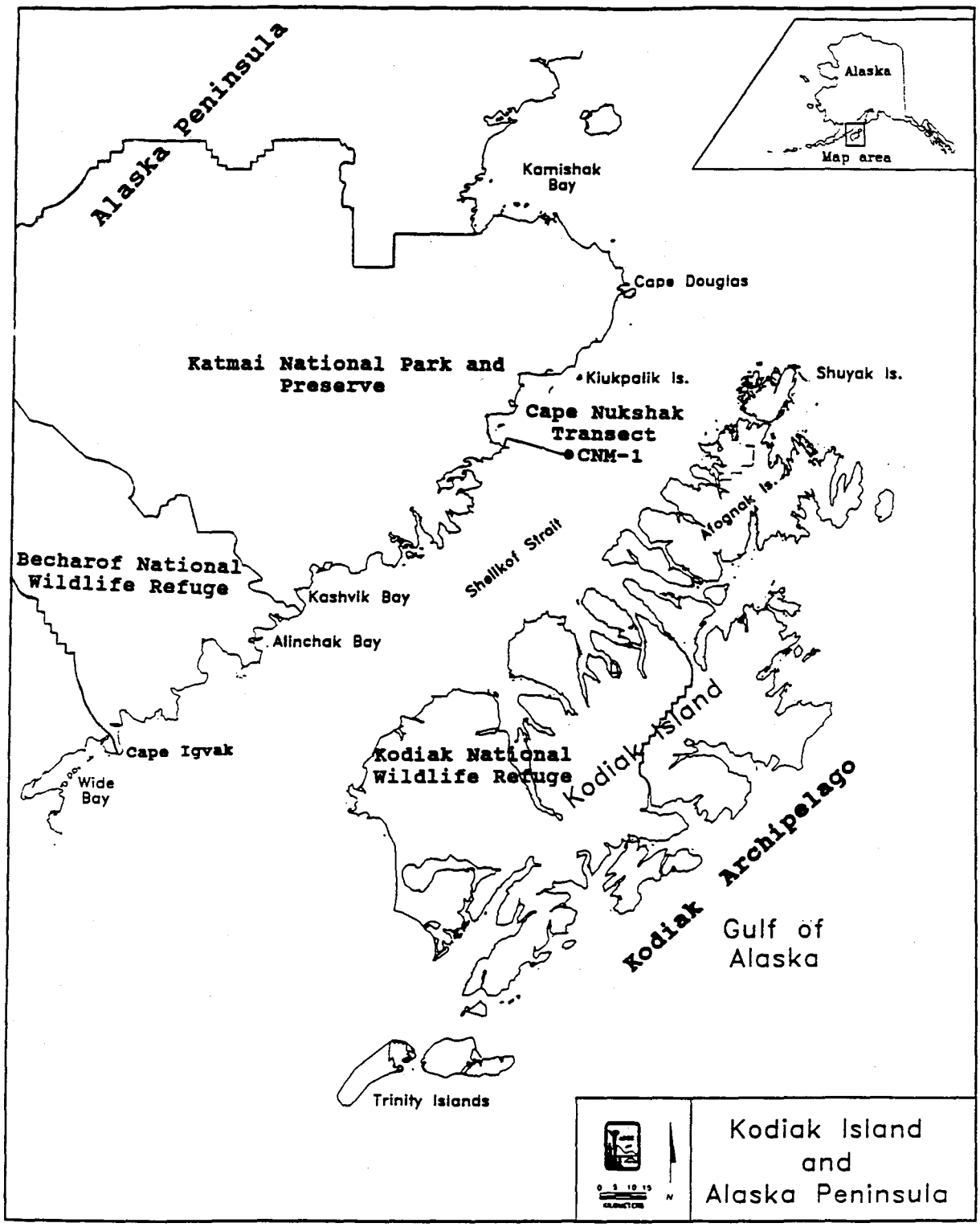


Figure 3. Location of the two geographic regions within the Alaska Peninsula (Katmai National Park and Preserve and the Becharof Unit of the Alaska Peninsula/Becharof National Wildlife Refuge) and the Kodiak Archipelago.



4. Kodiak Archipelago: This area includes Kodiak Island, Afognak Island and Shuyak Island. The land managers in areas of concern are the USFWS (Kodiak National Wildlife Refuge), ADNR and Koniag Incorporated (conveyed land within the Refuge Boundary) (Figure 3).

Site Selection and Prioritization

The greatest effort in this project was the site selection and prioritization process. The gathering of information required interviews with personnel involved in the various beach surveys since 1989 as well as examination of the segment files generated by the NPS, ADEC, USFWS and ADNR. The process of selecting potential oiled mussel sites primarily involved examination of databases generated from SCAT, NPS Shoreline Assessment, SSAT and MAYSAP assessment program records. However other avenues were also utilized. These included information from studies concerned with the geographic extent of oiled mussel beds outside of Prince William Sound and personal communications with "beach walkers" from the assessment programs of 1990 and 1991. The usefulness of these sources in determining the geographic extent of oiled mussel beds in the Gulf of Alaska will be discussed.

Information Sources

Personal Communications

Vital to this project were the discussions with various agency personnel who had been involved in previous assessment surveys. These agencies included NPS, ADEC, ADNR, USFWS and ADFG. Site information and recommendations were then checked against other shoreline assessment sources.

Associated Studies

Another source of information used to identify possible oiled mussel sites were other studies also concerned with oiling in the intertidal region. These studies included:

1. "Harlequin Duck Restoration Monitoring in Prince William Sound, Kenai, Kodiak and Alaska Peninsula Oil Spill Areas" (Restoration Project Number 71, 1992).

2. "Pre-and Post-Oil Intertidal Biological Assessments in Kenai Fjords National Park" (Miller and Duggins, 1990).

The first study was interested in determining whether there was reproductive failure of Harlequin Ducks both inside and outside of Prince William Sound. To accomplish portions of this study it was imperative that the geographical extent of oiled mussel beds be determined. The databases formed in the preliminary phases of this study were used to see if any "new" beach segments containing previously unidentified oiled mussel beds could be found for use in our study. A total of 11 segments were

identified in this database that warranted further consideration and were added to the growing number of potential sites.

The Miller and Duggins (1990) study listed above was undertaken within Kenai Fjords National Park in 1989. The findings served as a guideline in determining sites to be chosen for potential oiled mussel sites. In conjunction with the SSAT and MAYSAP reports of selected beach segments, this study offered a comprehensive assessment of intertidal biota and oiling conditions as seen in 1989, and was helpful in the prioritization of candidate sites within the park.

Shoreline Assessment Surveys

Various shoreline assessment surveys conducted after the Exxon Valdez spill provided information on the geographic extent of oiled mussels in the Gulf of Alaska (Table 1). The usefulness of each survey in identifying candidate oiled mussel sites is discussed below.

Table 1. Primary shoreline assessment surveys used in determining the geographical extent of oiled mussel beds in the Gulf of Alaska.

Report	Survey Time
Shoreline Cleanup and Assessment Team(SCAT)	Spring/Summer 1989
Spring Shoreline Assessment Team(SSAT)	Spring 1990
NPS Shoreline Assessment	Spring/Summer 1990
August Shoreline Assessment Program(ASAP)	Fall 1990
May Shoreline Assessment Program(MAYSAP)	Spring 1991

1989 Exxon SCAT Assessments

Exxon formed a Shoreline Cleanup and Assessment Team (SCAT) in the spring of 1989 to evaluate shoreline segments for oil contamination and recommend site-specific treatment techniques. The team consisted of a geologist/geomorphologist, archaeologist, a marine biologist, an Exxon representative/supervisor, and a U.S. Coast Guard representative. The SCAT geologist was responsible for the oil concentration estimates and shoreline descriptions. The archaeologist conducted a cultural resource evaluation based on the location of known historic/prehistoric sites, and an ecological evaluation by the marine biologist included a brief description of the biota and general habitat assessment. Thus, three forms were completed for each individual segment:

1. Shoreline Oil Evaluation
2. Cultural Resource Evaluation
3. Ecological Evaluation

We used both the Shoreline Oil Evaluation and Ecological Evaluation forms to help determine the extent of oiling and mussel concentrations/distribution for impacted shorelines (form samples are included in Appendix A). Although the data from the SCAT surveys from 1989 were fairly "dated", the information was still useful in accounting for historical oiling, and assisted in prioritizing sites when more recent evaluations (1990 or 1991) were incomplete. The SCAT surveys were especially useful for site selections within the two National Park regions since an NPS representative sometimes accompanied the team during assessments of park shorelines and could provide input during the assessment process.

1990 Exxon and Joint Agency SSAT

In spring 1990, Exxon developed interagency teams to survey heavy and moderately oiled segments identified by the original SCAT surveys of 1989 and other oiled segments with specific environmental concerns identified by resource agencies. These Shoreline Survey Assessment Teams (SSAT) began surveying beach segments within the Gulf of Alaska in April 1990. The surveys were conducted by six-person teams physically walking the shoreline and recording observations. The surveys determined both surface and subsurface oil conditions, assessed the potential habitat effects of various treatment recommendations and surveyed for any adverse effects to local wildlife. Detailed maps and sketches were also produced that depicted the exact location, coverage, and characteristics of the oil.

Documents produced from the SSAT that were essential for our determination of the extent of oiling on or near mussel concentrations were the following:

1. Shoreline Ecological Summary Form

2. Biological Comment Sheet

Samples of these forms can be seen in Appendix B.

1990 NPS Shoreline Assessments

The National Park Service augmented the SSAT surveys in 1990 by continuing shoreline assessments and oil mapping on shoreline segments not included in the schedules of the joint-agency teams (Schoch, 1990a). The objective of this assessment was to produce comprehensive documentation of oil distribution on all shorelines with light and very light oil contamination in Kenai Fjords, Lake Clark, Katmai and Aniakchak National Park units. Terminology and protocols established by Exxon for the SSAT were adopted by the NPS assessment teams. In addition to the shoreline oil assessment field data forms listed above, an intertidal biological community description was also conducted on selected segments within Katmai National Park and Preserve by a marine

biologist. The NPS shoreline assessments were therefore another essential tool in determining the extent of oiling on or near mussel concentrations for this study.

1990 Exxon and Joint Agency ASAP

The objective of the August Shoreline Assessment Program (ASAP) was to determine the status of oiled shorelines where cleanup occurred in 1990. The August surveys helped to determine areas requiring additional work in 1990 and the need for assessment surveys in the spring of 1991(Schoch, 1990a). These joint agency teams consisted of six-person teams (plus a Resource Protection Officer when working along National Park shorelines). For selected beaches throughout the Gulf of Alaska, the ASAP assessments were another important tool for further refining the extensive list of candidate oiled mussel sites by offering well documented fate and persistence data on beaches that were known to contain moderately to densely packed mussel beds.

1991 Exxon and Joint Agency MAYSAP

In the spring of 1991, Exxon, in conjunction with various resource agencies, developed interagency teams to survey certain shorelines in the Gulf of Alaska and perform debris pickup as needed. These May Shoreline Assessment Program (MAYSAP) teams began surveying beaches in April 1991 and generally consisted of six-person teams. The primary objectives included documenting: 1) surface and subsurface oiling and recording the information on forms, maps and sketches, and 2) key intertidal biota, wildlife observations, and sensitive resources.

The following documents produced from the MAYSAP were essential for assistance in determining the extent of oiling on or near mussel concentrations:

1. MAYSAP Field Shoreline Comment Sheet
2. MAYSAP Shoreline Oiling Summary Form
3. MAYSAP Biological Summary Form
4. MAYSAP Sketch Map Form/Bio Map Form

Samples of these forms can be seen in Appendix C.

Since the MAYSAP assessment contained the most current information on the known heavily oiled segments in the Gulf of Alaska, it was extensively used in our study.

Site Prioritization by Region

Once a compilation of potential oiled mussel sites was completed, the next task was to further refine or prioritize the segments. Since relative oiling within each region was different, a priority ranking was established within each geographic region. This produced an extensive list, in particular for the Outer Kenai Coast region; consequently, a refined listing (either low or high priority) was compiled based upon relative likelihood for the presence of oil, either underneath or immediately upslope from a mussel bed; presence of moderately to densely packed mussel beds; geographic (spill zone) representation; and a constrained operating schedule. This priority listing produced 59 oiled mussel candidate sites within the 5 geographic regions.

Kenai Fjords National Park:	4 candidate sites
Outer Coast Kenai Peninsula and Associated Islands:	31 candidate sites
Alaska Peninsula/Katmai National Park and Preserve:	13 candidate sites
Alaska Peninsula/Becharof Wildlife Refuge:	2 candidate sites
Kodiak Archipelago:	9 candidate sites

Kenai Fjords National Park

According to the Kenai Fjords Shoreline Oil Assessment Report (Schoch, 1990b), 26% of the total park shoreline was impacted by beached oil, and most of that coverage (90% of affected park shoreline) was considered to be light or very light. Where oil did come ashore, it was deposited in the highest portion of the intertidal zone, where both floral and faunal abundance and diversity were considered low. In general, biological damage to Kenai Fjords National Park's intertidal shoreline appeared to be light (Miller and Duggins, 1990). Four possible sites within park lands were considered for further scrutiny. These candidate sites are listed in Table 2, which also shows their relative priority ranking and the upland land manager.

Table 2. Prioritization of candidate sites and upland land manager within Kenai Fjords National Park.

Candidate Site & Segment #	Priority	Land Manager
Pony Cove AI003A	High	NPS
McArthur Pass MR001A	High	NPS
Verdant Cove HA002A	Low	NPS
Yalik Bay YB002A	Low	NPS

Outer Coast of the Kenai Peninsula and Associated Islands

Many beaches within this region, received heavy oiling in 1989 (ADEC, 1989). Because of the extreme variability of oiling throughout this region, it was difficult to evaluate the various criteria for location and present persistence of oiling, but areas including Tonsina Bay, Port Dick, Rocky Bay, Windy Bay, Chugach Bay and the Pye Islands received oil impacts within the intertidal regions (ADEC, 1989, 1990; Dudiak and Middleton, 1991). The 1991 MAYSAP reports for this area contained references to mussel beds still harboring underlying oil and prevalent sheens. Interviews with ADEC, and ADFG personnel all indicated that there were opportunities to find oiled mussel beds in this region (personal communications, Crosby, 1992; Glenn, 1992; Middleton, 1992). Further examination of information for this area resulted in 31 sites being selected as candidate oiled mussel sites. Relative priorities and land managers of these sites are listed in Table 3.

Alaska Peninsula/Katmai National Park and Preserve

The Katmai National Park and Preserve shoreline received oiling, primarily in discontinuous patches, ranging from heavy to very light (Schoch, 1990a). The degree of oiling was highly variable within this region, and the oil that did arrive on the beaches was generally in the form of mousse, due to the distance from the spill source in PWS (Schoch, 1990a). Most of the oil deposition on beaches was in the upper or supra intertidal regions where mussel concentrations are rare (Schoch, 1991). Documentation that indicated mussel concentrations came in direct contact

Table 3. Prioritization of candidate sites and upland land managers within the outer coast of the Kenai Peninsula and associated Islands.

Candidate Sites & Segment #	Priority	Land Manager
Tonsina Bay		
TB002A	High	ADNR
TB003A	High	ADNR
TB004A	High	ADNR
TB005A	High	ADNR
TB005B	High	ADNR
TB006A	Low	ADNR
West Arm/Port Dick		
PD004A	High	ADNR
PD010A	High	ADNR
Windy Bay		
WB002A	High	Pt. Graham Corp.
WB002B	High	Pt. Graham Corp.
WB002C	High	Pt. Graham Corp.
WB002E	High	Pt. Graham Corp.
WB009A	High	Pt. Graham Corp.
Rocky Bay		
RB001A	High	ADNR
RB001B	Low	ADNR
RB005A	Low	Pt. Graham Corp.
RB005B	Low	Pt. Graham Corp.
Chugach Bay		
CB003B	Low	Pt. Graham Corp.
CB004B	Low	Pt. Graham Corp.
Morning Cove		
PY008B	High	USFWS
PY008C	High	USFWS
PY008E	High	USFWS
PY008F	High	USFWS
Ragged Island		
PY015B	High	USFWS
PY006	Low	USFWS
PY007A	Low	USFWS
Nuka Passage		
YP002A	High	ADNR
YP004A	Low	ADNR
Nuka Island		
NK001A	High	ADNR
NK002A	High	ADNR
Petroff Point		
PP001A	Low	ADNR

with the stranded oil was also sparse. However, 13 sites were identified by reports (SCAT, SSAT, ASAP, NPS assessments, MAYSAP) and personal communication (Schoch, 1992) as having possible oil impacts on or near mussel concentrations. These candidate sites are listed in Table 4.

Table 4. Prioritization of candidate sites and upland land manager within Katmai National Park and Preserve.

Candidate Site & Segment #	Priority	Land Manager
Ninagiak Island		
K0919HB050A	High	NPS
K0919HB050B	High	NPS
Cape Nukshak		
K0920CN002A	High	NPS
Cape Gull		
K0922CG001A	High	NPS
K0923CG003A	High	NPS
Cape Douglas		
K0910CD001A	Low	NPS
Big River		
K0916BR001B	Low	NPS
Kuliak Bay		
K0924KU004A	Low	NPS
Kukak Bay		
K0921KU003A	Low	NPS
Ninagiak Reef		
K0919HB100A	Low	NPS
Kashvik Bay		
K0935KA002A	Low	NPS
K0935KA003A	Low	NPS
K0936KA001A	Low	NPS

Alaska Peninsula/Becharof Wildlife Refuge

Overall, shoreline oil impacts observed along the Alaska Peninsula/Becharof National Wildlife Refuges in 1990 were very light to none except for the Becharof Unit of the Alaska Peninsula/Becharof Wildlife Refuge. Despite clean-up efforts during 1989, 25% of the refuge shoreline, was affected by scattered patches of narrow to wide bands of oil (Dewhurst,

et.al., 1990). The northernmost portion of Becharof Wildlife Refuge, Alinchak Bay, was the area of highest concern for this study. This was due to several factors: 1) reports of oil impacted mussels within Alinchak Bay (SSAT,MAYSAP) and along an offshore shelf north of Alinchak Bay (personal communication, Dewhurst 1992); and 2) proximity to Katmai National Park and Preserve and the summer's constrained operating schedule. Observations of oiling (primarily sparse tarballs, patties and staining on driftwood) in the middle to lower third of the intertidal zone and rainbow sheening were prevalent for Alinchak Bay (personal communication, Dewhurst, 1992).

Two candidate sites were identified after document searches in the SSAT and MAYSAP reports; they are listed in Table 5.

Table 5. Prioritization of candidate sites and upland land manager within Becharof Unit of the Alaska Peninsula/Becharof National Wildlife Refuge.

Candidate Site & Segment #	Priority	Land Manager
Alinchak Bay		
K1002AS007A	High	USFWS
K1005AS004B	Low	USFWS

Kodiak Archipelago

The islands comprising the Kodiak Archipelago (Shuyak, Afognak, and Kodiak) were categorized as one geographic unit, however, summarizing the oil impacts over this large area was exceedingly difficult. This study therefore, relied on interviews with field personnel involved in the SSAT and MAYSAP joint-agency assessments to further refine the extensive list of oil impacted shorelines and select specific beaches where oil impacts were observed on or near mussel beds. Actual observations of dense mussel beds along any portion of the Kodiak Archipelago were not recorded in any conversations. However, five areas were designated as oiled-mussel sites since initial oiling was heavy to moderate and impacts on the intertidal were recorded (personal communications, Barnhart, 1992; Hensel, 1992; Murphy, 1992). These areas were:

Kodiak Island:	Chief Pt. Area
	Sturgeon Lagoon
Shuyak Island:	Perevalnie Passage
	Shuyak Harbor
Afognak Island:	Malina Bay

Further evaluation of these areas via the SSAT and MAYSAP reports, resulted in 9 sites being selected as candidate oiled mussel sites. Relative priorities and upland land managers of these sites are listed in Table 6.

Table 6. Prioritization of candidate sites and upland land managers within the Kodiak Archipelago.

Candidate Site & Segment #	Priority	Land Manager
Chief Point		
K0619CK005A	High	USFWS
K0619SB006A	High	USFWS
K0620SB001A	High	USFWS
Perevalnie Passage		
K0110SI003A	High	ADNR
K0110SI005A	High	ADNR
K0111SI004M	Low	ADNR
Shuyak Harbor		
K0103SS002B	Low	ADNR
Malina Bay		
K0210MB006A	Low	USFWS
Sturgeon Lagoon		
K0634SL009A	Low	Koniag Inc.

Logistical Considerations

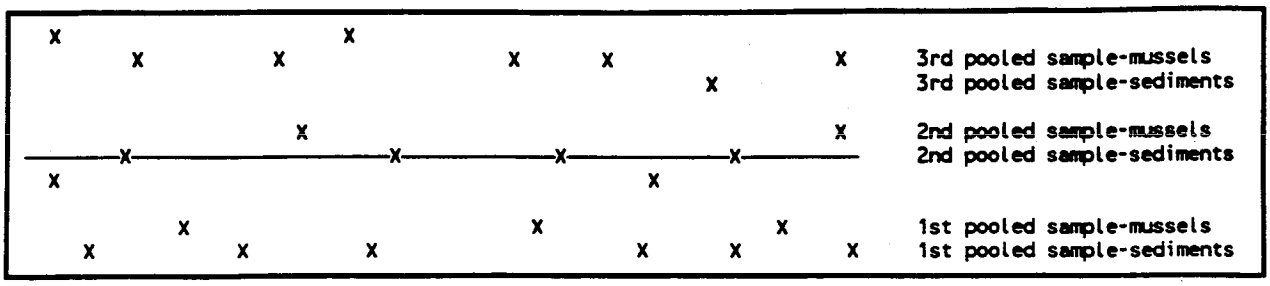
The 73 foot motor vessel "Waters" was contracted by the National Park Service for the summer. The oiled mussel study was one of several projects that used the vessel to conduct surveys. During the extreme low tides of each month the vessel was used by an intertidal study crew, so the oiled mussel project worked the moderate low tides.

Participating in the actual surveys were also NPS and ADEC personnel with expertise on the historic oiling of the National Park units and the outer coast of the Kenai Peninsula, respectively.

Sampling Protocols

The sampling technique used by the National Park Service differed from the existing NOAA protocols for collection of mussels and substrate. The general pattern of sampling is shown in Figure 4.

Figure 4. General pattern of sampling along oiled mussel transects.



Mussels: A meter tape was placed approximately through the middle of the mussel bed. In ideal locations, a 30-meter transect was used, however, the extreme variability in the density and extent of mussel beds among locations, sometimes led to much shorter transects being used. In some cases, transects only 12-meters long were sampled. The transect was placed as close as possible parallel to the water line and in some cases, the transect was bent in order to accommodate changes in substrate variability and mussel concentrations. Pooled mussel samples were then collected; each sample jar contained 20-30, 2-5 cm. mussels (enough to produce >10 grams tissue) taken at 8-10 haphazardly-chosen sites along the transect. Decontaminated (methylene-chloride rinsed) scissors were used to cut mussels from the byssal threads. Samples were stored in 8 oz I-Chem (300 series) hydrocarbon-free jars. Mussels were temporarily stored in a chilled cooler, transported and frozen within 2-4 hours. This same procedure was followed for transects that were parallel to, but above and below the original transect. The distances between the original transect line and the upper and lower lines varied (according to the physiogamy of the bed) from 0 to 2 meters. Thus, three pooled mussel samples were taken from a bed. This technique differed from the NOAA technique by having 3 separate transects with pooled samples rather than 3 replicate pooled samples along one transect.

Sediments: The same transect line for sampling mussels was used to collect the substrates and sediments immediately underlying the sampled mussel bed. Each pooled sample consisted of 8-10 subsamples in each jar. Subsamples (a mixture of byssal mat and sediment) were taken at the exact sampling sites as for mussels. Substrate was turned over with a trowel (not chemically clean), then cut away from the byssal/sediment matrix with chemically clean (methylene-chloride rinsed) scissors. Care was taken to collect sediment not in direct contact with the trowel. Sediment was then collected with a chemically clean spoon no more than 2cm below mussels. Plant, animal material and large rocks were excluded from the jars. Composite substrate/sediment samples were then placed in chemically clean 4 oz I-Chem (300 series) jars, transported in a chilled cooler and frozen within 2-4 hours. One blank sample was taken at each site. This consisted of a chemically clean 4-oz jar that was kept open for the duration of taking one substrate sample.

Photo Documentation: Close-range views of the substrate, mussels and oiling were taken, as well as overviews of the transect line and prominent landmarks. Photographs were later labelled and are currently stored at the NPS Alaska Regional Office/Coastal Programs Division.

Sample Handling: All sample handling, data collection, chain-of-custody procedures, and shipping methods followed established EVOS Natural Resource Damage Assessment (NRDA) protocols as developed by the NOAA/Auke Bay Laboratory.

RESULTS

Forty-four sites were visited this summer in the Gulf of Alaska. Thirty sites along the Kenai Peninsula were visited, four of which were within Kenai Fjords National Park; eight sites along the Alaska Peninsula (all within Katmai National Park and Preserve) were visited; and six sites were examined in the Kodiak Archipelago. Based on these visits, 13 sites were sampled (12 from the Kenai Peninsula and 1 from Katmai National Park and Preserve). The locations of the 13 sites sampled are shown in Figures 5a and 5b, while detailed maps and descriptions for the sampled sites can be found in Appendix D. Table 7 lists all of the sites sampled.

Table 7 Sampling Sites

Sites sampled during oiled mussel bed survey, May 31 - June 11, June 20 - June 28 and July 28 - August 7, 1992, Kenai Peninsula and Alaska Peninsula.

SITE	GENERAL LOCATION	BEACH SEGMENT	DATE
Tonsina Bay 1	N.E. corner of bayhead	TB003A	06/08/92
Tonsina Bay 2	N.E. corner of bayhead	TB003A	06/08/92
Tonsina Bay 3	S.W. pocket beach	TB003A	06/08/92
Tonsina Bay 4	Grim Beach	TB004A	06/23/92
Tonsina Bay 5	Otter Beach	TB003A	06/23/92
Morning Cove	N.W. cove	PY008B	06/10/92
Windy Bay 1	Oystercatcher Is., W. beach	WB009A	06/21/92
Windy Bay 2	North shore, W. of log ramp	WB002C	06/21/92
Windy Bay 3	North shore,E. side of cove	WB002B	06/21/92
Rocky Bay	Grungy cove, N.E. side	RB005B	06/24/92
Mars Cove	Groucho Cove, N. shore	PD004A	06/22/92
Pikes Point	W. side of Isthmus	PD010A	06/22/92
Cape Nukshak	E. of cape, N. beach	K0920CN002A	08/06/92

Table 8 includes all segments on the original priority list for each geographic region and additional segments visited opportunistically, but not initially prioritized. The first column includes all those segments that were identified by NPS, ADEC, ADFG, USFWS staff and assessment databases as possibly containing the presence of EVOS oil within or immediately adjacent to moderate to dense mussel beds, plus the opportunistically-visited sites mentioned above. The third column presents the relative priority assigned to prioritized segments. The fourth column presents the survey date while the fifth column reflects the findings of the summer field observational surveys conducted by the NPS team. The sixth column presents the preliminary analytical results for sediments as determined by UV fluorescence screening, with values reported as ug/g wet weight total oil equivalents.

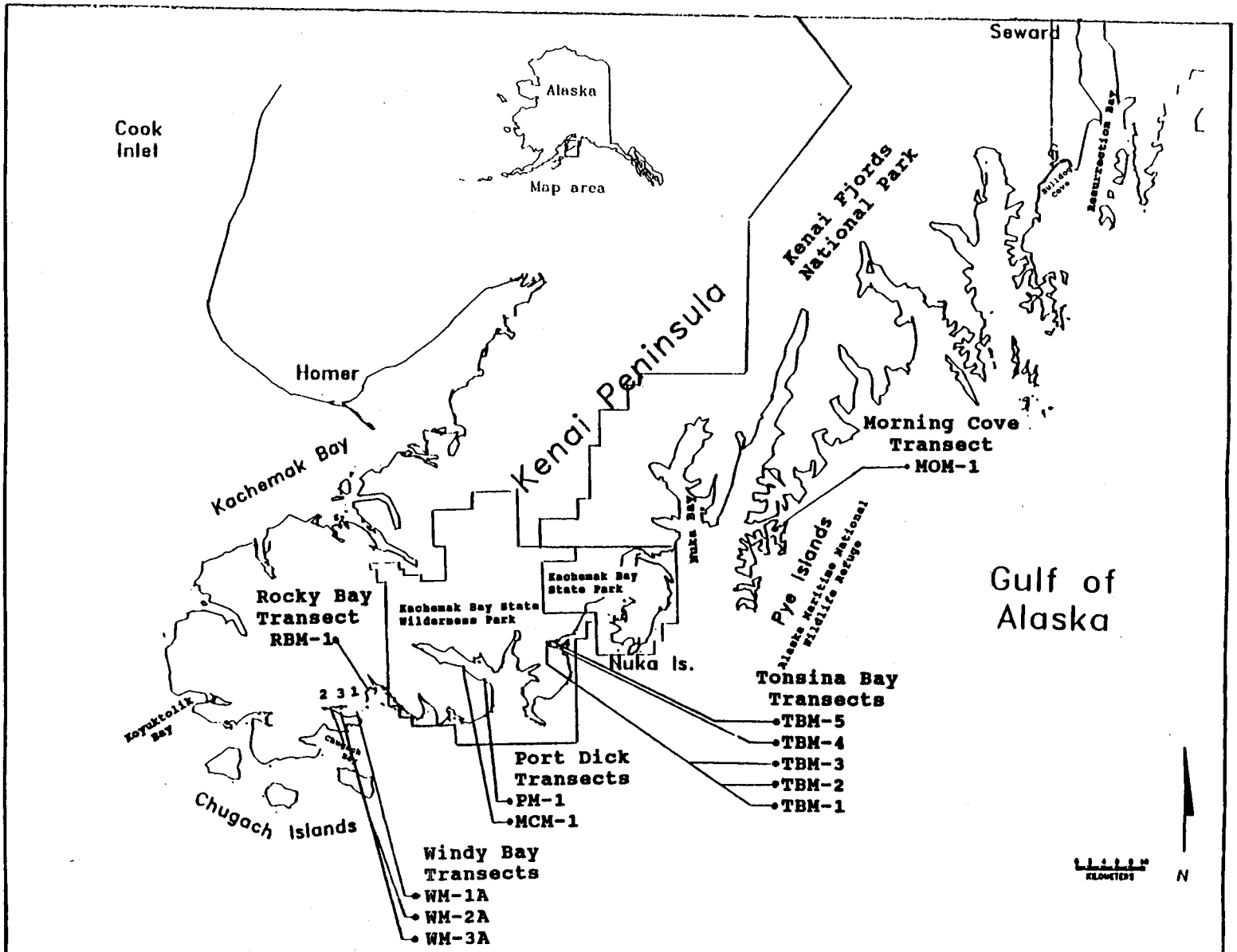


Figure 5a. General locations of the oiled mussel transects along the outer coast of the Kenai Peninsula.

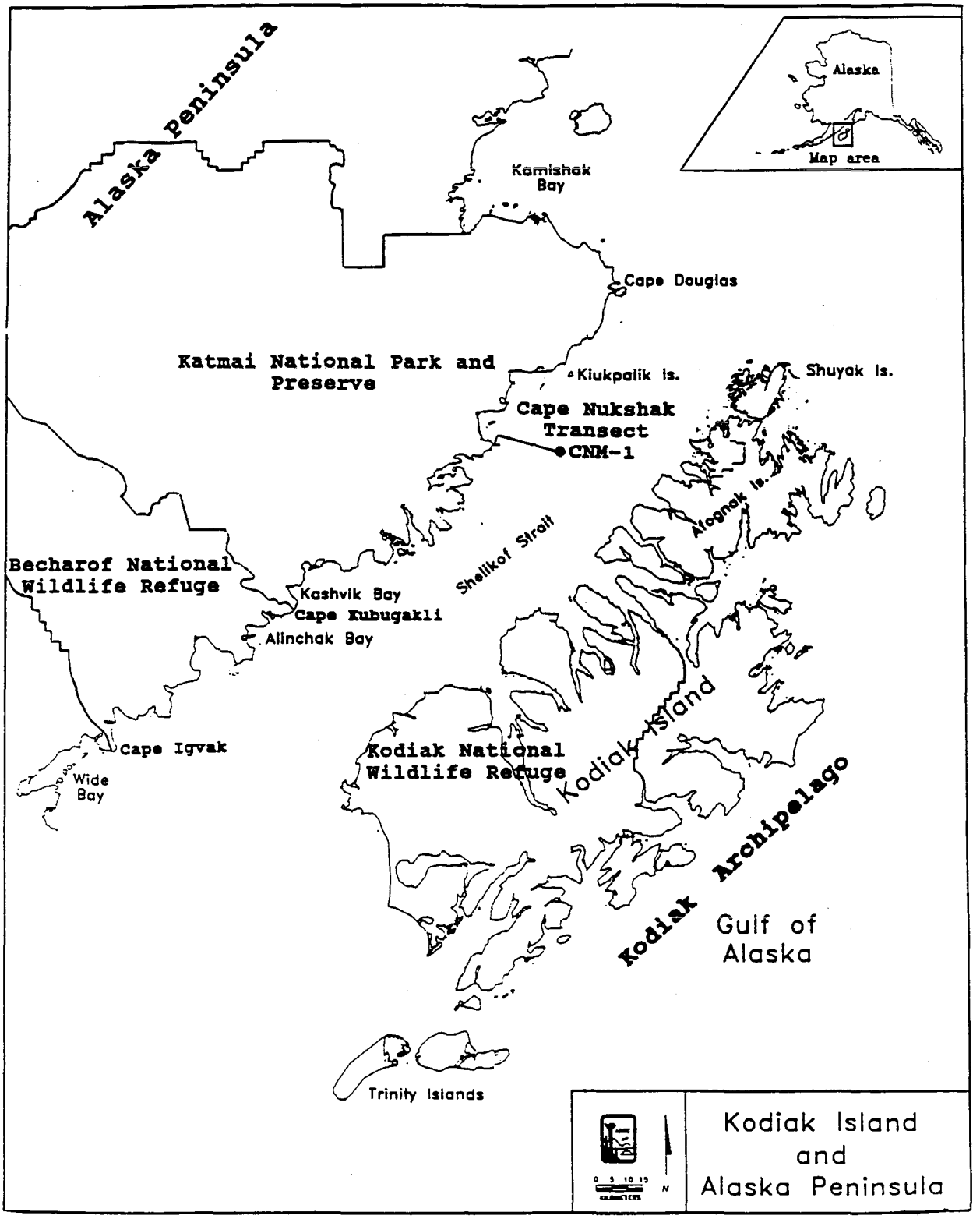


Figure 5b. General location of the oiled mussel transect (Cape Nukshak - CNM-1) in Katmai National Park and Preserve, Gulf of Alaska.

Table 8. MUSSEL BED STUDY SEGMENT LIST

Segment Number (1)	General Location	Priority	Survey Date	OILED (2)	OE of Sediments mean (ppm) (3)
AI-003A	PONY COVE	HIGH			
CB-003B	CHUGACH BAY	LOW			
CB-004B	CHUGACH BAY	LOW			
HA-002A	VERDANT COVE	LOW	06/05/92	NO	
K0103SS002B	SHUYAK HARBOR	LOW			
K0110SI003A	PEREVALNIE PASS	HIGH	06/25/92	NO	
K0110SI005A	PEREVALNIE PASS	HIGH	06/25/92	NO	
K0111SI004M	PEREVALNIE PASS	LOW	06/25/92	NO	
K0210MB006A	AFOGNAK-MALINA	LOW			
K0619CK005A	CHIEF COVE	HIGH	08/05/92	NO	
K0619SB006A	CHIEF COVE	HIGH	08/05/92	NO	
K0620SB001A	CHIEF COVE	HIGH	08/25/92	NO	
K0634SL009A	STURGEON LAGOON	LOW			
K0906CP002A	SHAW ISLAND	*	07/29/92	NO	
K0908CD003A	CAPE DOUGLAS	*	07/30/92	NO	
K0910CD011A	CAPE DOUGLAS	LOW			
K0914SK101A	KIUKPALIK IS.	*	07/31/92	NO	
K0916BR001B	BIG RIVER	LOW			
K0919HB050A	NINAGIAK ISLAND	HIGH	07/19/92	NO	
K0919HB050B	NINAGIAK ISLAND	HIGH	08/01/92	NO	
K0919HB100A	NINAGIAK REEF	LOW			
K0920CN002A	CAPE NUKSHAK	HIGH	08/06/92	YES	577.34
K0921KU003A	KUKAK BAY	LOW			
K0922CG001A	CAPE GULL	HIGH	08/02/92	NO	
K0923CG003A	CAPE GULL	HIGH			
K0924KU004A	KULIAK BAY	LOW			
K0935KA002A	KASHVIK BAY	LOW	08/04/92	NO	
K0935KA003A	KASHVIK BAY	LOW			
K0936KA001A	KASHVIK BAY	LOW			
K1002AS007A	ALINCHAK BAY	HIGH			
K1005AS004B	ALINCHAK BAY	LOW			
MR-001A	McARTHUR PASS	HIGH	06/10/92	NO	
NK-001A	NUKA ISLAND	HIGH	06/09/92	NO	
NK-002A	NUKA ISLAND	HIGH	06/09/92	NO	
NO SEG. #	HARRIS BAY	*	06/02/92	NO	
PD-003A	PORT DICK	*	06/22/92	NO	
PD-004A	PORT DICK	HIGH	06/22/92	YES	9,122.11
PD-010A	PORT DICK	HIGH	06/22/92	YES	3,524.67
PP-001A	PETROFF POINT	LOW			

* Additional sites visited, but not initially prioritized.
(1) Containing a potentially oiled mussel bed.
(2) Results of summer observational survey.
(3) Mean oil equivalents (OE) for 3 pooled sediment samples/site, determined by UV fluorescence and expressed as micrograms/gram (wet weight).

Table 8 Continued. MUSSEL BED STUDY SEGMENT LIST

Segment Number (1)	General Location	Priority	Survey Date	OILED (2)	OE of Sediments mean (ppm) (3)
PY-006	PYE ISLANDS	LOW			
PY-007A	PYE ISLANDS	LOW			
PY-008B	PYE ISLANDS	HIGH	06/10/92	YES	8,874.70
PY-008C	PYE ISLANDS	HIGH	06/10/92	NO	
PY-008E	PYE ISLANDS	HIGH	06/10/92	NO	
PY-008F	PYE ISLANDS	HIGH	06/10/92	NO	
PY-015B	PYE ISLANDS	HIGH			
RB-001A	ROCKY BAY	HIGH			
RB-001B	ROCKY BAY	LOW			
RB-005A	ROCKY BAY	LOW			
RB-005B	ROCKY BAY	LOW	06/23/92	YES	248.57
TB-001A	TONSINA BAY	*	06/07/92	NO	
TB-002A	TONSINA BAY	HIGH	06/08/92		
TB-003A	TONSINA BAY #1	HIGH	06/08/92	YES	2,263.98
TB-003A	TONSINA BAY #2	HIGH	06/08/92	YES	2,217.12
TB-003A	TONSINA BAY #3	HIGH	06/08/92	YES	513.28
TB-003A	TONSINA BAY #5	HIGH	06/08/92	YES	1,794.17
TB-004A	TONSINA BAY	HIGH	06/23/92	YES	7,268.50
TB-005A	TONSINA BAY	HIGH			
TB-005B	TONSINA BAY	HIGH	06/07/92		
TB-006A	TONSINA BAY	LOW	06/08/92	NO	
WB-002A	WINDY BAY	HIGH	06/21/92	NO	
WB-002B	WINDY BAY	HIGH	06/21/92	YES	765.80
WB-002C	WINDY BAY	HIGH	06/21/92	YES	4,644.77
WB-002E	WINDY BAY	HIGH	06/21/92	NO	
WB-007A	WINDY BAY	*	06/21/92	NO	
WB-009A	WINDY BAY	HIGH	06/21/92	YES	3,043.51
YB-002A	YALIK BAY	LOW	06/09/92	NO	
YP-002A	NUKA PASSAGE	HIGH			
YP-004A	NUKA PASSAGE	LOW	06/01/92	NO	

* Additional sites visited, but not initially prioritized.
(1) Containing a potentially oiled mussel bed.
(2) Results of summer observational survey.
(3) Mean oil equivalents (OE) for 3 pooled sediment samples/site, determined by UV fluorescence and expressed as micrograms/gram (wet weight).

UVF Screening Results

Sediment samples collected in 1992 have been analyzed using a UV fluorescence screening procedure adapted from Krahn et al.(1991). Excitation/emission spectra of the extracts were read at the phenanthrene wavelength (260/380 nm), and values reported are ug/g wet weight total oil equivalents (OE). This procedure does not measure individual analytes within a sample, but does approximate total oil concentration and allows comparison of relative oil concentrations between and among samples (Babcock et al., 1993). The UV screening allows for more rapid, cheaper analysis of samples than by the more chemically-explicit GC/MS procedure.

Table 9 shows the sediment sample data that was analyzed for total petroleum hydrocarbons using UVF. Values are reported in ug/g wet weight total oil equivalents (OE). Also shown are the samples chosen for the more detailed GC/MS analytical procedure to be conducted later this year. The mean, standard deviation, and standard error are listed for each of the pooled samples.

The UV analyses of sediments collected in the Gulf of Alaska show highest levels of petroleum hydrocarbon concentrations from Mars Cove in Port Dick (mean= 9,122.11 ± 1,887.62 standard error ug/g wet weight(OE)), Morning Cove in the Chiswell Islands (8,874.70 ± 4,707.27), Grim Beach in Tonsina Bay (7,268.5 ± 1,707.65), and Windy Bay (4,644.77 ± 954.39)-- all located along the Kenai Peninsula.

The lowest values were obtained from the one site sampled along the Alaska Peninsula (Cape Nukshak), located within Katmai National Park and Preserve (mean= 577.34 ± 478.94) and a small beach in Tonsina Bay (513.28 ± 175.86) along the Kenai Peninsula.

Figure 6 represents the mean (measured in oil equivalents of ug/g ww) concentration of total hydrocarbons of sediments for each of the 3 pooled samples for each site. Although each of the pooled samples cannot be called replicates, as is the case for the NOAA samples, the OE have been averaged to give an overall estimate of the relative degree of oiling found at each site.

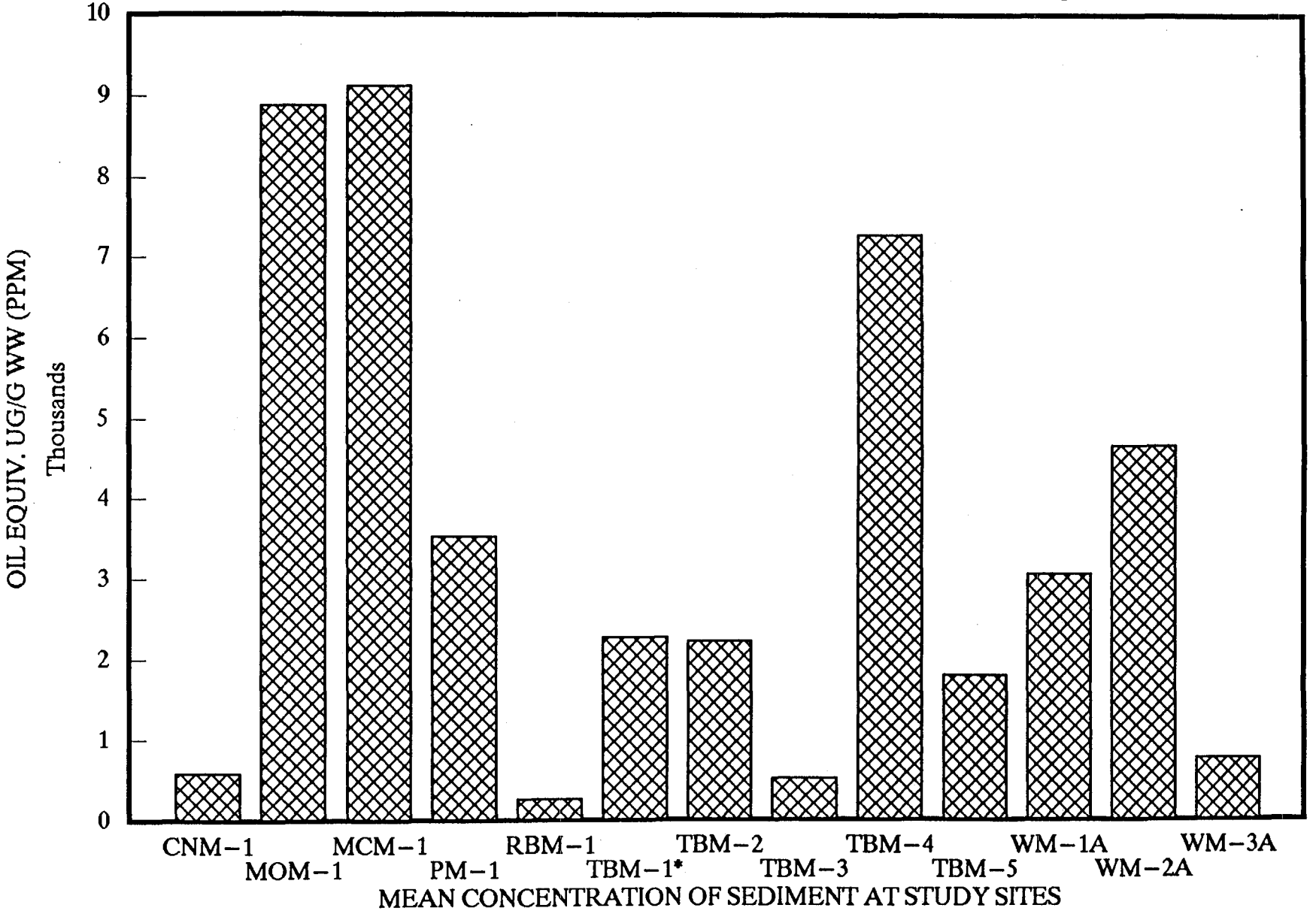
Figure 7 shows the total oil equivalents (OE) of sediments for pooled samples from each zone. In general, each pooled sample was taken haphazardly along a transect laid through the middle of the bed or from parallel zones set above or below the mid transect. The highest individual sample concentration is from Morning Cove (20,072.45 ug/g ww OE) .

TABLE 9
SEDIMENT SAMPLES ANALYZED FOR TOTAL PETROLEUM HYDROCARBONS USING UVF SCREENING

GENERAL LOCATION	SEGMENT NO	SITE ID	DATE	GC/MS	SAMPLE ID	ZONE **	OIL EQUIV. UG/G WW***	STATISTICS *** N	MEAN	STDEV	STDERR
CAPE NUKSHAK	CN002A	CNM-1	06-Aug-92		302701	BELOW	84.03				
CAPE NUKSHAK	CN002A	CNM-1	06-Aug-92		302703	ALONG	422.05				
CAPE NUKSHAK	CN002A	CNM-1	06-Aug-92	***	302705	ABOVE	1225.94	3	577.34	478.94	276.52
MORNING COVE	PY008B	MOM-1	10-Jun-92		302425	BELOW	894.52				
MORNING COVE	PY008B	MOM-1	10-Jun-92	***	302427	ALONG	20072.45				
MORNING COVE	PY008B	MOM-1	10-Jun-92		302429	ABOVE	5657.13	3	8874.70	8153.23	4707.27
PORT DICK/MARS COVE	PD004A	MCM-1	22-Jun-92		302526	BELOW	8797.80				
PORT DICK/MARS COVE	PD004A	MCM-1	22-Jun-92	***	302528	ALONG	13278.64				
PORT DICK/MARS COVE	PD004A	MCM-1	22-Jun-92		302530	ABOVE	5289.89	3	9122.11	3269.45	1887.62
PORT DICK/PIKES POINT	PD010A	PM-1	22-Jun-92		302533	BELOW	2040.30				
PORT DICK/PIKES POINT	PD010A	PM-1	22-Jun-92		302535	ALONG	3322.30				
PORT DICK/PIKES POINT	PD010A	PM-1	22-Jun-92		302537	ABOVE	5211.40	3	3524.67	1302.48	751.99
ROCKY BAY/GRUNGY COVE	RB005B	RBM-1	24-Jun-92	***	302604	BELOW	635.20				
ROCKY BAY/GRUNGY COVE	RB005B	RBM-1	24-Jun-92		302606	ALONG	46.40				
ROCKY BAY/GRUNGY COVE	RB005B	RBM-1	24-Jun-92		302608	ABOVE	64.10	3	248.57	273.49	157.90
TONSINA BAY/BAYHEAD	TB003A	TBM-1	08-Jun-92		302404	NORTH	1929.93				
TONSINA BAY/BAYHEAD	TB003A	TBM-1	08-Jun-92		302406	ALONG	3725.88				
TONSINA BAY/BAYHEAD	TB003A	TBM-1	08-Jun-92		302408	SOUTH	1136.14	3	2263.98	1083.32	625.46
TONSINA BAY/BAYHEAD	TB003A	TBM-2	08-Jun-92	***	302411	BELOW	4077.04				
TONSINA BAY/BAYHEAD	TB003A	TBM-2	08-Jun-92		302413	ALONG	1533.13				
TONSINA BAY/BAYHEAD	TB003A	TBM-2	08-Jun-92		302415	ABOVE	1041.20	3	2217.12	1330.41	768.11
TONSINA BAY/S.W. BEACH	TB003A	TBM-3	08-Jun-92		302418	BELOW	398.09				
TONSINA BAY/S.W. BEACH	TB003A	TBM-3	08-Jun-92		302420	ALONG	211.41				
TONSINA BAY/S.W. BEACH	TB003A	TBM-3	08-Jun-92		302422	ABOVE	930.34	3	513.28	304.59	175.86
TONSINA BAY/GRIM BEACH	TB004A	TBM-4	23-Jun-92		302540	BELOW	9438.87				
TONSINA BAY/GRIM BEACH	TB004A	TBM-4	23-Jun-92		302542	ALONG	3086.63				
TONSINA BAY/GRIM BEACH	TB004A	TBM-4	23-Jun-92		302544	ABOVE	9280.00	3	7268.50	2957.74	1707.65
TONSINA BAY/OTTER BEACH	TB003A	TBM-5	23-Jun-92		302547	BELOW	971.30				
TONSINA BAY/OTTER BEACH	TB003A	TBM-5	23-Jun-92		302549	ALONG	1005.90				
TONSINA BAY/OTTER BEACH	TB003A	TBM-5	23-Jun-92	***	302601	ABOVE	3405.30	3	1794.17	1139.33	657.79
WINDY BAY/OYSTERCATCHER	WB009A	WM-1A	21-Jun-92		302507	BELOW	1035.63				
WINDY BAY/OYSTERCATCHER	WB009A	WM-1A	21-Jun-92		302505	ALONG	2006.80				
WINDY BAY/OYSTERCATCHER	WB009A	WM-1A	21-Jun-92		302509	ABOVE	6088.11	3	3043.51	2189.06	1263.85
WINDY BAY/N. LOG RAMP	WB002C	WM-2A	21-Jun-92	***	302512	BELOW	6980.91				
WINDY BAY/N. LOG RAMP	WB002C	WM-2A	21-Jun-92		302514	ALONG	3552.50				
WINDY BAY/N. LOG RAMP	WB002C	WM-2A	21-Jun-92		302516	ABOVE	3400.90	3	4644.77	1653.06	954.39
WINDY BAY/N. SHORE	WB002B	WM-3A	21-Jun-92		302519	BELOW	987.07				
WINDY BAY/N. SHORE	WB002B	WM-3A	21-Jun-92		302521	ALONG	883.13				
WINDY BAY/N. SHORE	WB002B	WM-3A	21-Jun-92		302523	ABOVE	427.20	3	765.80	243.16	140.39

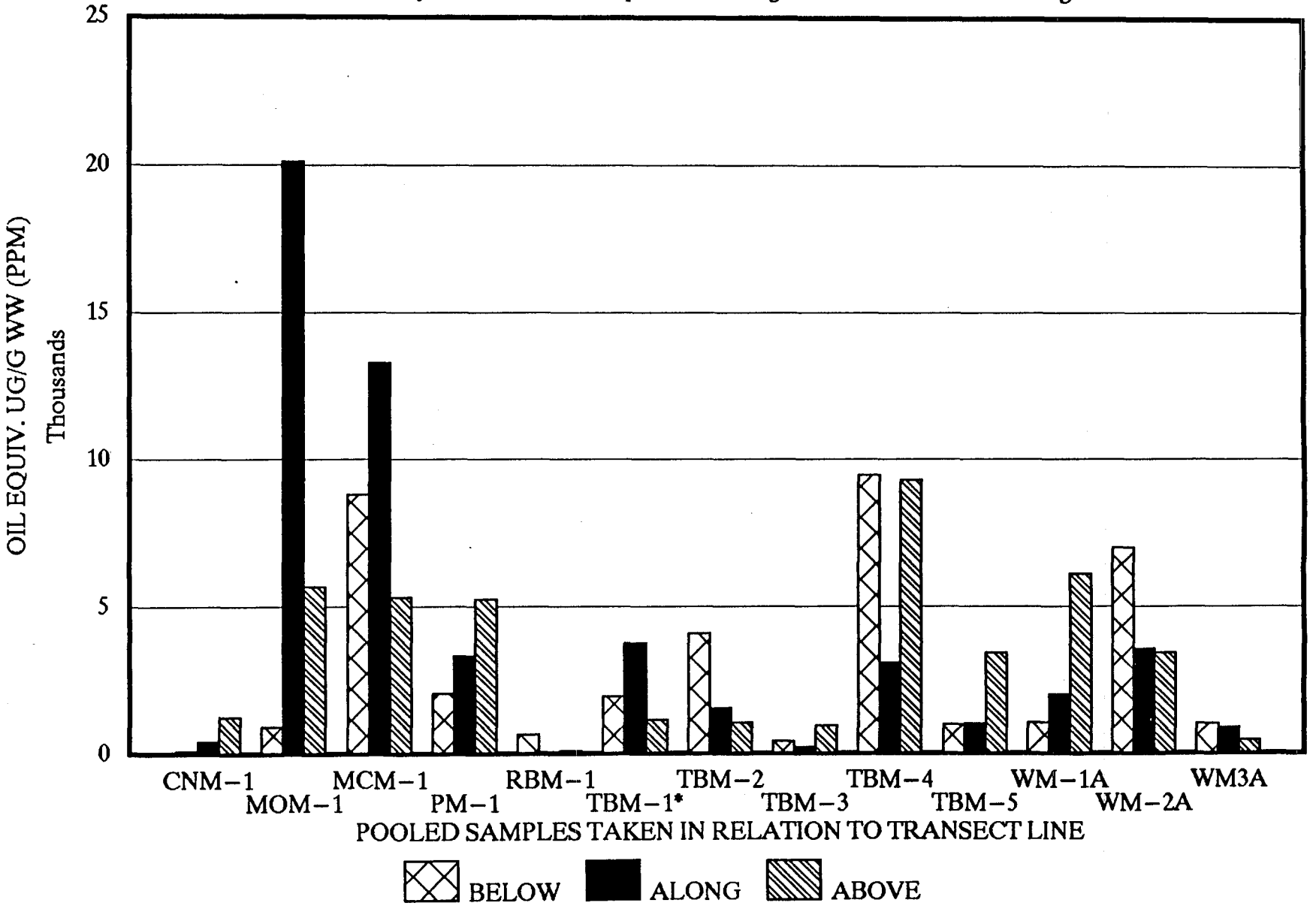
* SAMPLES CHOSEN FOR GC/MS ANALYSIS
** WHERE POOLED SAMPLE WAS TAKEN IN RELATION TO TRANSECT LINE
*** MICROGRAMS PER GRAM (WET WEIGHT) ANALYZED WITH UVF

FIGURE 6 Mean Concentrations(ug/g,wet weight) of Sediments Sampled For Each Site Analyzed for Total Oil Equivalents using UV Fluorescence Screening



* Vertical transect

FIGURE 7 Concentrations(ug/g wet weight) of Pooled Sediment Samples Analyzed for Total Oil Equivalents using UV Fluorescence Screening



* Transect oriented vertical to water's edge

Sampling Variation Among Beds

Some variation in the sampling method occurred between beds due to differences in the general structure of beds and the density of mussels. Three types of patterns fell out: 1) sites where substrates controlled the sampling (i.e., substrate variation limited the occurrence of mussels and hence the placement of transects); 2) sites where both oiling and mussels were sparse or patchy, and a wider zone was necessary in order to accomplish sampling; and 3) sites where oiling and mussels occurred in great enough concentrations that sampling was straightforward.

The first category, where substrates controlled sampling, occurred in Morning Cover (MOM-1), Mars Cove (MCM-1), and Windy Bay (WM-2A). In these areas, transects placed among large boulders and talus were bent several times in order to track the concentrations of mussels and concomitant oil. Sampling at these sites reflected the patchiness of the mussels and concentrated along cracks and crevices at the base of boulders. At Mars Cove (MCM-1) and Windy Bay (WM-2A), this caused an increase in the width of sampling zones. However, at Morning Cove, the presence of extremely large boulders tended to concentrate the entire sampling in an area only one to two feet above and below the mid transect.

Sites where moderate to light numbers of mussels and light oiling led to wider and more varied sampling included Cape Nukshak (CNM-1), Rocky Bay (RBM-1), and one site in Windy Bay (WM-3A).

Sampling at the remaining sites (excluding Tonsina Bay #1 (TBM-1)) was more straightforward, since mussel concentrations and oiling were not sparse, and sampling above and below the transect could be done easily. These sites included Pikes Point in Port Dick (PM-1), Oystercatcher Island in Windy Bay (WM-1A), and four beaches in Tonsina Bay (TBM-2), (TBM-3), (TBM-4), and (TBM-5).

A further pattern or limitation not described above applies to the remaining site, Tonsina Bay (TBM-1). At this site, the oiling of the mussel bed had a strong vertical orientation, hence the transects were run vertically in order to effectively sample oiled mussels. This limits some comparisons of samples from this bed with samples from other beds, but accomplished the overall goal of sampling the bed chemically.

Table 10 lists the sampling pattern (regime) for each site. Pooled samples taken along the transect are not shown.

TABLE 10. Sampling pattern for each site.

SAMPLING ZONE REGIME *		
SITE	BELOW	ABOVE
MOM-1	1 - 2	1 - 2
MCM-1	1 - 3	1 - 3
WM-2A	1 - 2	1 - 2
CNM-1	1 - 6	1 - 4
RBM-1	1 - 3	1 - 2
WM-3A	1 - 3	1 - 3
PM-1	2	2
WM-1A	1 - 2	1 - 2
TBM-1**	1	1
TBM-2	1	1
TBM-3	1 - 2	1 - 2
TBM-4	1	1
TBM-5	2 - 4	2 - 4

* Distances in feet; range of maximum distances from the mid transect.
** Transect oriented perpendicular to water's edge.

Potential Sampling Sites for Future Study

Table 11 lists other potential sites in the Gulf of Alaska. These sites have not been sampled but have been identified as possibly having moderately to densely packed oiled mussel beds (see text).

Table 11. Potential oiled mussel sites in the Gulf of Alaska not sampled by this study.

LOCATION	BEACH SEGMENT	LAND MANAGER
Aialik Peninsula, Pony Cove	AI003A	NPS
Chugach Bay, N.W. shore	CB003B	Pt. Graham
Chugach Bay, S. shore	CB004B	Pt. Graham
Chugach Bay, N. shore	CBO03C	Pt. Graham
Nuka Island, N.E.(Site 1-MAYSAP)	NK001A	ADNR
Nuka Island, N.E.(Site A1-MAYSAP)	NK002A	ADNR
Nuka Island, N.E.(Site A2-MAYSAP)	NK002A	ADNR
Rocky Bay, Rocky Point	RB001A	ADNR
Rocky Bay, Rocky Point	RB001B	ADNR
Tonsina Bay (Site A3-MAYSAP)	TB002A	ADNR
Tonsina Bay (Site A1-MAYSAP)	TB002A	ADNR
Tonsina Bay, Long Island Cove	TB005B	ADNR
Alinchak Bay, North cove	K1002AS007A	USFWS

Additional Site Information

Additional detailed site information is included in the following appendices:

Appendix D: Site summaries for sampled sites. Contained in Appendix D are the site summaries for each of the 13 sites sampled this summer (See Table 7). Transect data with references cited and treatment history are included in tables. Detailed site description and mussel/oiling conditions are included as well as reference maps.

Appendix E: Reconnaissance of sites visited but not sampled. Included in this list are sites visited but not on the original priority list. Recommendations are included for sites that might possibly meet sampling criteria (Table 9).

Appendix F: Information and recommendations for sites not visited, but originally on the priority list. Recommendations for further considerations are included here and these sites are listed in Table 9.

DISCUSSION

We have documented that the presence of 12 mussel beds along the Kenai Peninsula and Alaska Peninsula contain petroleum hydrocarbon levels in sediments in excess of 500 ug/g wet weight oil equivalents. Nine of these mussel beds show sediment petroleum hydrocarbon levels in excess of 1700 ug/g wet weight oil equivalents.

Concentrations of oil equivalents varied greatly not only among sites, but also with respect to the general pattern of oiling within sites there is no clear trend within a bed in the location of the greatest concentration of oil. These chemical analyses generally reinforce the visual observations that oiling in mussel beds is highly variable.

The relationship to contamination in directly underlying sediments at selected sites will be clarified when GC-MS mussel analyses become available.

STATUS OF SAMPLE ANALYSES

Costs for this project were held down by utilizing a UV fluorescence (UVF) screening of sediments to select mussel and sediment samples for detailed analysis by gas chromatography/mass spectroscopy (GC/MS).

At this time all sediments have been screened and selected sediment and mussel samples will be analyzed later this year at NOAA's Auke Bay Lab by GC/MS.

The final report will include presentation of all chemical analyses and discussion of the relationship between oil contamination in mussels and underlying sediments, and the degree of weathering of the oil in the samples.

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APPENDICES

Appendix A
Selected form samples of a completed SCAT report

SHORELINE OIL EVALUATION

Date: 31 July 89 Time: 1702 - 2037 Observer: Mann

Surveyed From: Foot/Boat/Helio/Plane Weather: Sun/Cloud/Rain/Snow/Fog

LOCATION

LOCATION north shore of McArthur Pass SEGMENT NUMBER MM R-1

LENGTH OF SHORELINE SEGMENT: 9 Km (5.7 miles)

ACCESS: Foot/Vehicle/Boat/Barge/Helio/Float Plane

SHORELINE:

Shoreline Type: SPI/SEA/COV/HLD/STRT Slope: LANG/HANG/VER

Wave Exposure: High/Med/Low

Sediment: B 24 % / C 1 % / P 1 % / G 0 % / S 0 % / M 0 % / R 75 %

Drift Debris on Beach: Yes/No Supra/Upper/Mid/Lower Type —

OIL

Degree of Oiling: Heavy/Moderate/Light/No Oil/Unobserved

Area of Beach Impact: SU / SP / I / M / L

Continuous: Y/N % of Segment 10 Width of Band: 0.5 - 4 m

Sporadic: Y/N % of Segment 90

Est. Oil Thickness where > 1cm: 5 cm Est. Oil Penetration: 10 cm

Pooled Oil: 1 % "Free" Oil: 0 % Coated: H 25 % / M 50 % / L 25 %

Fresh 0 % Mousse 25 % Tar Formation: 75 %

Drift Debris Oiled ? Yes/No Supra/Upper/Mid/Lower Amount: H/M/L

Comments:

This is a bedrock shoreline with occasional areas of boulders. Subsidence of several meters occurred during the 1964 earthquake putting trees into the intertidal zone. There is easy access for barges (except on the exposed shores along McCarty Fjord). Only site A is recommended for cleanup. This site appears to have been oiled relatively recently (in last 2 months) judging by the limited extent of wave-clearing on the beach. A surprisingly large amount of mousse

ECOLOGICAL EVALUATION

LOCATION: Rye Islands, McArthur Pass SITE: North shore OBSERVER: M. Fawcett

LOCATION PREFIX: M.R SEG. NO.: 1 LENGTH: 9000 (M)

DATE: 31 Jan 89 TIME (HHMM): 1700-2037 TIDE HT.: +1.2 to +1.6 (M)

OILED ZONE: Splash (High) (Medium) Low

SUBSTRATUM: (Rocks) (Boulder) (Cobble) Gravel Sand Mud

LIVE BIOTA

Fucus (algae): (Patchy) Y/N Contin. Y/N (Dense) Y/N Sparse Y/N None Y/N

Mytilus (Mussels): (Patchy) Y/N Contin. Y/N (Dense) Y/N Sparse Y/N None Y/N

Balanus (Barnacles): (Patchy) Y/N Contin. Y/N (Dense) Y/N Sparse Y/N None Y/N

Littorina
(Patchy) Y/N Contin. Y/N (Dense) Y/N Sparse Y/N None Y/N

Limpets: (Patchy) Y/N Contin. Y/N Dense Y/N (Sparse) Y/N None Y/N

OTHER OBSERVATIONS: Pisaster ochraceus abundant, especially at more exposed area to the west

CLEANUP PRECAUTIONS: No constraints on cleanup at site A. A stream enters at site A, but is not suitable for anchoring.

MAMMALS: Otters ___ Harbor Seals ___ Sea Lions ___ Whales ___
Other ___

BIRDS: 1 eagle, GW Gulls, ~100 kittiwakes nesting at Point

GENERAL OBSERVATIONS: Most of segment consists of vertical rock faces

Appendix B
Selected form samples of a completed SSAT report

SHORELINE ECOLOGICAL SUMMARY

REVISION: 3/22/90

Segment ST/ WB 9 Subdivision A Date (mo / day / yr) 4/7/90

Time (24 hr) 1540-1700 Biologist M. Fawcett

(A) Substrate type and % of segments:
(1) Bedrock 60 (2) Boulder 20 (3) Cobble 5 (4) Pebble 5 (5) Sand 10 (med. gravel) (6) Silt 0

(B) Overall % cover of biota (% of segment): Dense ✓ Moderate ___ Low ___

(C) Density, substrate preference (by number from A, above), & vertical zonation of major taxa: (upper-U; mid-M; low tidal-L); juveniles / adults (X) , new settlement (③)

Photographs:
Roll No. ST-1-5
Frames 6-9-14

BARNACLES

Dense			Moderate			Sparse			Rare			
1U	1M	1L	1U	1M	1L	1U	1M	1L	1U	1M	1L	
②	③	2	③	2	X	2	2	2	2	2	2	
3	X	3	X	3	3	3	3	3	3	3	3	NOT PRESENT
4	4	4	4	4	4	4	4	4	4	4	4	
5	5	5	5	5	5	5	5	5	5	5	5	
6	6	6	6	6	6	6	6	6	6	6	6	

MYTILUS

Dense			Moderate			Sparse			Rare			
1U	1M	1L	1U	1M	1L	1U	1M	1L	1U	1M	1L	
2	2	2	2	X	2	2	2	X	2	③	2	
3	3	3	3	X	3	3	3	X	3	3	3	NOT PRESENT
4	4	4	4	4	4	4	4	4	4	4	4	
5	5	5	5	5	5	5	5	5	5	5	5	
6	6	6	6	6	6	6	6	6	6	6	6	

GASTROPODS

Dense			Moderate			Sparse			Rare			
1U	1M	1L	1U	1M	1L	1U	1M	1L	1U	1M	1L	
2	2	2	2	X	2	③	2	X	2	2	2	
3	3	3	3	X	3	X	3	3	3	3	3	NOT PRESENT
4	4	4	4	4	4	4	4	4	4	4	4	
5	5	5	5	5	5	5	5	5	5	5	5	
6	6	6	6	6	6	6	6	6	6	6	6	

FUCUS

Dense			Moderate			Sparse			Rare			
1U	1M	1L	1U	1M	1L	1U	1M	1L	1U	1M	1L	
2	2	2	2	X	2	2	2	X	2	2	2	
3	3	3	3	X	3	3	3	X	3	3	3	NOT PRESENT
4	4	4	4	4	4	4	4	4	4	4	4	
5	5	5	5	5	5	5	5	5	5	5	5	
6	6	6	6	6	6	6	6	6	6	6	6	

Wildlife Observations/ General Comments:

1 eagle, mature
2 white-winged scoters

see attached sheet

Ecological Considerations:

55 - bird concentration area

WB 9 M.H. Fawcett 4/7/90

Wildlife Observations & Comments

The boulder field on the west side of the island had considerable surface oil remaining in the middle and upper intertidal areas. Below the main oiled zone there is a dense bed of mussels and a well developed community including Fucus, littorines, limpets (Notoacmea scutum). Some sheen was seeping landward into the mussel bed.

On the northeast (exposed) side of the island and on around to the southwest side the small brown acorn barnacle (Chthamalus dalli) has recently settled in vast numbers blanketing the upper and middle shore levels from about +3 to +11 ft, mainly on vertical faces and large boulders. I also observed one small patch (~20 x 40 cm) of newly settled mussel spat on the NE side. There are dense beds of juvenile mussels (3-12 mm) as well, mainly on the north and east sides. Large anemones (Tealia), chitons Katharina and limpets (N. scutum) are common in the low intertidal zone on the north and east sides of the island.

Appendix C
Selected form samples of a completed MAYSAP report

MAYSAP FIELD SHORELINE COMMENT SHEET

TEAM NO. 4 SEGMENT PY 003 SUBDIVISION B DATE May 16 91

ADEC
NAME Clara S. Crosby SIGNATURE Clara S Crosby

☐ NTR ☒ TREATMENT RECOMMENDED.
There are 3 subdivisions within this Seg. which could be worked on in conjunction with one another to remove 'Hot Spots' of surface oiling. These are B, C & E I have seen crews work on areas of comparable with less accessible oil & recover a significant portion. Recommended treatment is manual removal - hand crews - All 3 subdiv. should take less than one day.

EXXON
NAME George P. Stiles SIGNATURE George P. Stiles

☒ NTR The patches of MS at the southern most end of this segment were partially worked. (18 bags) during the survey. The MS is in the boulder cracks and around the edges of the large boulders. Further cleanup would be difficult due to the boulder size and would recover a very insignificant amount of weathered oil.

LANDMANAGER
NAME JOHN P. HARNOTTER OF USFWS SIGNATURE John P. Harnotter 5/16/91

☒ NTR Pockets of oil remain from previous cleanup operations. Some of this oil was removed during the survey. The remainder would be difficult to remove and an insufficient amount would be recovered for time expended. Thus, further cleanup is not recommended.

USCG/NOAA
NAME CWO2 J. McMahon SIGNATURE [signature]

☑ NTR
What Oil remains is highly inaccessible. Cleanup measures would be excessively costly in view of the insignificant contribution.

WITH [illegible]

MAYSAP SHORELINE OILING SUMMARY

TEAM NO. 4

SEGMENT PV-002

SUBDIVISION 3

OG [illegible] BIO J. Barry

ADEC Crosby LANDMANAGER Headrick for USFWS

DATE MAY / 16 / 91

EXXON George P. Stiles USCG/NOAA McMahon / McDonald

TIME 07 : 20 to 08 : 20 TIDE LEVEL +2.5 ft. to -0.7 ft. ENERGY LEVEL: [X] H [ ] M [ ] L

SURVEYED FROM: [X] FOOT [X] BOAT [ ] HELO WEATHER: [ ] SUN [X] CLOUDS [ ] FOG [X] RAIN [ ] SNOW

TOTAL LENGTH SHORELINE SURVEYED: 966 m NEAR SHORE SHEEN: [ ] BR [ ] RB [ ] SL [X] NONE

EST. OIL CATEGORY LENGTH: W ___ m M 8 m N 2 m VL 366 m NO 690 m US – m

LOC	SURFACE OIL CHARACTER AP	MS	TB	SOR	CV	CT	ST	FL	DB	NO	SURFACE SEDIMENT TYPE	SHORE SLOPE VHML	AREA WIDTH m	AREA LENGTH m	ZONE S	UI	MI	LI	NOTES
A1		T			T	T	T				Bould	H	1	200		X			See map
A2		P			T	T					"	"	4	8		X			"
A3		P				T							2	8		X			"
A4		S			T	T					"		1	166		X			"
A5		S									"		1	10		X			

DISTRIBUTION: C = 91–100%; B = 51–90%; P = 11–50%; S = 1–10%; T = <1%

SLOPE: V = VERTICAL; H = HIGH ANGLE; M = MEDIUM ANGLE; L = LOW ANGLE PHOTO ROLL # MAYSAP- 4-4-1 to 4 FRAMES ___

PIT NO.	PIT DEPTH (cm)	SUBSURFACE OIL CHARACTER OP	HOR	MOR	LOR	OF	TR	NO	OILED ZONE cm-cm	CLEAN BELOW Y/N	H2O LEVEL (cm)	SHEEN COLOR BRSN	PIT ZONE S	UI	MI	LI	SURFACE-SUBSURFACE SEDIMENTS	NOTES
	No pits		boulders on bedrock															

SHEEN COLOR: B = BROWN; R = RAINBOW; S = SILVER; N = NONE

OG COMMENTS: See map. Long segment of steep bedrock with boulder talus. Oiling confined to the southern end of the segment as patches of MS around base of boulders. Partly picked up as indicated on map. Access difficult due to slope and

MAYSAP BIOLOGICAL SUMMARY FORM

TEAM #	4	DATE/TIME	May 16, 1991 0720 - 0820
SEGMENT #	PY008	TIDAL HEIGHT (Range)	+2.5 => -0.9
SUBDIVISION	B	BIOLOGIST	JIM BARRY
SEA STATE	Calm	WIND SPEED/DIRECTION	Calm, cloudy

COMMENTS / OBSERVATIONS - OILED SUBDIVISIONS

A1 Oil at this location is splatter in the high upper intertidal zone along a boulder talus shore. Black lichen and scattered limpets, as well as a few littorine snails are the only biota very near the oiled area. Barnacles, limpets, littorine snails, and ephemeral red and green algae become abundant slightly below the oiled area (ca 1-2 ft). Fucus is moderately to densely abundant in the mid-to-low shore. Mussels are less abundant in this inner portion of the bay and form patches in crevices from mainly in the middle zone. The low intertidal has abundant red and green algae, with dense brown algae in the subtidal.

Manual pickup was performed (completed?) at this site. Additional manual removal, if performed, would not negatively impact the biota at this location.

A2 Oil (CT,MS) at this location occurs in the upper intertidal zone and extends towards the middle intertidal zone. Black lichen is the most abundant conspicuous species very near the oil on this boulder/cobble talus shore. Limpets and littorine snails are present in sparse to moderate patches, with some individuals found directly on the oil. Small patches of dead mussels are partially to completely buried by the oil, and are likely a remnant of the initial impact of the spill. Live mussels are present in crevices in the boulder talus, with small adults and moderate densities of juveniles, mostly at tidal levels below the oiled area. Fucus is sparsely distributed on boulders near the oiled area, and is more abundant in the middle to lower zone. Red and green algae are dense in the low shore, with dense cover of kelps in the subtidal.

Manual pickup was performed at this site during the survey. Additional manual pickup will not harm the biota at the site.

(continued)

WILDLIFE OBSERVATIONS - Completed on all subdivisions

BIRDS	# OF SPECIES	TOTAL BIRDS	FISH OBSERVED SPECIES PRESENT
Eagles	1	1	
Seabirds			
Waterfowl			
Gulls/Kittiwakes	2	30	
Shorebirds	1	1	
Corvids	1	2	
Other Birds			

MARINE MAMMALS	# OBSERVED	LAND MAMMALS - SPECIES	# OBSERVED
Sea Otters			
Pinnipeds (specify)			
Whales (specify)			

Shoreline subdivision map showing important biological features attached.

Initials 5/23/91 C.W.

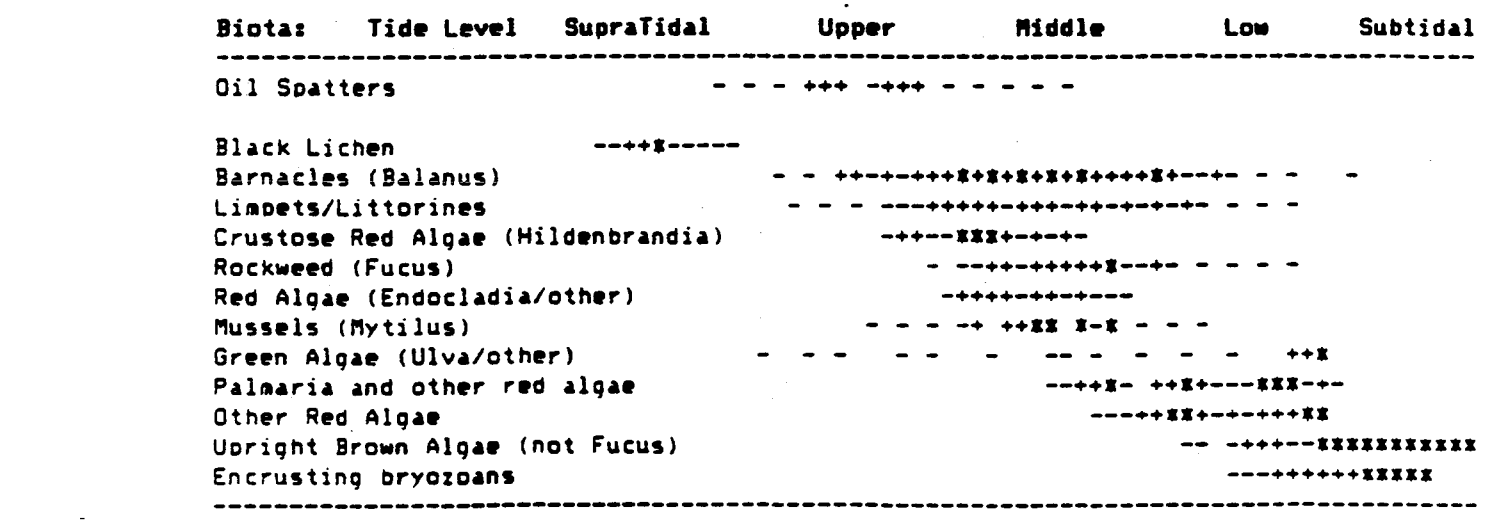
A3,A4 This oiled site (MS) extends occurs in the upper and middle zone. Biota near the oiled area is similar to A2, with black lichen in the highest oiled area, and more typical intertidal species, such as limpets, littorine snails, barnacles, and Fucus, in the middle zone area. Mussels also are sparsely to moderately abundant in the oiled area. Crustose red algae (Hildenbrandia) is abundant on many boulders near the oiled area and is in direct contact with oil. All of these species are found in direct or nearly direct contact with the oiled sediments, though their abundances are appear to be slightly greater in adjacent non-oiled areas. Nevertheless, the site appears to be quite 'healthy', in that all of the major species are present in all life stages. The algal community below the oiled area has dense red and green algae, with dense brown algae in the subtidal. Many invertebrates are abundant from the upper to the lower zone. In particular, the bryozoan Schizoporella sp. is very abundant under low zone cobble.

Some manual pickup was performed at this site. Additional cleanup, if recommended will not have negative impacts on the biota at the site.

Miscellaneous Observations

An adult bald eagle picked a dead kittiwake from the water and ate it in a nearby tree. Two other dead gulls were seen on the water.

General Zonation Pattern along PY008-B



Legend: (-) Sparse to rare, (+) Moderate, (*) Abundant

List of Species from PY008-B

A. Marine Plants

1. Diatoms, Blue Greens
2. Green Algae - Chlorophyta
   Cladophora sp., Enteromorpha sp., Prasiola meridionalis, Ulva sp., Urospora sp.
3. Brown Algae - Phaeophyta
   Alaria marginata, Ectocarpus sp., Fucus distichus, Hildenbrandia sp., Laminaria groenlandica, Ralfsia sp., Syctosiphon lomentaria

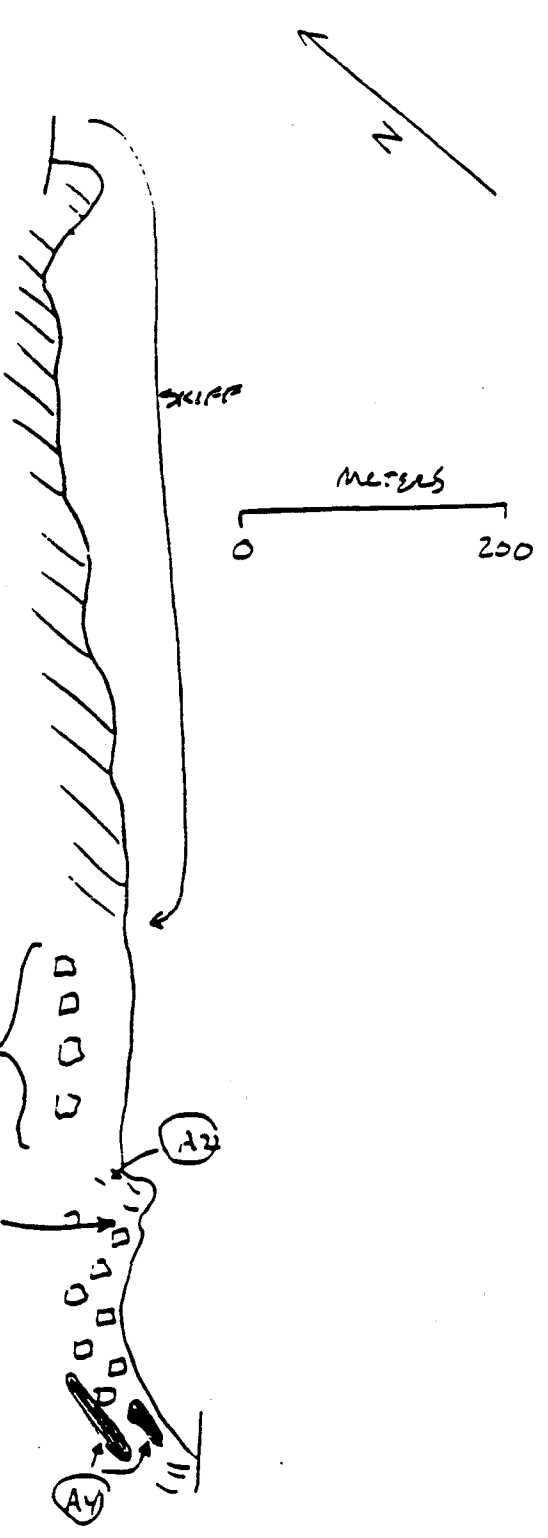
PY008-B Biology Summary, continued

4. Red Algae - Rhodophyta
   Bangia fuscopurpurea, Endocladia muricata, Halosaccion glandiforme, Lithothamnion sp., Membranoptera dimorpha, Odonthalia floccosa, Palmaria palmata, Petrocelis sp., Porphyra sp., Rhodomela larix
5. Higher Plants - Leymus mollis (beach rye grass)

II. Marine Animals
1. Sponges - Porifera - Halichondria bowerbanki?
2. Anemones - Anthopleura artemesia, Epiactis prolifera?, Metridium senile, Urticina crassicornis,
6. Nemertean Worms - Ribbon Worms - Emplectonema gracile
8. Polychaete Worms
   Glyceridae
   Nepthyidae
   Nereidae - Nereis spp.
   Serpulidae - Serpula sp., Crucigera sp., Eudistylia polymorpha
   Spriorbidae - Spirorbis sp.
9. Peanut worms - Sipunculids - Phascolosoma agassizii
10. Crustaceans
   a. Amphipods - Orchestia sp.?, Traskorchestia traskiana
   b. Barnacles - Balanus glandula, Semibalanus cariosus
   c. Crabs - Haplogaster sp., Paguridae (hermit crabs)
   d. Isopods - Cirdana harfordi, Idotea wosnesenskii, Gnorimorsphaeroma oregonensis
11. Mollusca
   a. Chitons - Cryptochiton stelleri, Mopalia sp., M. mucosa, Katharina tunicata, Tonicella lineata,
   b. Snails - Gastropods
      Littorina sitkana, L. keenae, Nucella lamellosa, N. lima, Searlesia dira
   c. Limpets - Lottia digitalis, L. persona, Tectura fenestrata, T. persona, T. scutum, Siphonaria thersites
   e. Bivalves - Chlamys hastata, Mytilus edulis, Pododesmus cepio
12. Echinoderms
   a. Brittle Stars - Ophiolus aculeatus?, Ophiothrix spiculata?, Amphipholis?
   b. Sea stars - Crossaster papposus, Dermasterias imbricata, Henricia leviuscula, Leptasterias hexactis, Orthasterias keonleri, Pisaster ochraceus, Pycnopoida helianthoides, Solaster dawsoni,
   c. Sea Cucumbers - Holothurians - Eupentacta sp.
   d. Urchins - Strongylocentrotus droebachiensis
13. Bryozoans - Membranipora sp., Microporina borealis, Schizoporella sp.
14. Ascidians - Synocium? sp., Aplidium?
15. Fishes
   Cottidae -
   Stichaeidae - Xiphister atropurpureus, X. mucosus

IV. Birds - Bald Eagle (1), Glaucous-winged Gull (15), Black-legged Kittiwake (15), Western Sandpiper (5), Fox Sparrow (2), Crow (1)

10 SKETCH MAP P4008-B JP Barclay MAY 16 1991 0720 - 0820	Legend Steep bedrock / talus Large Boulders / talus / Steep Bedrock



A1 [cr, cu, ms]
BLACK LICHEN, SCATTERED LIMPETS & BARNACLES NEAR OIL. STEEP BOULDER TALUS SHORE WITH FUCUS, BARNACLES, MODERATE TO SPARSE PATCHES OF MUSSELS IN CRUVICES. DENSE RED & GREEN ALGAE IN LOW SHORE. BROWN ALGAE IN SUBTIDAL

A2 (ms, cr, cu)
BLACK LICHEN, BARNACLES, LITTORINES, LIMPETS - ALL SPARSE SOME OF THESE FOUND DIRECTLY CONTACTING OIL. SOME DEAD MUSSELS, PROBABLY FROM THE INITIAL SPILL, JUVENILE MUSSELS, BARNACLES, LITTORINES, LIMPETS. LOWER ZONE - DENSE RED, GREEN ALGAE. BROWN ALGAE IN SUBTIDAL

A3, A4 - SIMILAR TO A2 - BLACK LICHEN, LIMPETS, SNAILS, BARNACLES, SOME IN CONTACT WITH OIL. MUSSELS ALSO NEAR, AND IN CONTACT WITH, OIL (SPARSE PATCHES). RICH ETC INTERTIDAL BELOW. FUCUS, RED, GREEN ALGAE ABUNDANT BELOW.

Appendix D
Site summaries for sampled sites

SEGMENT: TB-003A **TRANSECT:** TBM-1 **DATE:**06/08/92		
OBSERVERS: Cusick, Schoch		
LOCATION: Tonsina Bay, N.W. Bayhead, N.E Quadrant, Site F (MAYSAP).		
REFERENCES: SSAT, MAYSAP		
TREATMENT HISTORY:1989-Manual treatment, Bioremediation(Type?) 1990-Manual treatment, tarmat removal, Bioremediation(Type?) 1991-Manual clean-up(1/2 bag SOR).		
LAT/LONG: 59°18'33"N, 150°57'05"W		
TIME: 1200-1300	**TIDE:** +3.49ft - +1.78ft	**FILM:**Roll 6
TRANSECT LENGTH:12m	**BEARING:** 101° True	**WEATHER:**Lt.Rain

SITE DESCRIPTION:

Transect TBM-1 was orientated perpendicular to the waters edge within the mid-intertidal zone of a gentle sloping tidal flat in the northeastern quadrant of the northwest corner of Tonsina Bay (Figure A). Located 38 meters and bearing 228° True from the middle of the transect was a tree marked with a Bioremediation treatment warning sign and marker (DEC #50981). Composition of sediment bed is angular/sub-angular pebbles and sand armored by scattered cobble. Transect was placed in the middle of a 13m X 5m patch of surface oil residue (SOR) corresponding to subdivision F on the MAYSAP sketch map (Figure B). An excellent intertidal summary of TB-003A can be found in the MAYSAP.

MUSSEL/OILING CONDITIONS:

Many barnacle covered cobble were scattered throughout the area, lying on top of the parent substrate and when these cobble were turned over, chocolate colored/shiny mousse was exposed. These "semi-mobile holdfasts" were also partially covered with mussels and Fucus, but seemed to be inactive in containing the oil surrounding them. Mussels also were found clinging onto the parent substrate amongst free floating Fucus mats and were in direct contact with oiled sediments. A higher concentration of dead mussels were seen lying on the sediment than on the cobble "holdfasts".

Oil at this location is best described as soft tarmat with entrenched sand and organics. Brown, dark brown/black mousse on the surface and immediately below the surface was found in patches throughout the area. Site had visible rainbow and silver sheens in footprints and overturned sediment exuded odor. Typically the oil was concentrated in raised "spurs" that were orientated perpendicular to the water edge and contained fewer fucus mats and living organisms than the lower areas. Probable cause for this phenomena is that oil entrenched sediments seem to cement together and better withstand wave erosion and deposition than the non oiled areas, causing this "spur and groove" formation.

SEGMENT: TB-003A **TRANSECT:** TBM-2 **DATE:**06/08/92		
OBSERVERS: Cusick, Schoch		
LOCATION: Tonsina Bay, N.W. Bayhead, N.E. Quadrant, Site F (MAYSAP).		
REFERENCES: SSAT, MAYSAP		
TREATMENT HISTORY:1989-Manual treatment, Bioremediation(Type?) 1990-Manual treatment, tarmat removal, Bioremediation(Type?) 1991-Manual clean-up (1/2 bag SOR).		
LAT/LONG: 59°18'33"N, 150°57'02"W		
TIME: 1310 - 1400	**TIDE:**+1.78ft - +1.00ft	**FILM:** Roll 6
TRANSECT LENGTH:30m	**BEARING:** 223° True	**WEATHER:**Lt.Rain

SITE DESCRIPTION:

Transect TBM-2 was orientated parallel with the waters edge within the mid-intertidal zone of a gentle sloping tidal flat in the northeastern quadrant at the head of Tonsina Bay (Figure A). Located 31 meters and bearing 353° True from the middle of the transect was a tree marked with a Bioremediation treatment warning sign and marker (DEC #50981). Since work was conducted during an ebbing tide this site was placed 10 meters seaward of the first transect (TBM-1) and was observed to be a better site for impacted mussels because of higher concentrations of oil and mussels. Area of survey corresponds to subdivision F on the MAYSAP sketch map (Figure B).

Sediment composition is angular/sub-angular pebbles and sand with scattered cobble armor.

MUSSEL/OILING CONDITIONS:

Similar to TBM-1, barnacle and mussel covered cobble were scattered over oil entrenched sediments. These cobble holdfasts accommodated most of the living mussels while many dead mussels were found entrenched within oiled sediments. Scattered mobile Fucus were observed throughout the area. Weathered mousse, surface oil residue (SOR) and sheen (silver and rainbow) were observed along transect and overturned cobble exposed brown/dark brown mousse and a pungent oil odor. Typically the mousse was concentrated in raised "spurs" that were orientated perpendicular to the water edge and contained fewer fucus mats and living organisms than the lower areas.

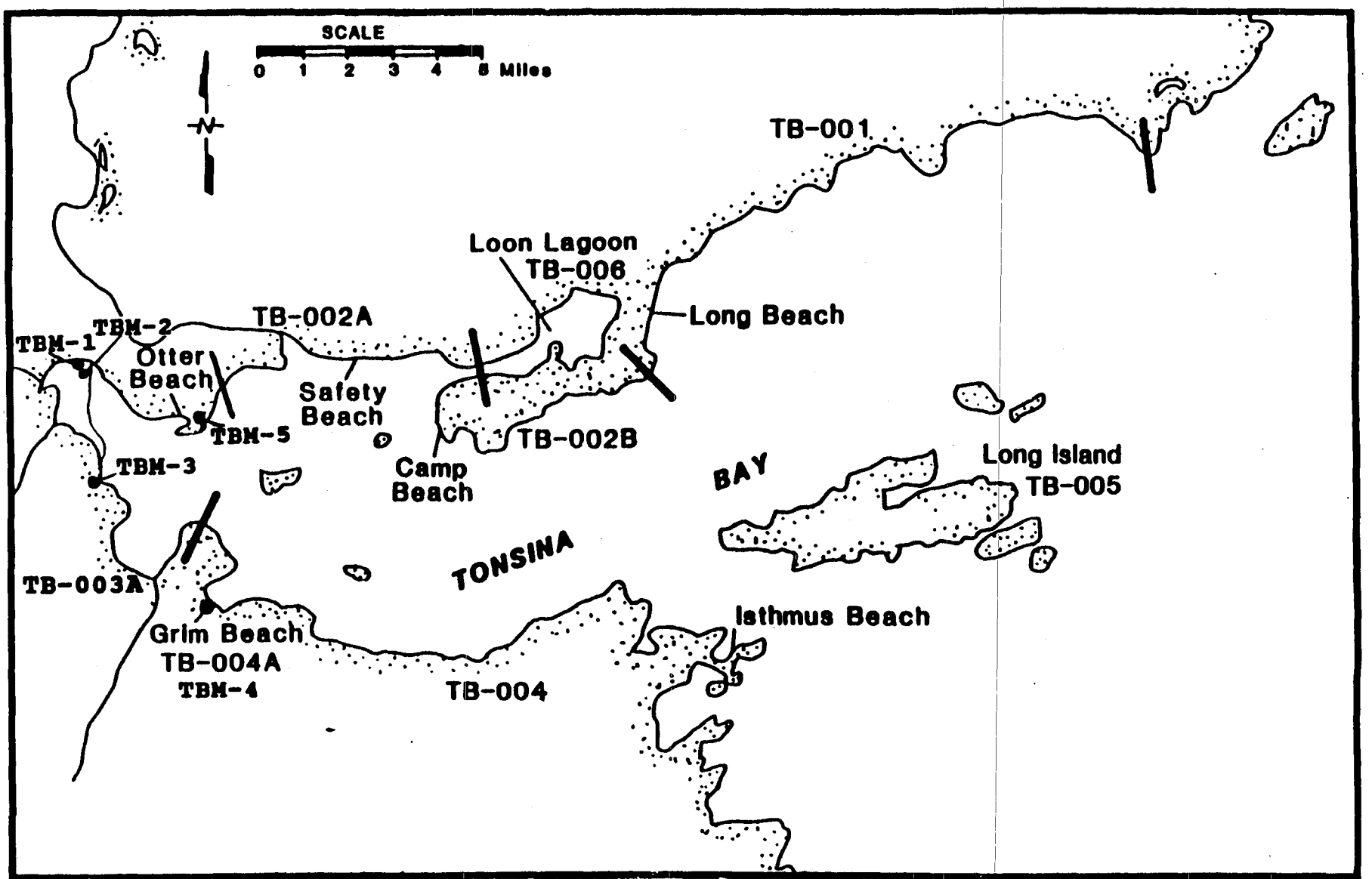


Figure A. Tonsina Bay oiled mussel transect locations (at●), Gulf of Alaska.

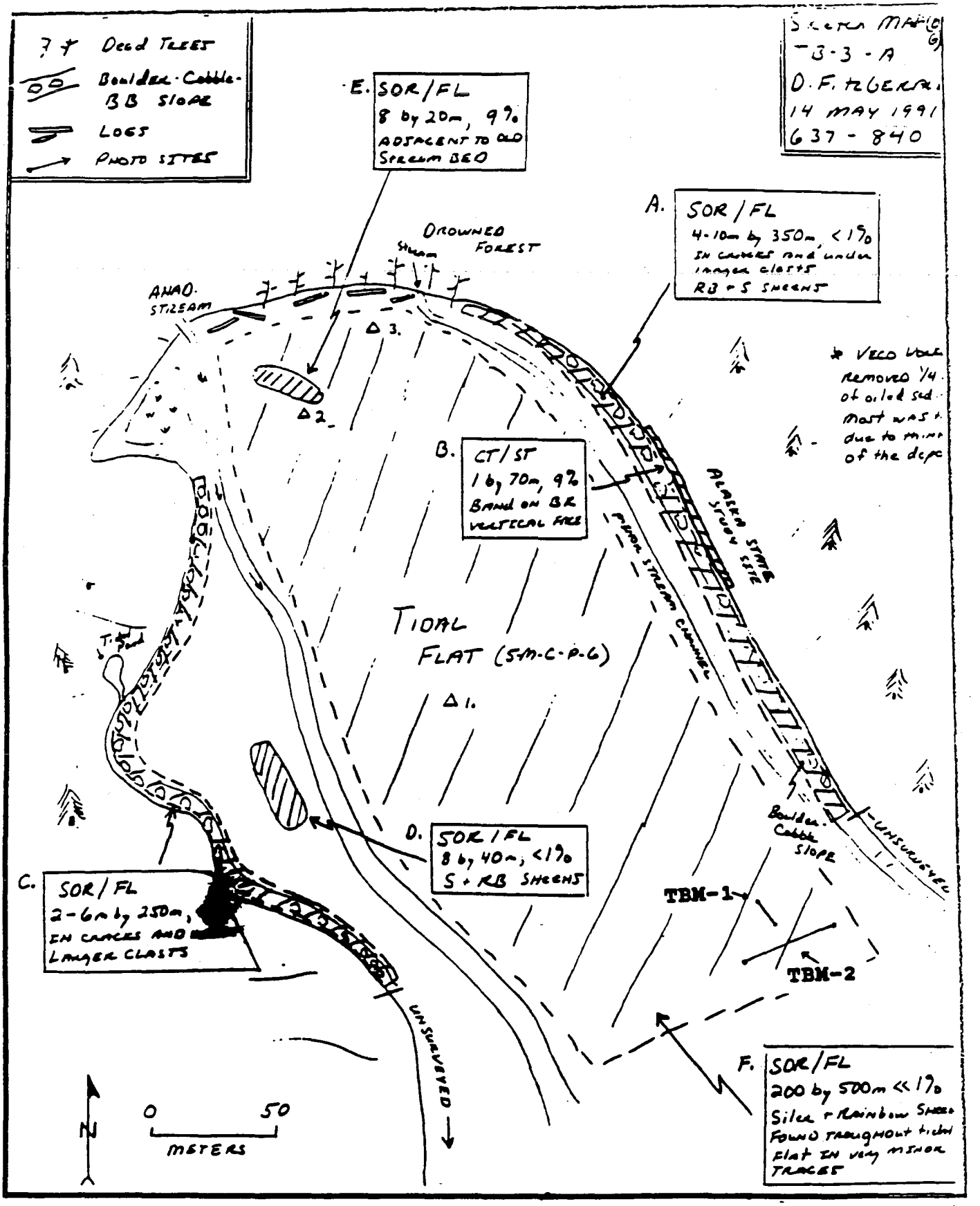


Figure B. Oiled mussel transects TBM-1, TBM-2, northwest corner of Tonsina Bay, Gulf of Alaska. EVOS segment TB-003A.

SEGMENT: TB-003A **TRANSECT:** TBM-3 **DATE:** 06/08/92		
OBSERVERS: Cusick, Schoch		
LOCATION: Tonsina Bay, N.W. Bayhead, South shore		
REFERENCES: SSAT, MAYSAP(unsurveyed)		
TREATMENT HISTORY:1989-Manual treatment, Bioremediation(Type?) 1990-Possible tarmat removal.		
LAT/LONG: 59°18'39"N, 150°56'58"W		
TIME: 1600 - 1700	**TIDE:**+3.04ft - +5.08ft	**FILM:** Roll 6
TRANSECT LENGTH:20m	**BEARING:** 353° True	**WEATHER:**Lt.Rain

SITE DESCRIPTION:

Transect TBM-3 was located in a small pocket beach at the southwestern end of Tonsina Bay, approximately 100 meters west of TBM-1 and TBM-2 (Figure A). This particular beach with a eastern exposure and 20° slope was not surveyed in the MAYSAP but was categorized as narrow oiling in 1990 (SSAT). The 20 meter transect was placed parallel with the waters edge amongst a low angle cobble and boulder area and directly below a large standing dead spruce tree marked with a Bioremediation treatment warning sign (Figure C).

MUSSEL/OILING CONDITIONS:

Even during this relatively poor low tide series the beach at this site was exposed enough to observe moderate to light densities of mussels lying under and amongst angular cobble and bonded to entrenched sand. Scattered mobile Fucus clumps. Some mussels along the transect had to be accessed by moving large cobble. Unweathered and shiny chocolate mousse was found under nearly all of the sampled mussels in conjunction with a distinct oil odor. Extensive sheens (silver and rainbow) and floating brown mousse were observed in several of the sampling pits.

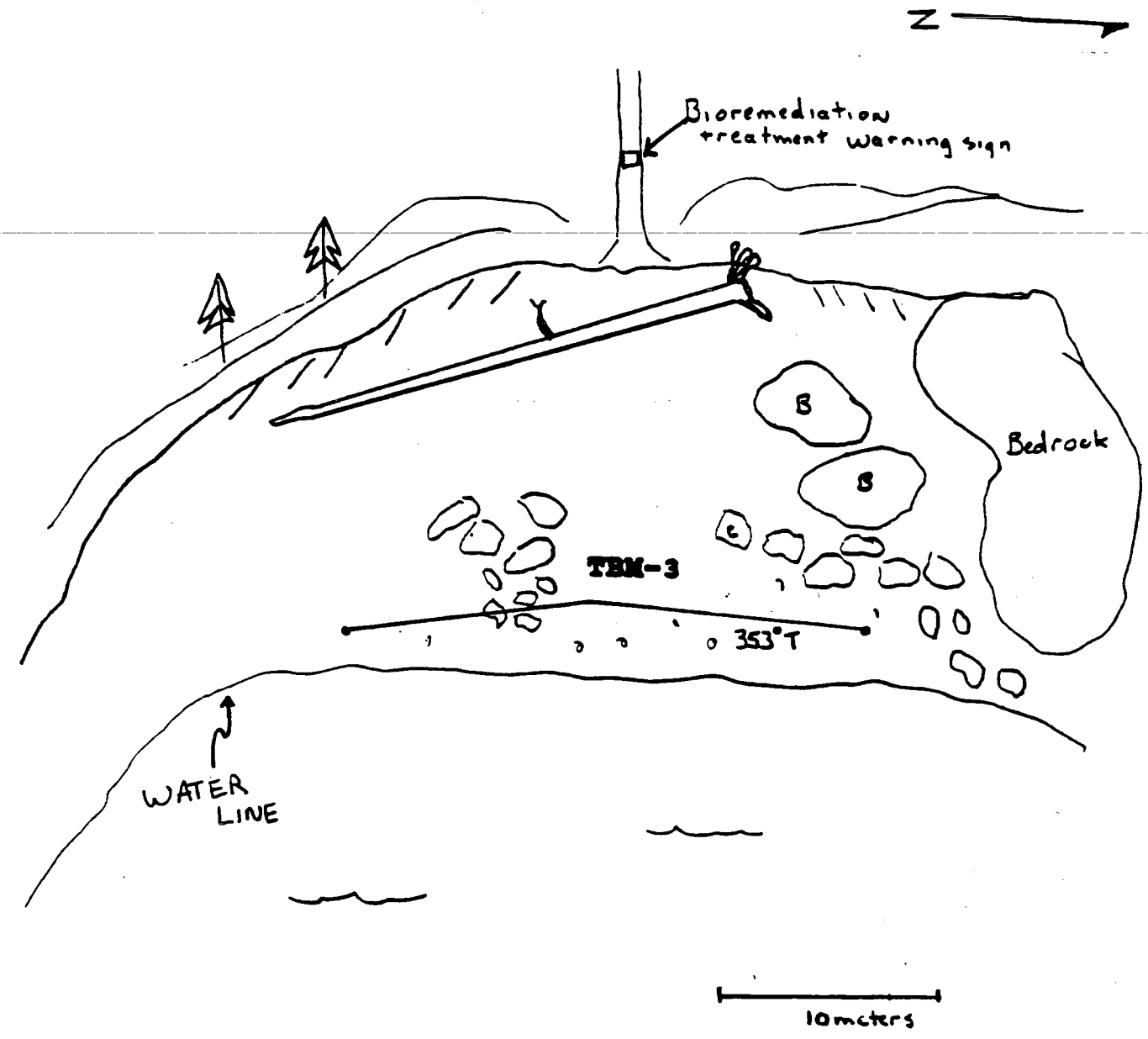


Figure C. Oiled mussel transect TBM-3, southwest, Tonsina Bay, Gulf of Alaska. EVOS segment TB-003A.

SEGMENT: TB-004A **TRANSECT:** TBM-4 **DATE:** 06/23/92		
OBSERVERS: Cusick, Crosby, Schoch		
LOCATION: Tonsina Bay, Grim Beach, ADEC station #312-T, ADFG Intertidal Biota Transect, Site A3(MAYSAP).		
REFERENCES:SSAT, ASAP, DEC Daily Beach Survey Report(7/23/90) MAYSAP, ADFG memo(Dudiak,Middleton,Crosby,5/30/91),ADEC transect data(ADEC,1992), ADFG Intertidal Biota Study(Dudiak, Middleton, 1991).		
TREATMENT HISTORY:1989-manual removal, mechanical treatment, Bioremediation. 1990-manual removal, cold water wash, Fucus removal, Customblen application. 1991-manual cleaning and tilling, Customblen application.		
LAT/LONG: 59°18'09"N, 150°56'34"W		
TIME: 1340 - 1408	**TIDE:** +2.48ft - +2.56ft	**FILM:** Roll 3
TRANSECT LENGTH:30m	**BEARING:** 143° True	**WEATHER:**Cloudy

SITE DESCRIPTION:

Grim Beach is known as the most heavily oiled beach in Tonsina Bay and one of the most severely impacted in the Homer Region (Clara Crosby, Personal Communication, 1992). Also known to contain a dense mussel bed, there have been reports generated as to clean-up considerations for the mussel bed. Jim Barry's Biological Summary (MAYSAP) contains a thorough description of the mussel bed as well as clean-up options. In response to these options a memo was sent to the State TAG representatives from ADFG Habitat Biologists Norma Dudiak and Jane Middleton, containing comments and information from their intertidal biota transect data taken in 1989 and 1990 (ADFG, 1991). Refer to the ADFG "Study of Intertidal Biota on Treated Beaches on the Outer Coast of the Kenai Peninsula" (Dudiak and Middleton, 1991) for a complete history of oiling conditions, treatments and biota found at this site.

Transect TBM-4 traverses oiled site A3 (MAYSAP) at the mid-intertidal zone (Figures A and D). The area had been visibly disturbed as indicated by areas where Fucus had been removed and sediment scoured. Sediment composition varied along the 30 meter transect with the majority of the mussel mat covering angular cobble, pebble and gravel clasts.

Because of our limited tidal window, sampling was conducted at water's edge. Sampling of mussels between 2m and 8m was suspended since area was under water.

MUSSEL/OILING CONDITIONS:

Majority of mussels connected to angular cobble with sizes ranging from 3cm to 4cm in length. Fucus cover moderately dense and discontinuous. Continuous surface oil residue entrenched within granule/pebble clasts and underneath mussel mat. Floating oil globules and silver sheens on nearly all sampling pits. Sheening observed on incoming tide.

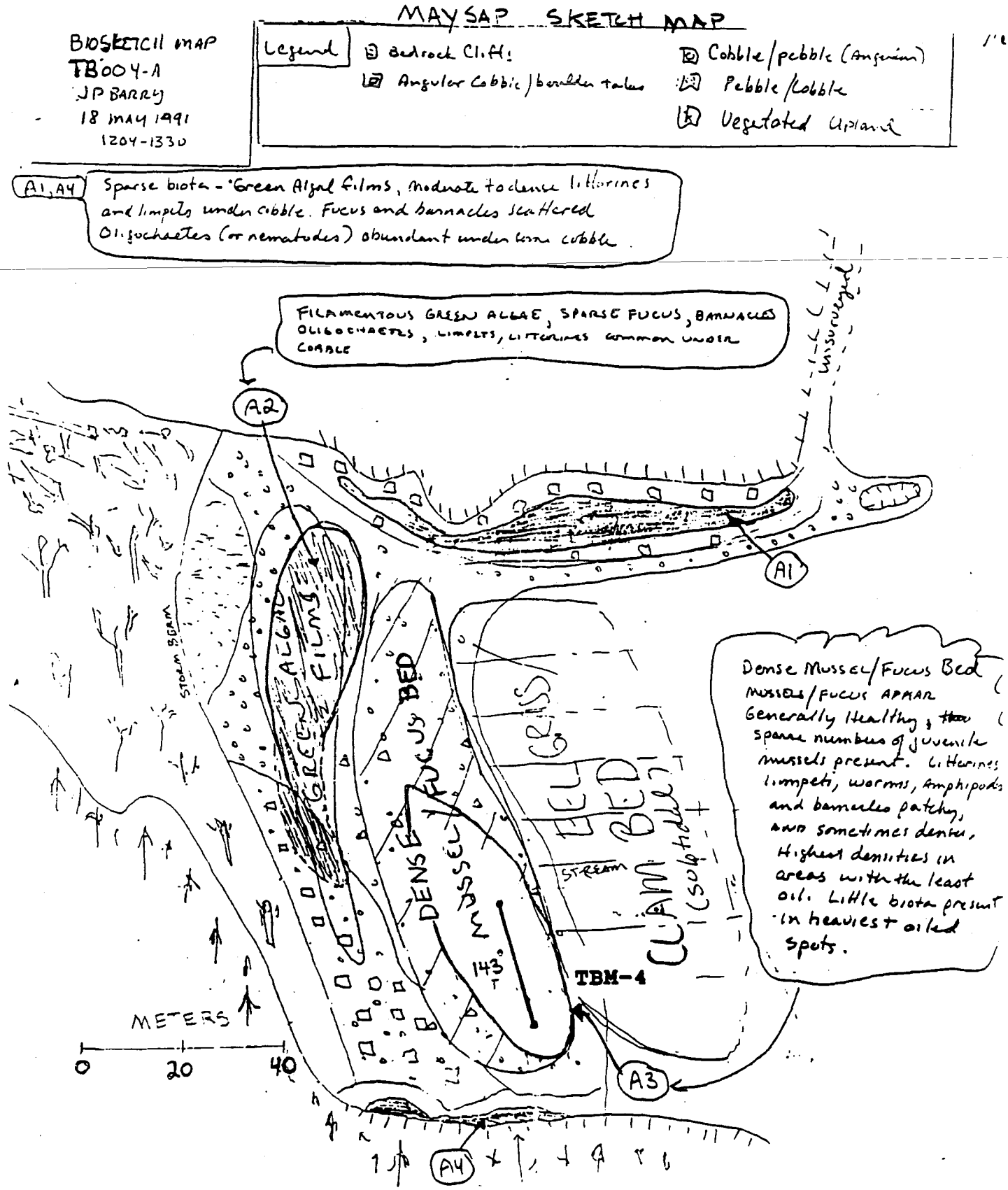


Figure D. Oiled mussel transect TBM-4 on Grim Beach, Tonsina Bay, Gulf of Alaska. EVOS segment TB-004A.

SEGMENT: TB-003A **TRANSECT:** TBM-5 **DATE:** 06/23/92		
OBSERVERS: Cusick, Crosby, Schoch		
LOCATION: Tonsina Bay, Otter Beach, Site A2(MAYSAP)		
REFERENCES:MAYSAP		
TREATMENT HISTORY:1989-manual treatment, Bioremediation ? 1990-manual treatment, Bioremediation ?. 1991-manual clean-up.		
LAT/LONG: 59°18'30"N, 150°56'41"W		
TIME: 1436 - 1510	**TIDE:** +2.98ft - +3.55ft	**FILM:** Roll 4
TRANSECT LENGTH:24m	**BEARING:**1st leg-198°T 2nd leg-139°T	**WEATHER:**Cloudy

SITE DESCRIPTION:

Transect TBM-5 is located on the east facing beach of a small point directly across from Grim Beach on the northwest shoreline of Tonsina Bay (Figure A). Locally known as Otter Beach and just west of the segment border for TB003A, the transect was placed within oiled site A2 as noted in J.M. Semples sketch map for the joint-agency MAYSAP (Figure E). Sediments were generally poorly sorted; granules and sand mixed within an organic matrix with large to small sub-angular to rounded pebbles and scattered boulders.

Transect line was bent at 10m to encompass greatest concentration of mussels and oiled sediments (Figure F). First pooled sampling conducted below the tape due to encroaching tide, followed by sampling along the tape and then above tape.

Raven observed dropping and breaking mussel shells from nearby tree and consuming contents.

MUSSEL/OILING CONDITIONS:

Medium sized mussels (2cm-3cm) were moderately dense throughout transect. Extremely dense Fucus covered majority of mussels. Underlying mussels in most sampling pits, were anaerobic muds and surface oil residue with a pungent sulfur/oil odor. Subsurface oil mixed with sand and organics down to 2cm. Silver and rainbow sheen present under Fucus cover and in sampling pits.

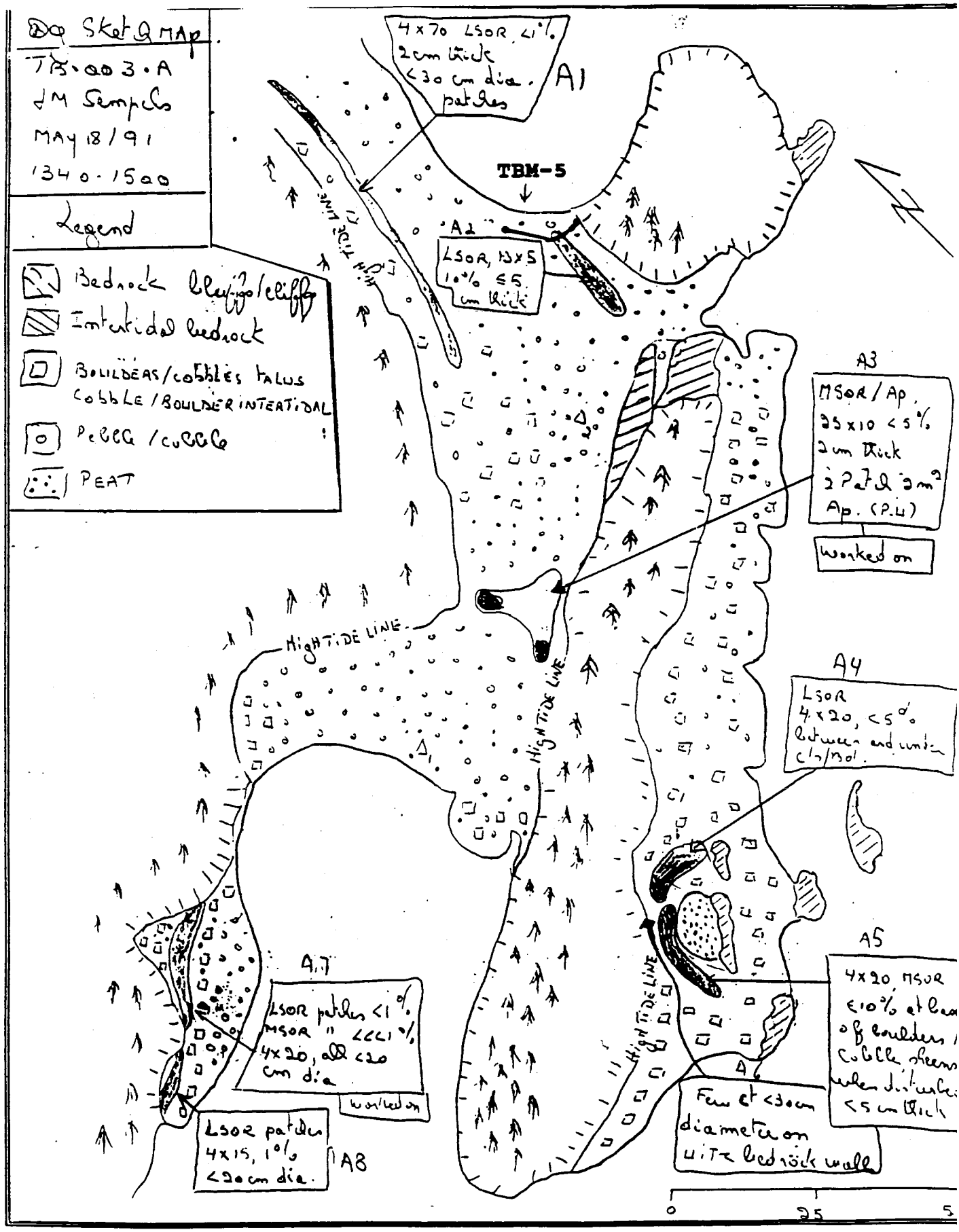


Figure E. Oiled mussel transect TBM-5 on east facing Otter Beach, Tonsina Bay, Gulf of Alaska. EVOS segment TB-003A.

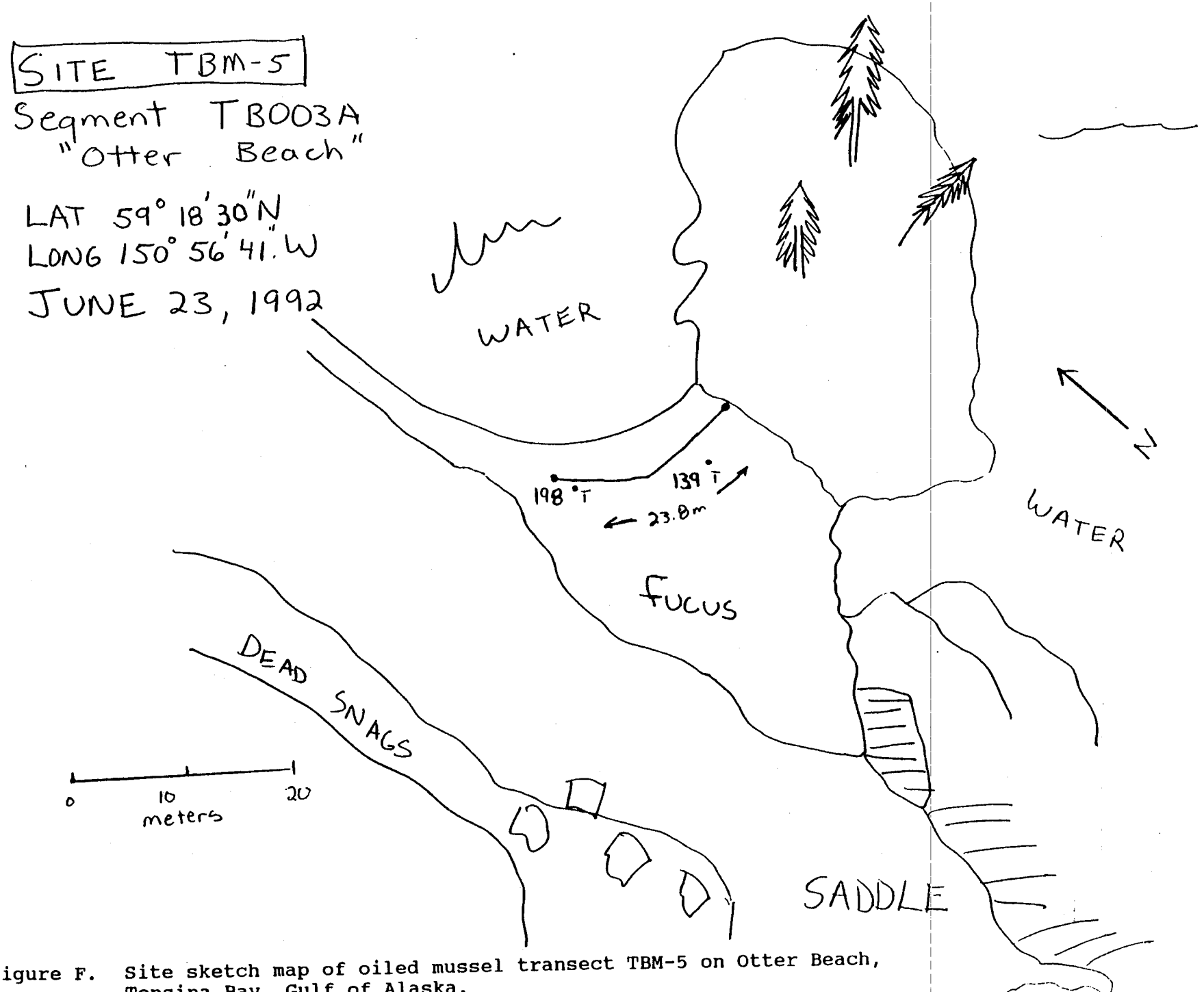


Figure F. Site sketch map of oiled mussel transect TBM-5 on Otter Beach, Mangina Bay, Gulf of Alaska.

SEGMENT: PY-008B **TRANSECT:** MOM-1 **DATE:** 06/10/92		
OBSERVERS: Cusick, Schoch		
LOCATION: Pye Islands, Ragged Island, Morning Cove, S.W.corner, Site A2 (MAYSAP).		
REFERENCES: ADEC Post-Treatment Survey Report(09/15/89), MAYSAP		
TREATMENT HISTORY: 1989-Inipol Application(08/15/89), Hot water wash, Manual treatment and pickup. 1990 - ?; 1991-Manual treatment - not completed.		
LAT/LONG: 59°27'05"N, 150°19'41"W		
TIME: 1627 - 1730	**TIDE:** +2.68ft - +3.44ft	**FILM:** Roll 7
TRANSECT LENGTH: 21m	**BEARING:** General- E to W	**WEATHER:** Sunny

SITE DESCRIPTION:

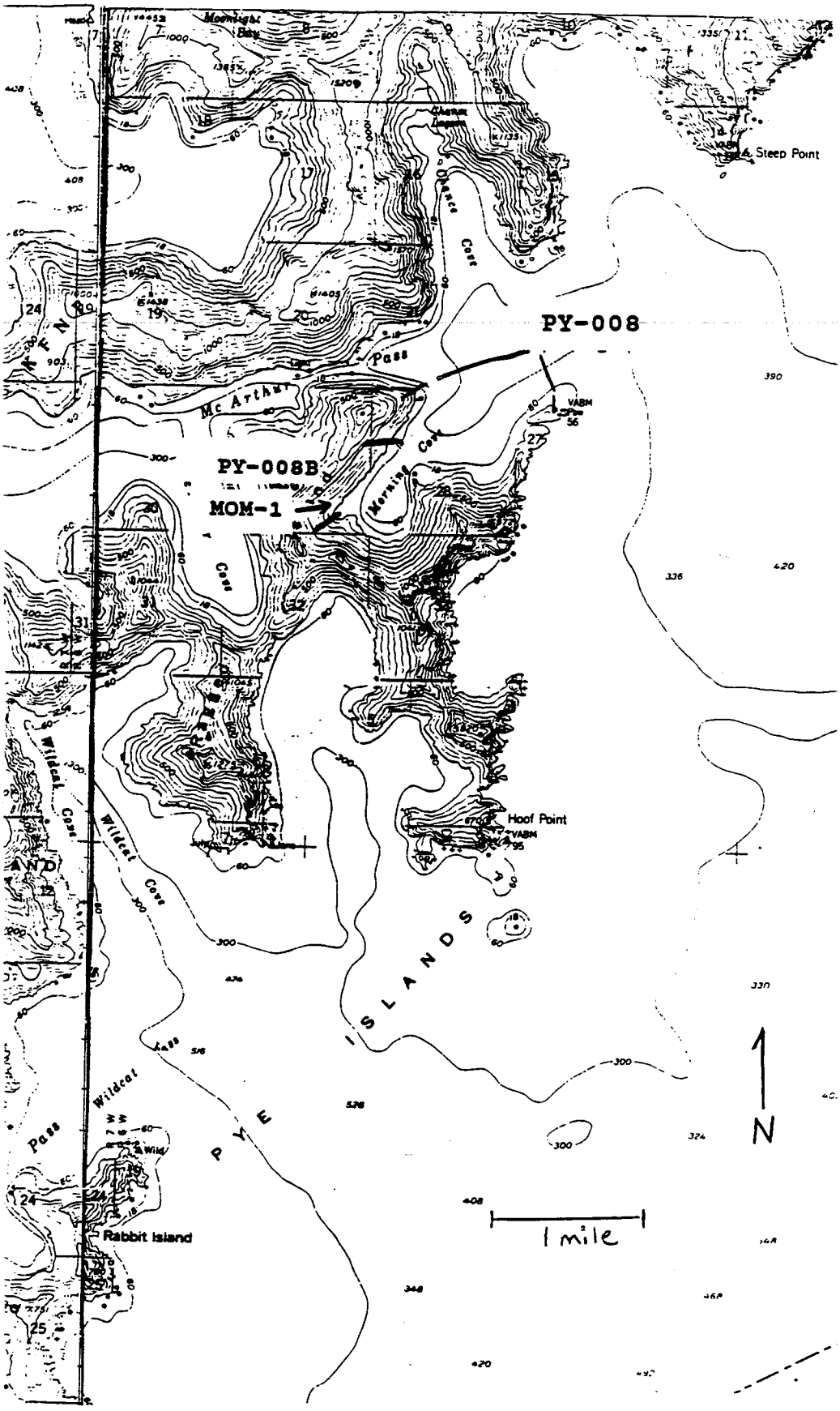
Morning Cove is located on the northeast corner of Ragged Island, within the Alaska Maritime National Wildlife Refuge - Pye Island Archipelago (Figure G). The transect was located along a bedrock saddle or low lying channel, landward of a huge boulder which makes a point on the southwest corner of Morning Cove. This site was designated Subdivision A2 on J.M Semples sketch map - MAYSAP (Figure H). The transect was bent in two places to include the greatest concentrations of oil residue and mussels amongst large boulders and bedrock (Figure I). The parent substrate was bedrock with thin deposits of broken barnacle shells and organic material lying in crevices. An excellent intertidal summary of PY008B can be found in the MAYSAP.

MUSSEL/OILING CONDITIONS:

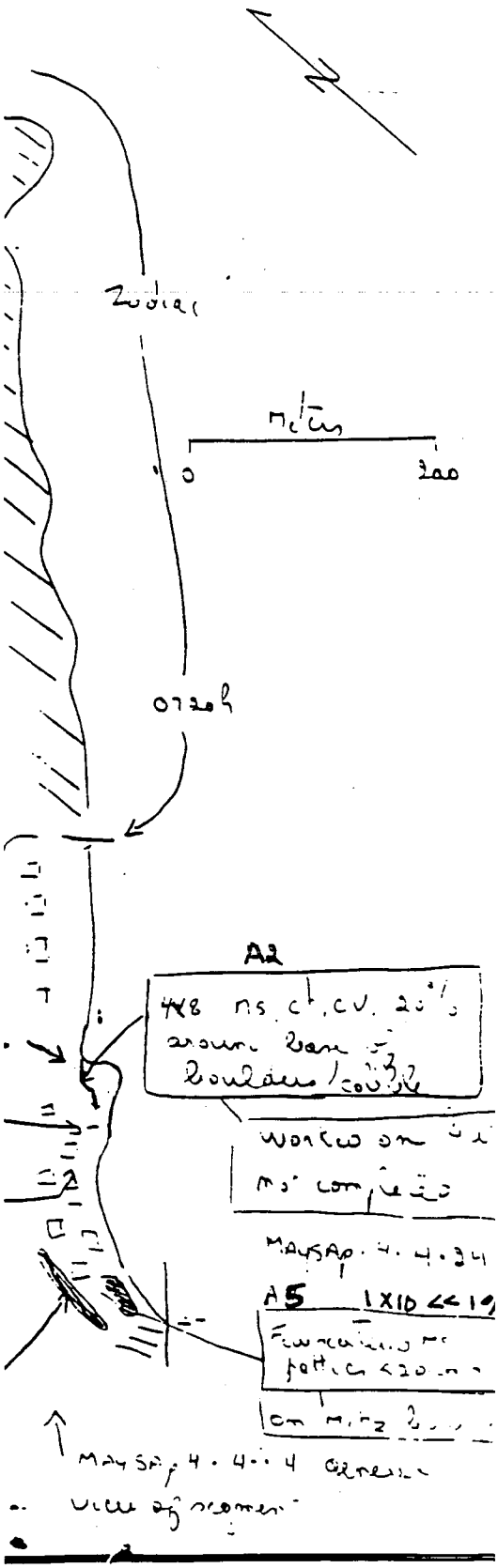
Patches of mussels were found clumped together and bonded to these deposits and amongst the edges of six small tidal pools within bedrock depressions.

All of these tidal pools contained a diversity of life (limpets, snails, barnacles, sculpins). Rainbow and silver sheens were noted on the pool surfaces. Most heavily impacted areas were in boulder/bedrock crevices where cobble/pebble were stuck in the tar/mousse and acting as support for mussels. Dead mussels and shells were abundant in areas with direct contact with dark brown/black tarmat patties along bedrock crevices, while nearby mussels seem to be thriving. Located 2 cm below most living mussels was a layer of mousse.

Unique at this site however, was that even though these mussels were attached to bedrock or immediately above the bedrock surface, there was a significant amount of sediment (crushed shells, sand granules and organic debris) entrenched below and within the byssal threads. A typical "trowel flip" consisted of slipping the trowel between bedrock and byssal mat and turning over the mussels and exposing the oiled substrate. Average mussel size was 2cm-3cm with some mussels up to 4cm long.



1 location of oiled mussel transect MOM-1, Morning Cove, lands, Gulf of Alaska. EVOS segment PY-008B.



of oiled mussel transect Gulf of Alaska. EVOS

Site MOM-1
Segment PY-008B
Morning Cove
LAT 59° 27' 05" N
LONG 150° 19' 41" W
June 10, 1992

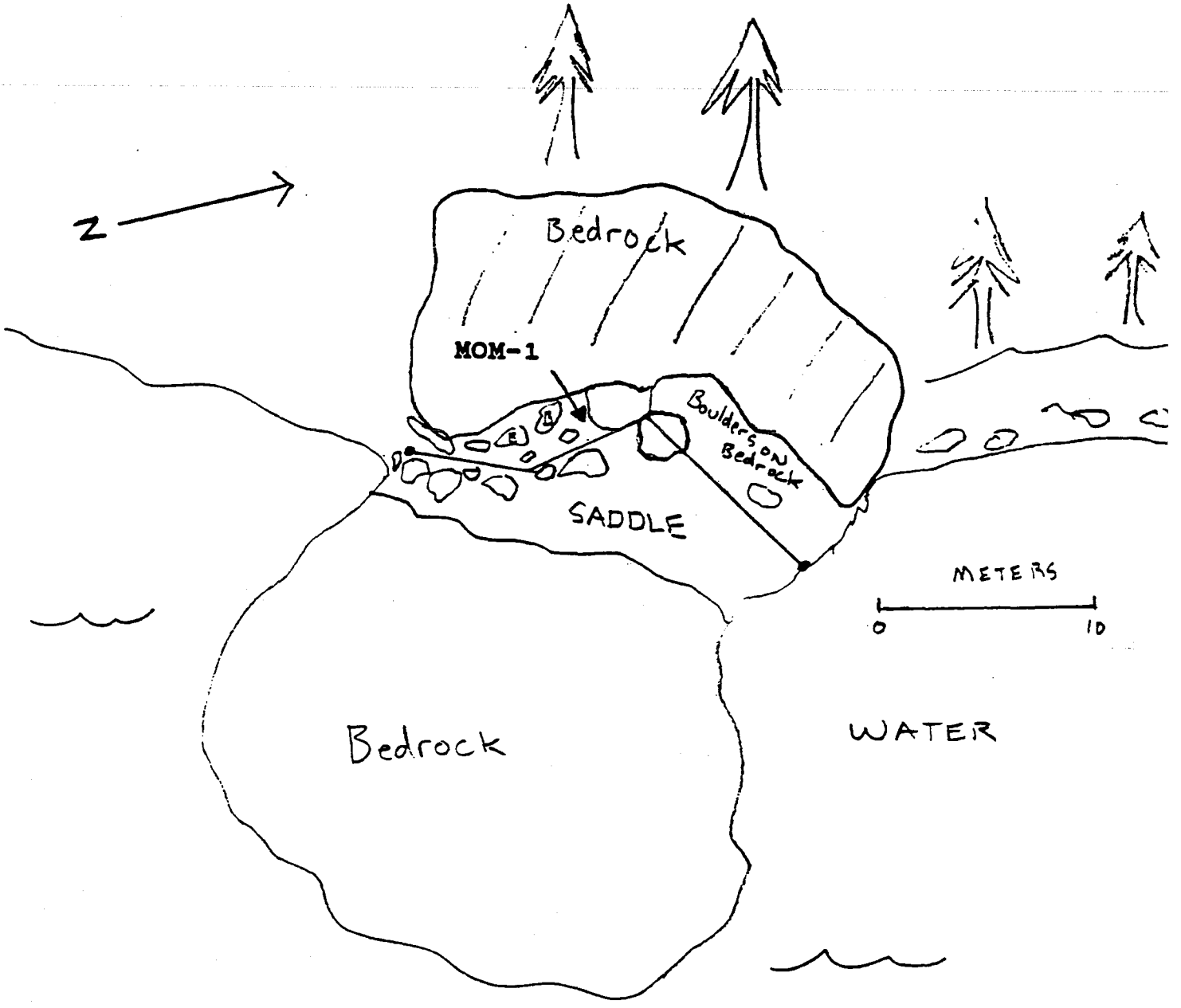


Figure I. Site sketch map of oiled mussel transect MOM-1, Morning Cove, Pye Islands, Gulf of Alaska. EVOS segment PY-008B.

SEGMENT: WB-009A **TRANSECT:** WM-1A **DATE:** 06/21/92		
OBSERVERS: Cusick, Crosby, Schoch		
LOCATION: Windy Bay, Oystercatcher Island, West Pocket Beach NOAA Hazmat site #WNB3, ADEC station #319-T, ADFG Intertidal Biota transect(Dudiak and Middleton, 1991).		
REFERENCES: SSAT,ASAP,MAYSAP,NOAA Hazmat Map, ADEC Transect Data(ADEC 1992), ADFG Inter-tidal Biota Study(Dudiak and Middleton, 1991).		
TREATMENT HISTORY:1989-Manual cleaning(07/17/1989, 07/20/1989) 1990-Manual removal/tilling. Inipol/Customblen applications. 1991-Manual removal.		
LAT/LONG: 59°13'31"N, 151°30'43"W		
TIME: 1000 - 1045	**TIDE:**+3.24ft - +1.90ft	**FILM:** Roll 1
TRANSECT LENGTH:27m	**BEARING:**1st leg-333° T 2nd leg-310° T	**WEATHER:**Cloudy

SITE DESCRIPTION:

The survey site is located on Oystercatcher Island, the small eastern-most island at the mouth of Windy Bay (Figure J). Approximately 40 meters wide, the west facing beach gently slopes and is primarily composed of sub-angular pebble, cobble and small boulder surface sediment. Subsurface sediment includes peat, clay, sand and granule clastics. Bedrock outcrops on both sides of the beach provide a sheltered environment by dissipating wave energy (ADEC, 1992). Biota on this site was reported to be dense and abundant (Dudiak and Middleton 1991).

It became apparent upon landing that significant weathering had occurred since the joint-agency MAYSAP conducted their survey in 1991. In order to encompass the heaviest oil/mussel concentration and sample in a similar area to the NOAA Hazmat study site - WNB3, it was decided to place the transect in the mid-intertidal zone parallel to the waters edge (Site A2-MAYSAP). The transect begins on the northeast side of Site A2 (MAYSAP) and continues through the mid to lower extent of the mussel bed, then makes a turn to the northwest at 22.6 meters and ends at 27 meters where the substrate changes from cobble to large boulder. Two maps are shown for this site: Figure K shows the transect superimposed on the MAYSAP sketch map for WB-009A, while Figure L shows the transect superimposed on the NOAA Hazmat Subsistence Study Map for WNB3.

MUSSEL/OILING CONDITIONS:

The mussel concentration at this site was observed as moderate with many dead and empty mussel shells comprising a large portion of the surface sediments. Mussels were found to be attached to sand granules and pebble within cobble interstices. Silver sheen observed on surface of a pool in the middle of the transect. Heaviest oiling comprised of scattered tarmat patties occurring above the transect which incorporated the sampling regime for the third pooled sample at this site. Local scarified appearance of the sediment bed was observed especially in the first three meters of the transect.

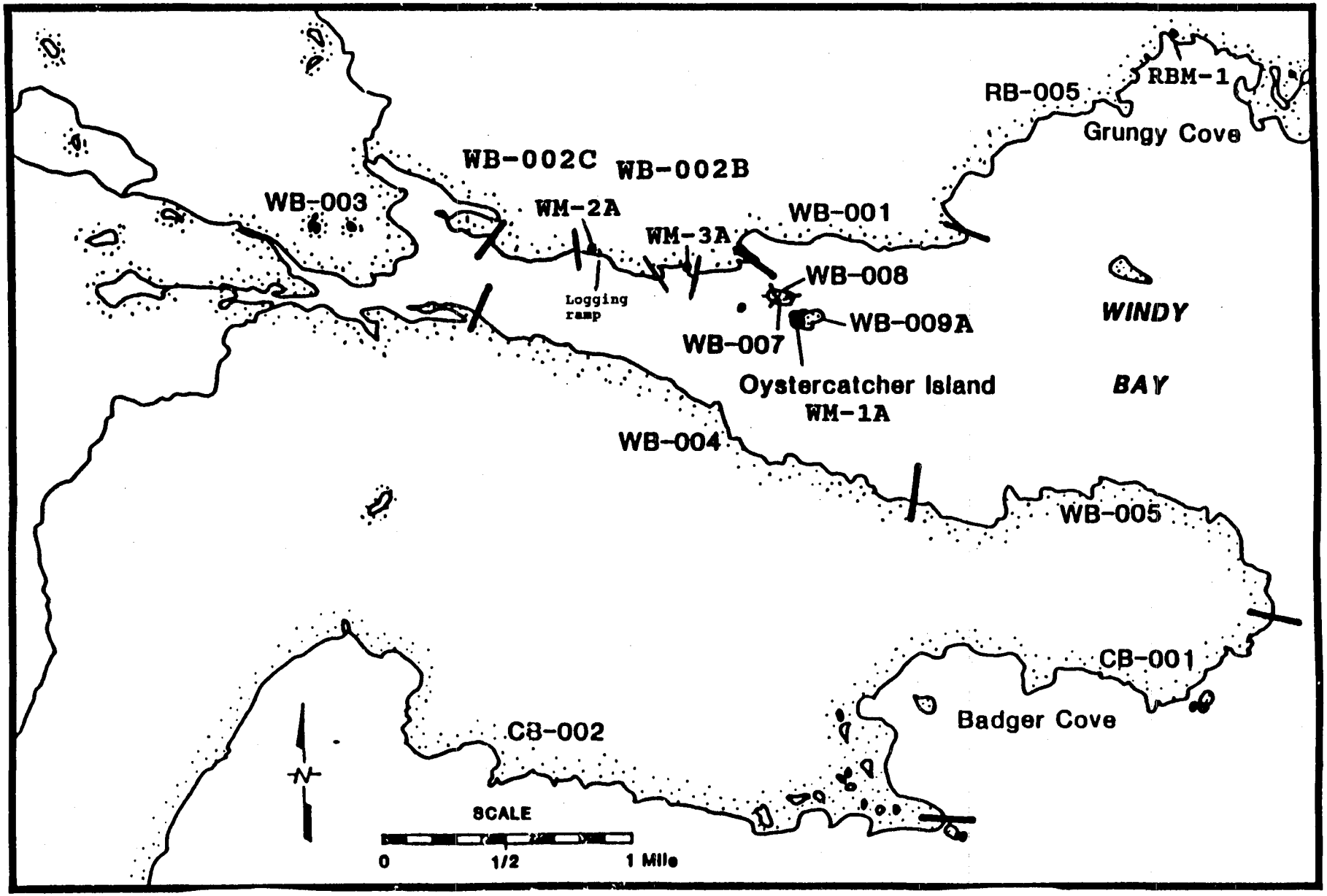


Figure J. Windy Bay and Rocky Bay oiled mussel transect locations (at●), Gulf of Alaska.

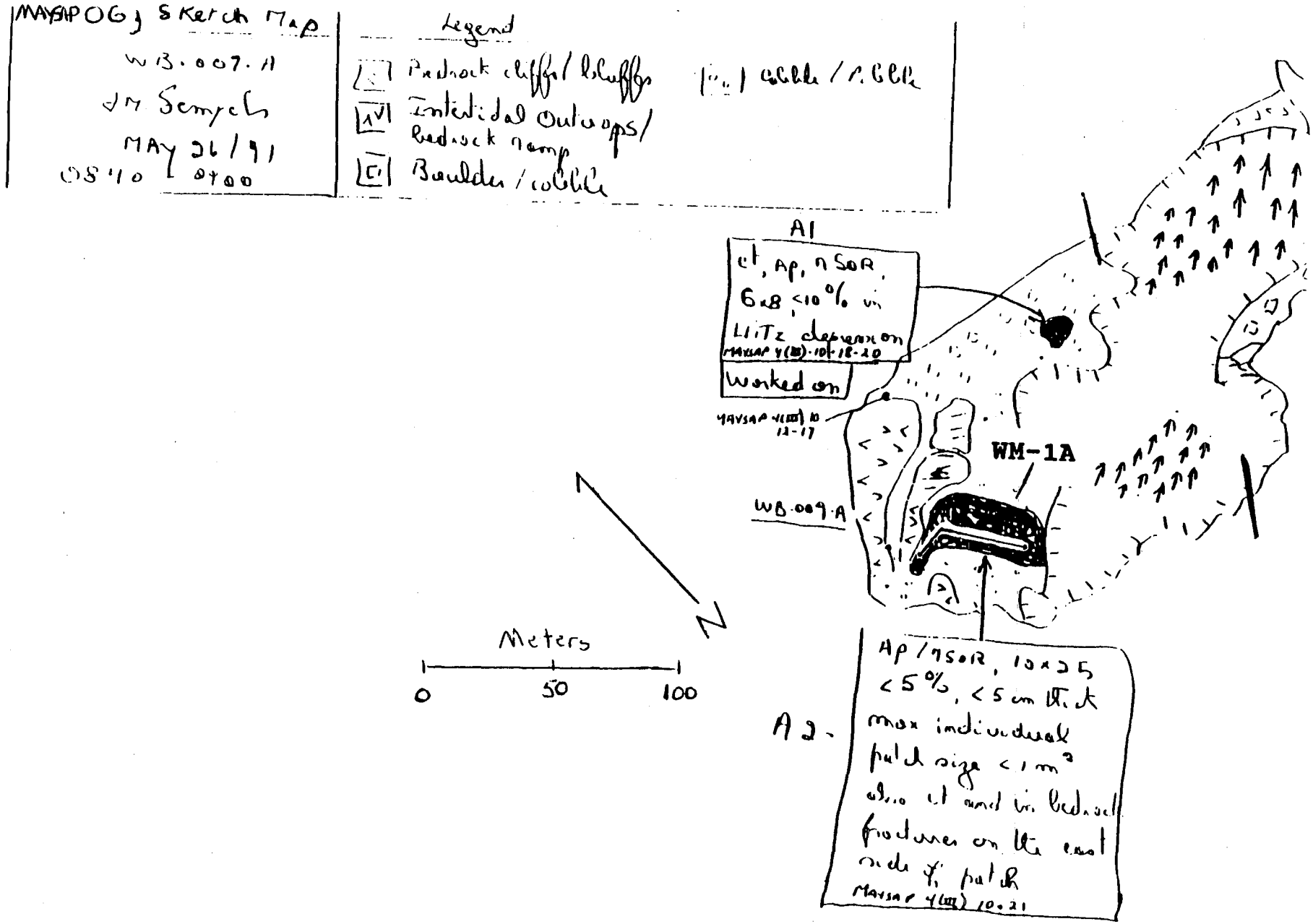


Figure K. MAYSAP sketch map showing location of oiled mussel transect WM-1A on Oystercatcher Island, Windy Bay, Gulf of Alaska. EVOS segment WB-009A.

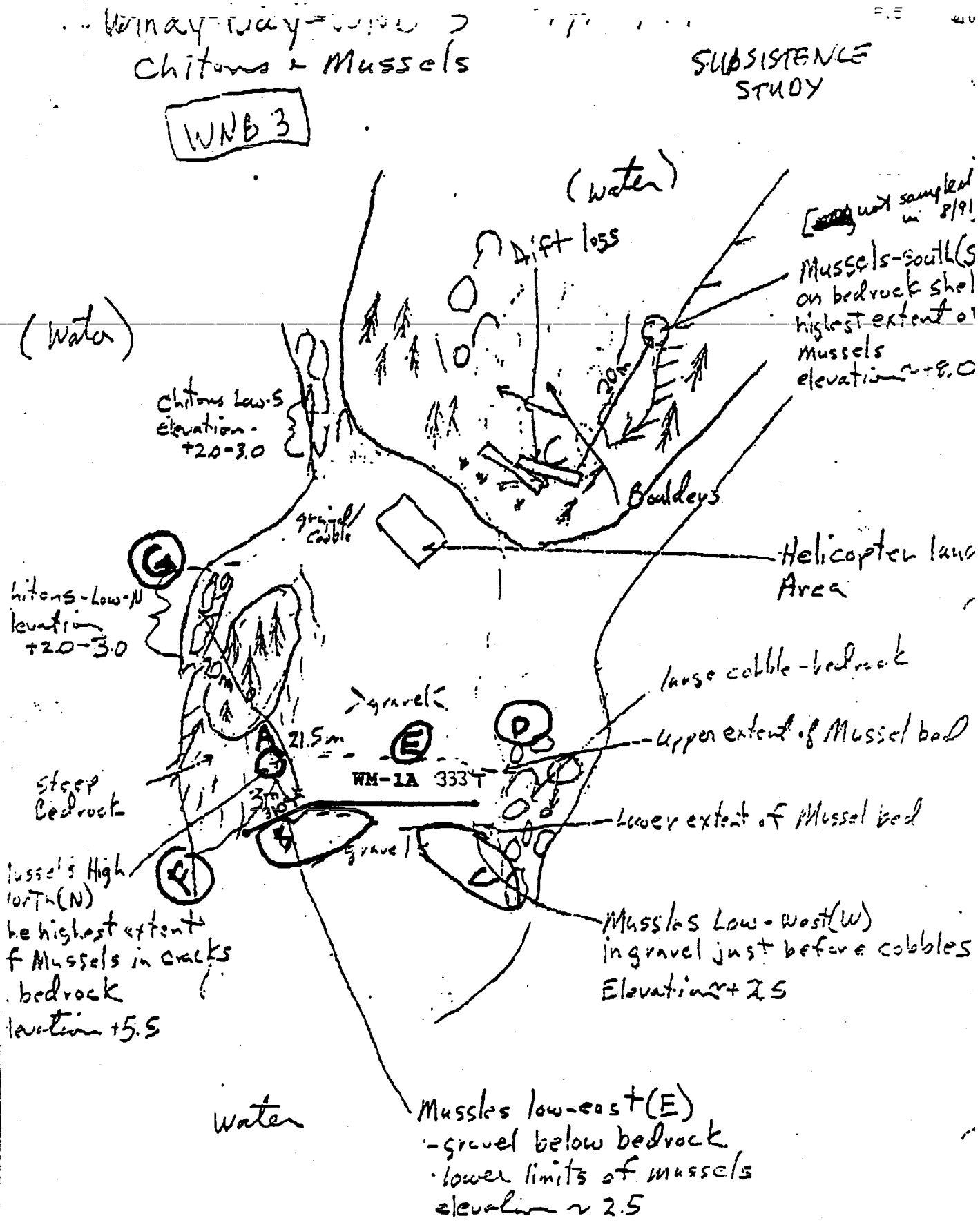


Figure L. NOAA Hazmat Subsistence Study Map showing location of oiled mussel transect WM-1A, Oystercatcher Island, Windy Bay, Gulf of Alaska. EVOS segment WB-009A.

SEGMENT: WB-002C **TRANSECT:** WM-2A **DATE:** 06/21/92		
OBSERVERS: Cusick, Crosby, Schoch		
LOCATION: Windy Bay, North Shore, 150m west of logging ramp. Site I(MAYSAP)		
REFERENCES: SSAT, MAYSAP		
TREATMENT HISTORY: 1989-Treatment unknown. 1990-Manual treatment. 1991-Manual treatment.		
LAT/LONG: 59°13'45"N, 151°32'15"W		
TIME: 1215 - 1255	**TIDE:** +0.85ft - +1.22ft	**FILM:** Roll 1
TRANSECT LENGTH:13m	**BEARING:** 324° True	**WEATHER:**Sunny

SITE DESCRIPTION:

This survey site is located within a large boulder/bedrock outcrop 150 meters west of a logging ramp on the north shore of Windy Bay (Figure J); corresponding to subdivision I - MAYSAP OG Sketch Map (Figure M). Sediment composition along the transect varies from an angular/sub-angular boulder/cobble area with an underlying substrate of pebble, crushed shell and sand size sub-angular quartz at the beginning of the transect, to a barnacle encrusted angular/sub-angular boulder and bedrock field (Figure N).

MUSSEL/OILING CONDITIONS:

Moderate concentrations of mussels, barnacles and littorines were observed at this site. Large mussels (length-5cm) attached strongly to shell and quartz sediments between angular and sub-angular cobble and hidden underneath moderately dense Fucus cover. Many dead mussels and mousse/sediment deposits observed along boulder/bedrock crevices. Sporadic surface oil residue with entrenched sediments in boulder interstices and beneath boulder/cobble armor. Silver/rainbow sheen observed on standing water along transect.

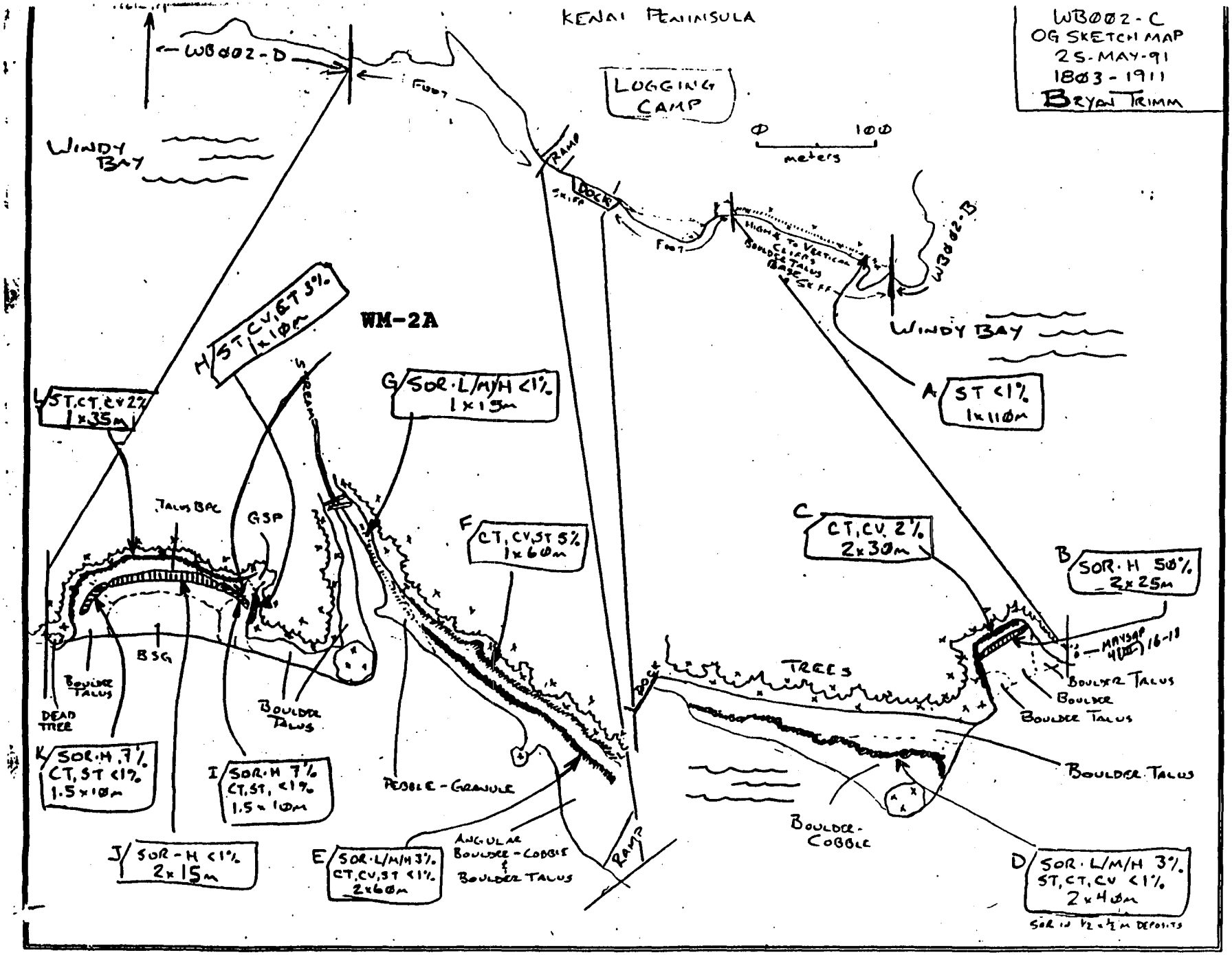


Figure M. MAYSAP sketch map showing location of oiled mussel transect WM-2A

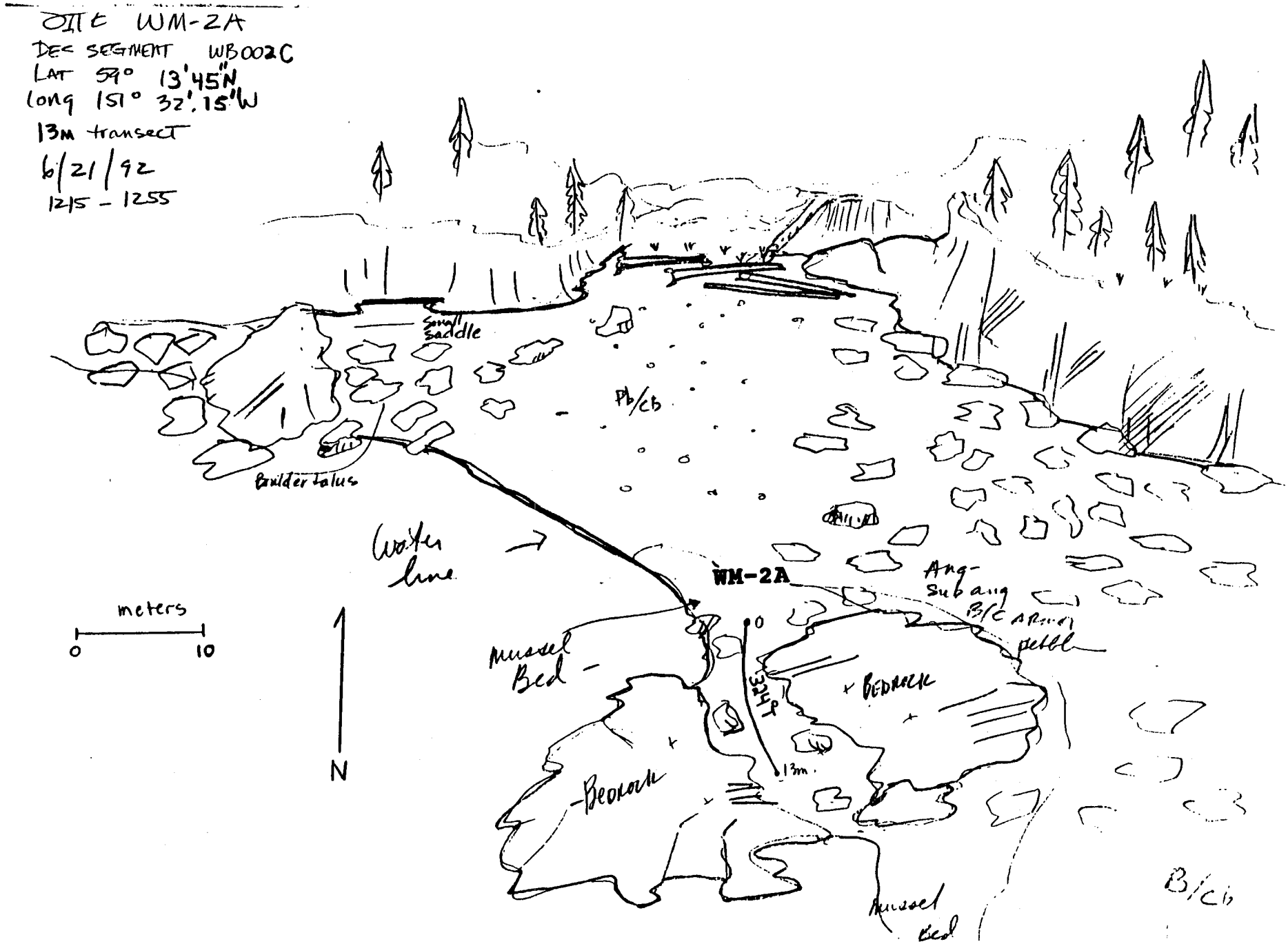


Figure N. Sketch map showing location of oiled mussel transect WM-2A, north shore Windy Bay, Gulf of Alaska. EVOS segment WB-002C.

SEGMENT: WB-002B **TRANSECT:** WM-3A **DATE:** 06/21/92		
OBSERVERS: Cusick, Crosby, Schoch		
LOCATION: Windy Bay, North Shore, Site C(MAYSAP)		
REFERENCES: SSAT, ASAP, MAYSAP		
TREATMENT HISTORY:1989-Manual treatment, Bioremediation ?. 1990-Manual treatment, recommended for Bioremediation. 1991-Manual treatment, recommended for Bioremediation.		
LAT/LONG: 59°14'04"N, 151°31'27"W		
TIME: 1330 - 1420	**TIDE:** +1.82ft - +3.58ft	**FILM:** Roll 1,2
TRANSECT LENGTH:11m	**BEARING:** 39° True	**WEATHER:**Sunny

SITE DESCRIPTION:

The survey site is located on the east side of a small cove along the north shore of Windy Bay (Figure J); corresponds to subdivision C - OG Sketch Map - MAYSAP (Figure O). Nearby headlands and intertidal bedrock outcroppings dissipate wave energy and create a low energy regime for the inner cove. Sediments consist of angular cobble and large boulder with intersticial pebble and sand. Transect length of only 11 meters reflects small area of mussel bed found at this site. Transect ran parallel to edge of water (Figure P).

MUSSEL/OILING CONDITIONS:

Intertidal oiling comments for this area can be seen in the MAYSAP Biological Summary Form for WB-002B. Moderate concentrations of mussels, littorines and barnacles were observed on day of transect. Most mussels anchored on intersticial sediments between angular cobble and large boulder. Oiling is very light to trace along transect with light surface oil residue and subsurface residual oil up to 2 cm in depth. Light rainbow sheens observed in sampling pits.

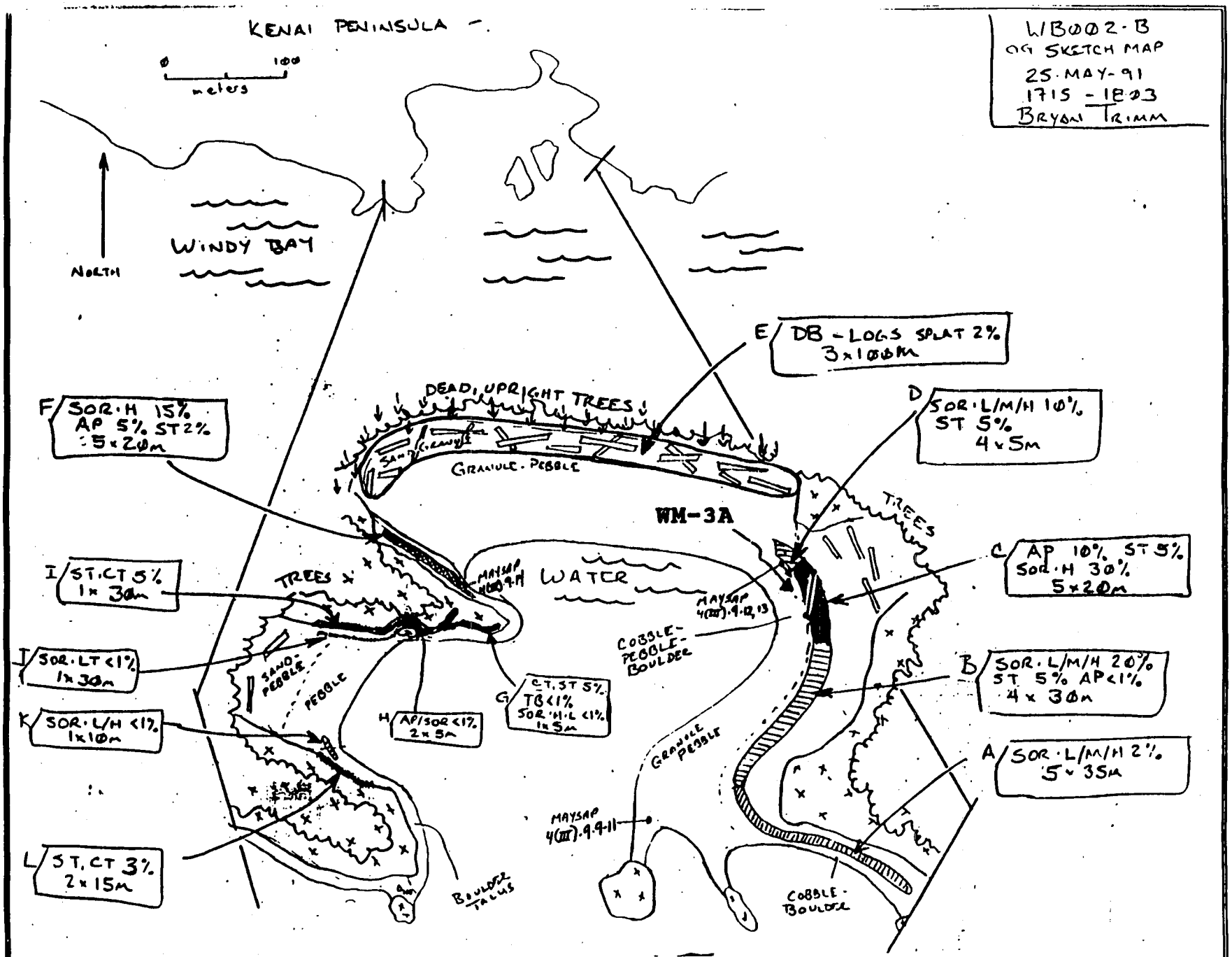


Figure 0. MAYSAP sketch map showing location of oiled mussel transect WM-3A

SITE WM-3A-
SEGMENT WB002B-
WINDY BAY
LAT: 59° 14' 04"N
LONG: 151° 31' 27"W
06/21/92

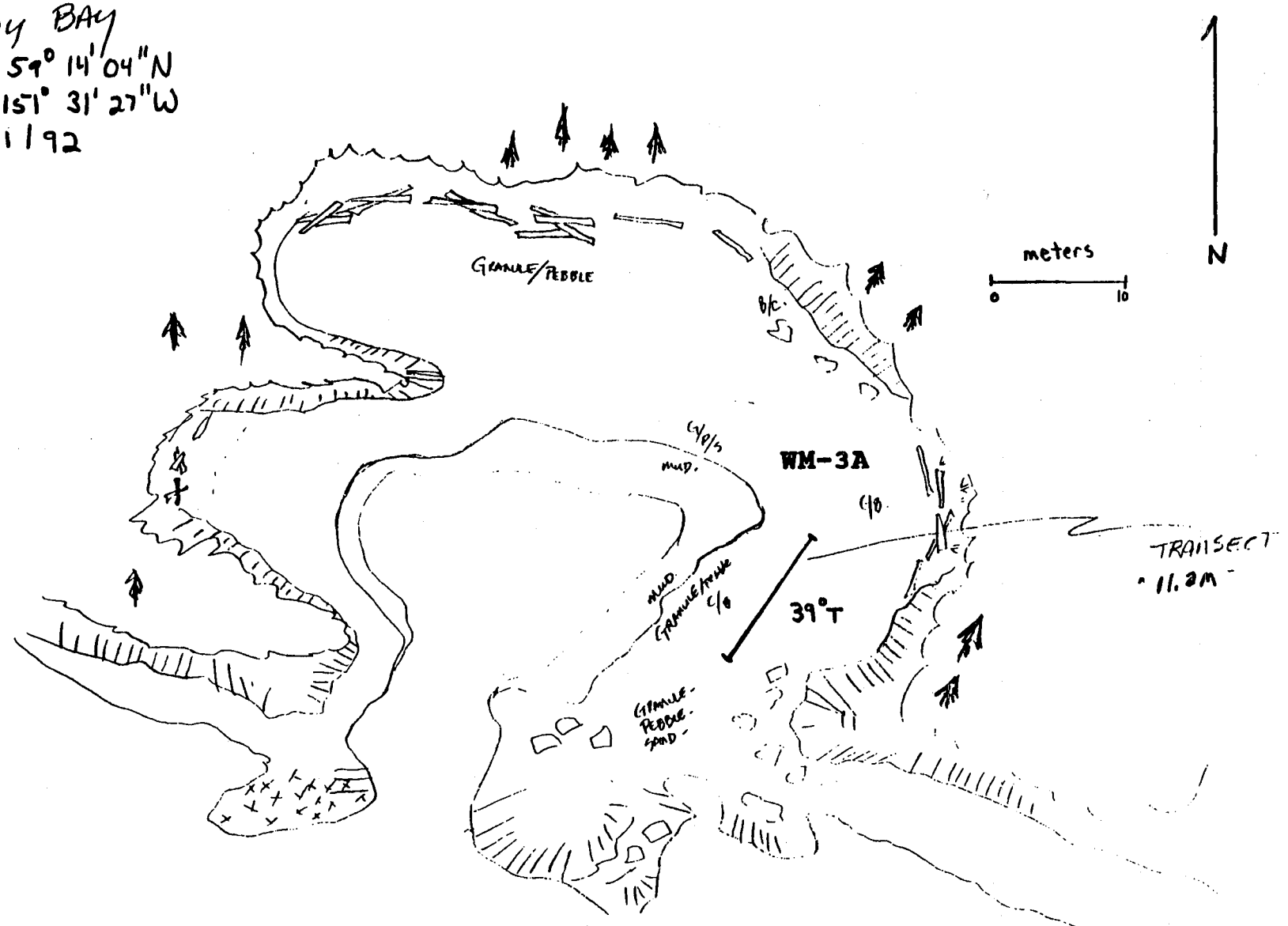


Figure P. Sketch map showing location of oiled mussel transect WM-3A, north shore Windy Bay, Gulf of Alaska. EVOS segment WB-002B.

SEGMENT: RB-005B **TRANSECT:** RBM-1 **DATE:** 06/24/92		
OBSERVERS: Cusick, Schoch		
LOCATION: Rocky Bay, Grungy Cove, 1 mile East of Picnic Harbor, Site A3 (MAYSAP).		
REFERENCES:SSAT, MAYSAP		
TREATMENT HISTORY:1989-manual treatment, Bioremediation?. 1990-manual treatment. 1991-Manual treatment.		
LAT/LONG: 59°14'30"N, 151°28'15"W		
TIME: 1429 - 1530	**TIDE:** +3.26ft - +3.72ft	**FILM:** Roll 5
TRANSECT LENGTH:10m	**BEARING:** 167° True	**WEATHER:**Cloudy

SITE DESCRIPTION:

Choice of site on this date was dependent on two factors: 1.) proximity to anchorage in Picnic Harbor and ease of area to land the skiff during marginal weather conditions. 2.) best chance of encountering mussels with such a poor low tide of +3.2ft. After discussions with DEC guide Clara Crosby and referring to other shoreline assessments,it was determined RB-005B offered the best criteria within this area (Figure J).

Referred to in the MAYSAP report as Area 3, this transect is located in a convoluted bay (known as Grungy Cove) east of the Windy Bay entrance and one mile west of Picnic Harbor (Figure Q). Refer to the Biological Comment Form in the SSAT for a complete site description. The transect ran ESE along the base of cliffs through a sub-angular boulder/cobble field on the NE corner of a small baylet (Figure R). Semi-porous sand/pebble matrix amongst large clasts. The local sediments showed signs of manual disturbance.

MUSSEL/OILING CONDITIONS:

As noted in the MAYSAP report, light surface oil residue was found in a small 4m X 5m patch amongst the sub-angular boulder/cobble and entrenched within a sand/granule matrix. Oiling was sporadic and very light along the transect. In one sampling pit, buried oil formed a 2cm thick lens 5cm below the surface. Mussel concentrations were moderate to light and were observed adhering to a semi-porous sand/pebble matrix on cobble and among boulders and cobble. Although a slight oil odor could be sensed along base of cliffs, no mussels were observed to be in direct contact with surface oil residue.

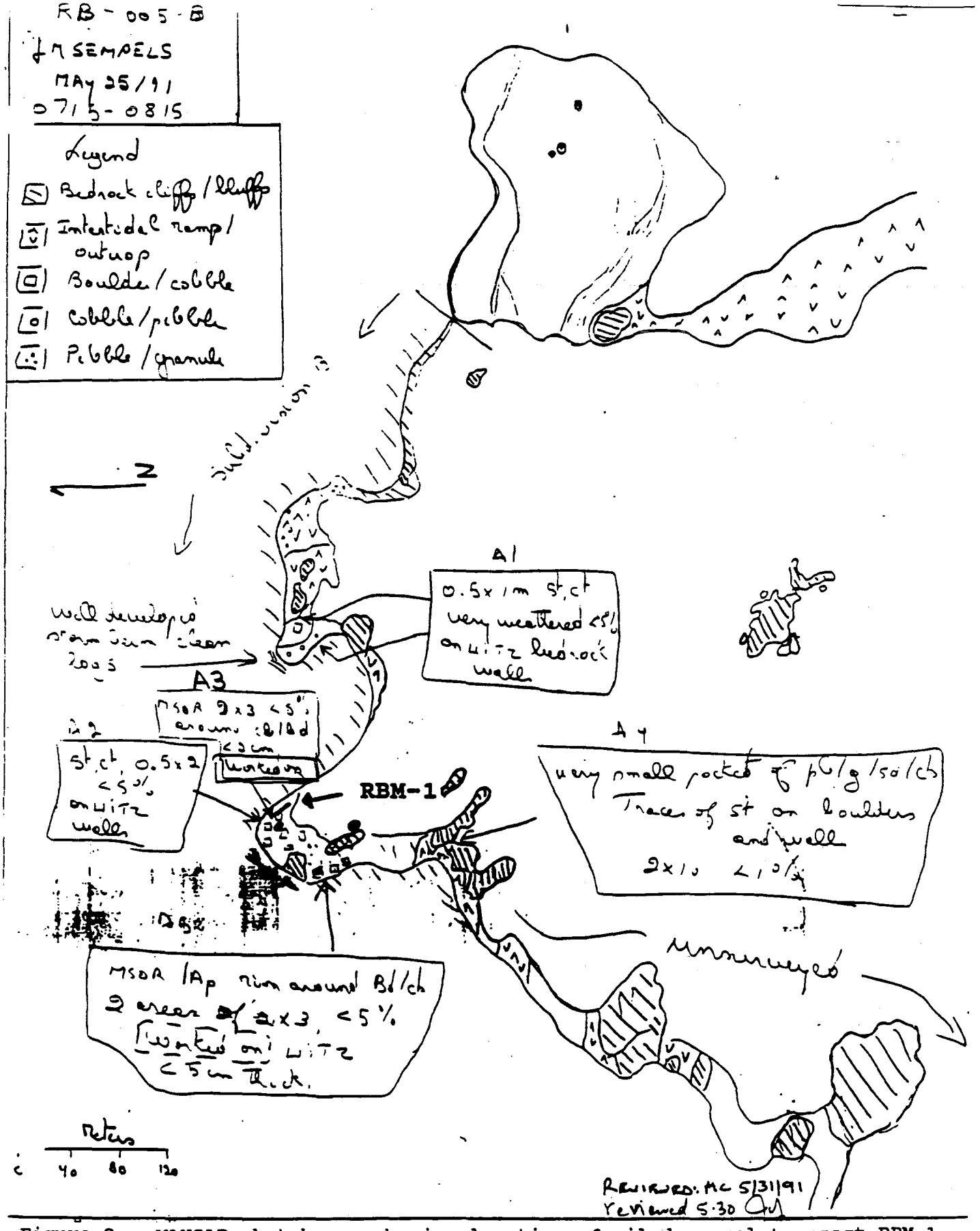


Figure Q. MAYSAP sketch map showing location of oiled mussel transect RBM-1 north Grungy Cove, Rocky Bay, Gulf of Alaska. EVOS segment RB-005B.

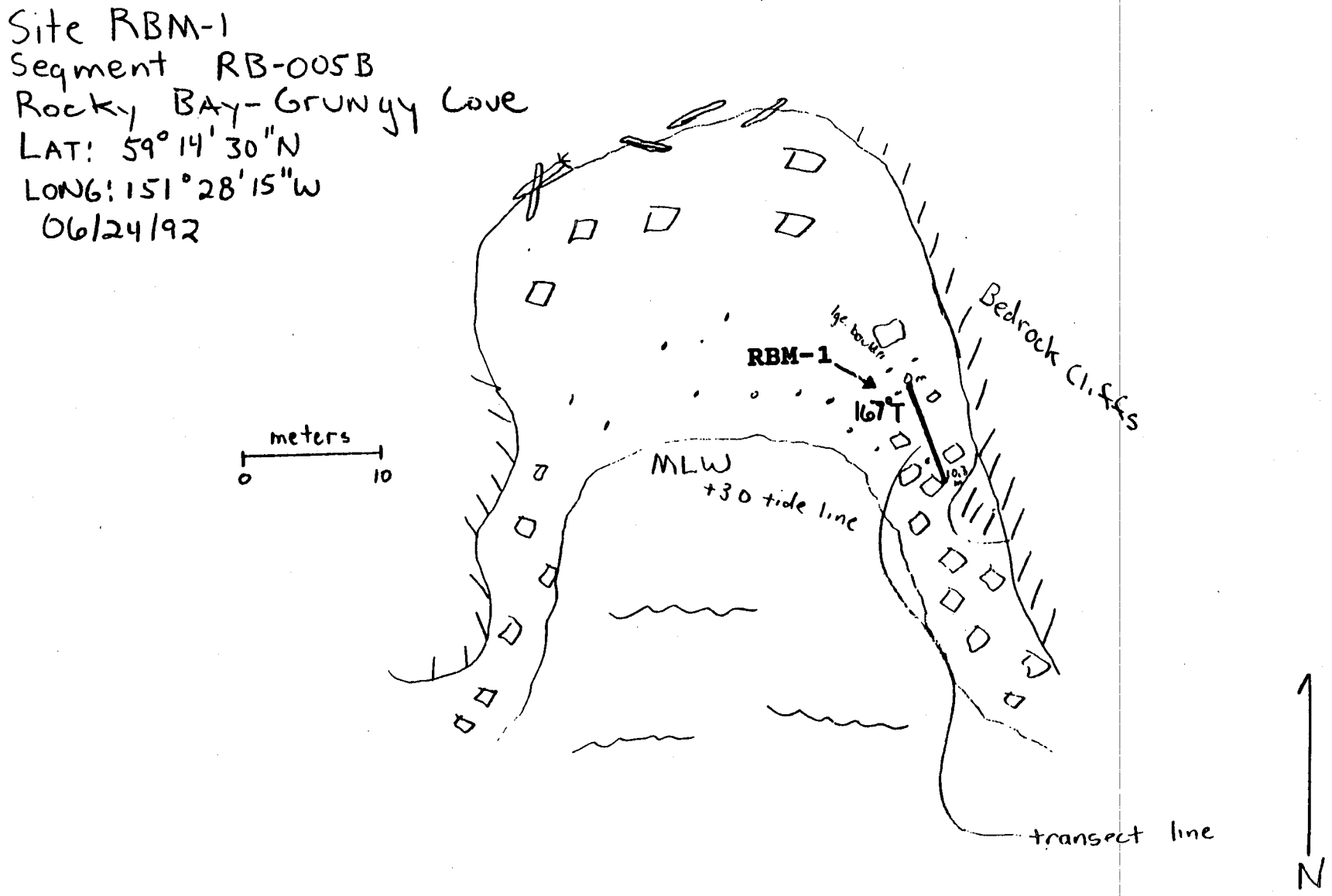


Figure R. Sketch map showing location of oiled mussel transect RBM-1, north Grungy Cove, Rocky Bay, Gulf of Alaska. EVOS segment RB-005B.

SEGMENT: PD-004A **TRANSECT:** MCM-1 **DATE:** 06/22/92		
OBSERVERS: Cusick, Crosby, Schoch		
LOCATION: West Arm Port Dick, Mars Cove, Eastern-most bight(Groucho Beach), ADEC station #323-T, ADFG Intertidal Biota Transect (Dudiak and Middleton, 1991).		
REFERENCES: SSAT, MAYSAP, ADEC Transect Data(ADEC,1992), ADFG Intertidal Biota Study(Dudiak and Middleton, 1991).		
TREATMENT HISTORY:1989-Extensive manual treatment, rock washing, high pressure warm water wash. 1990-manual rock washing, manual removal, Customblen applications. 1991-manual treatment.		
LAT/LONG: 59°16'42"N, 151°10'42"W		
TIME: 1100 - 1145	**TIDE:** +3.15ft - +2.30ft	**FILM:** Roll 2
TRANSECT LENGTH:27m	**BEARING:**1st leg-215°T 2nd leg-131°T 3rd leg-243°T	**WEATHER:**Lt.Rain

SITE DESCRIPTION:

Survey site is located in the first bight inside Mars Cove on the northern shore, known locally to clean-up workers in 1989 as Groucho Beach (Figure S). Transect area corresponds to Area III-B, subdivisions A4 and A5 on J.P. Barry's Site Map-MAYSAP (Figure T). In order to place the transect in the greatest concentration of oiled mussels the tape was bent in two places in between large bedrock outcroppings (Figure U). Sediment, mussel and oiling conditions varied while sampling along the transect. Refer to the ADFG "Study of Intertidal Biota on Treated Beaches on the Outer Coast of the Kenai Peninsula"(Dudiak and Middleton 1991) for a complete history of oiling conditions, treatments and biota found at this site.

MUSSEL/OILING CONDITIONS:

Sampling began at 2.2m along tape.

2.2m - 6m: Dense Fucus and moderate mussel concentrations. Very light surface oil residue. Majority of living mussels hidden below Fucus cover and attached to angular cobble; most mussels in this area are dead. Armoring sediments are angular/sub-angular cobble and small boulders with underlying shells, rust colored organics and anaerobic muds. Standing water up to 4cm deep.

6m - 1st leg(15.4m): Parallel to water. Angular cobble/pebble/granules. Heavy to light surface oil residue. Exposed patches of surface oil residue surrounded by thriving mussels, some of which are 3cm long. Sediment more porous (greater intersticial pore spaces) than muds at beginning of tape. Pungent oil residue, and silver sheens present upon agitation. Water droplets beading on live mussel shells and pebbles.

Site Summary for Transect MCM-1 continued:

15.4m - 2nd leg(21m): Perpendicular to water and through a small bedrock saddle. Extremely dense localized mussel bed. Mussels adhering to weathered oil entrenched sediments in cracks and crevices of bedrock.

21m - end of transect(27m): Tape continues down a narrow Fucus covered bedrock chute, carved between two rock outcroppings. Chute gradually slopes to water. Sheening observed in small pools. Light surface oil residue in cracks and crevices of bedrock. Many dead mussels and crushed shells adhering to weathered mousse up to 4 cm thick.

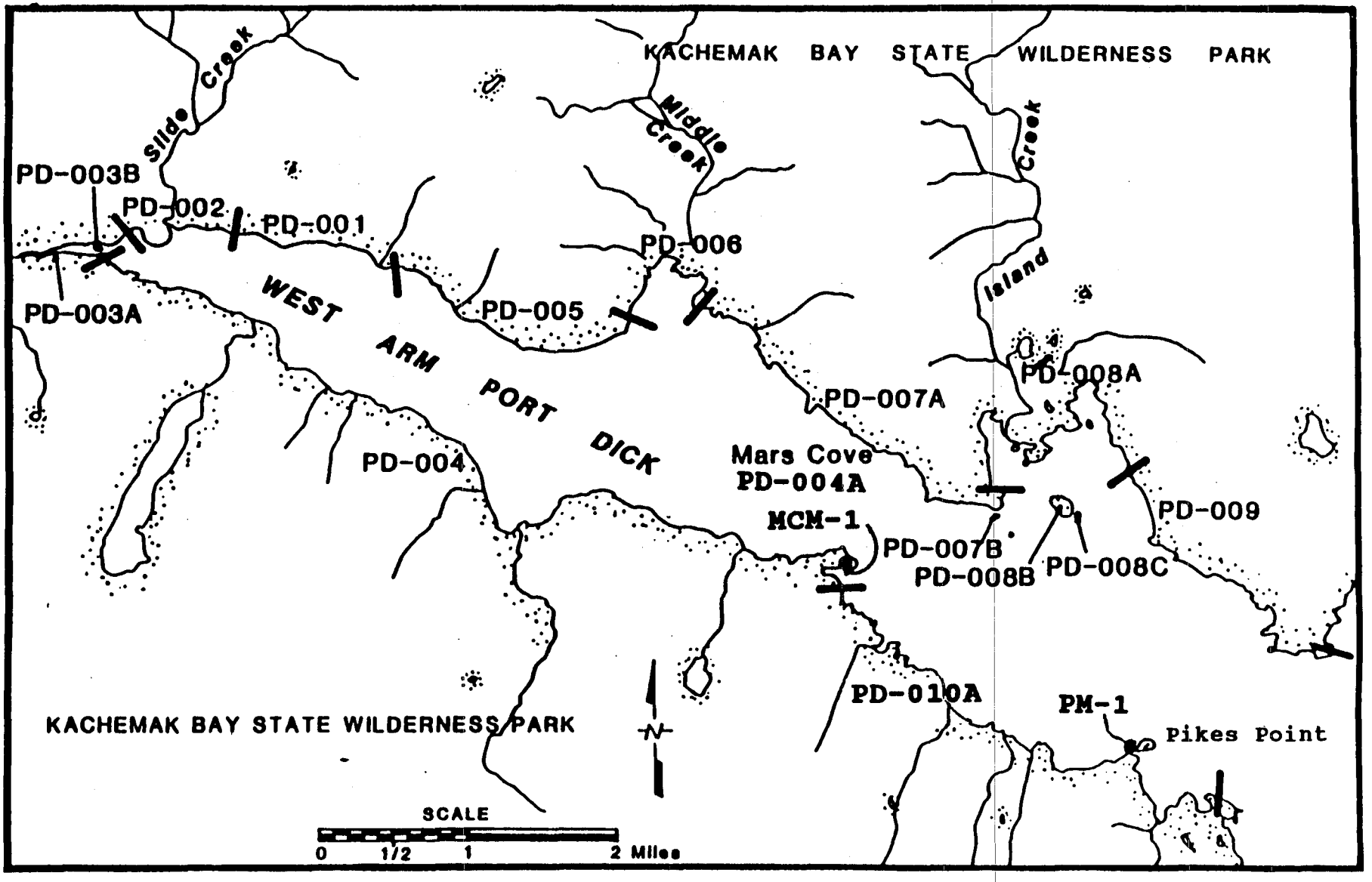


Figure 5. Mars Cove (MCM-1) and Pikes Point (PM-1) oiled mussel transect locations (at●) in the West Arm of Port Dick, Gulf of Alaska.

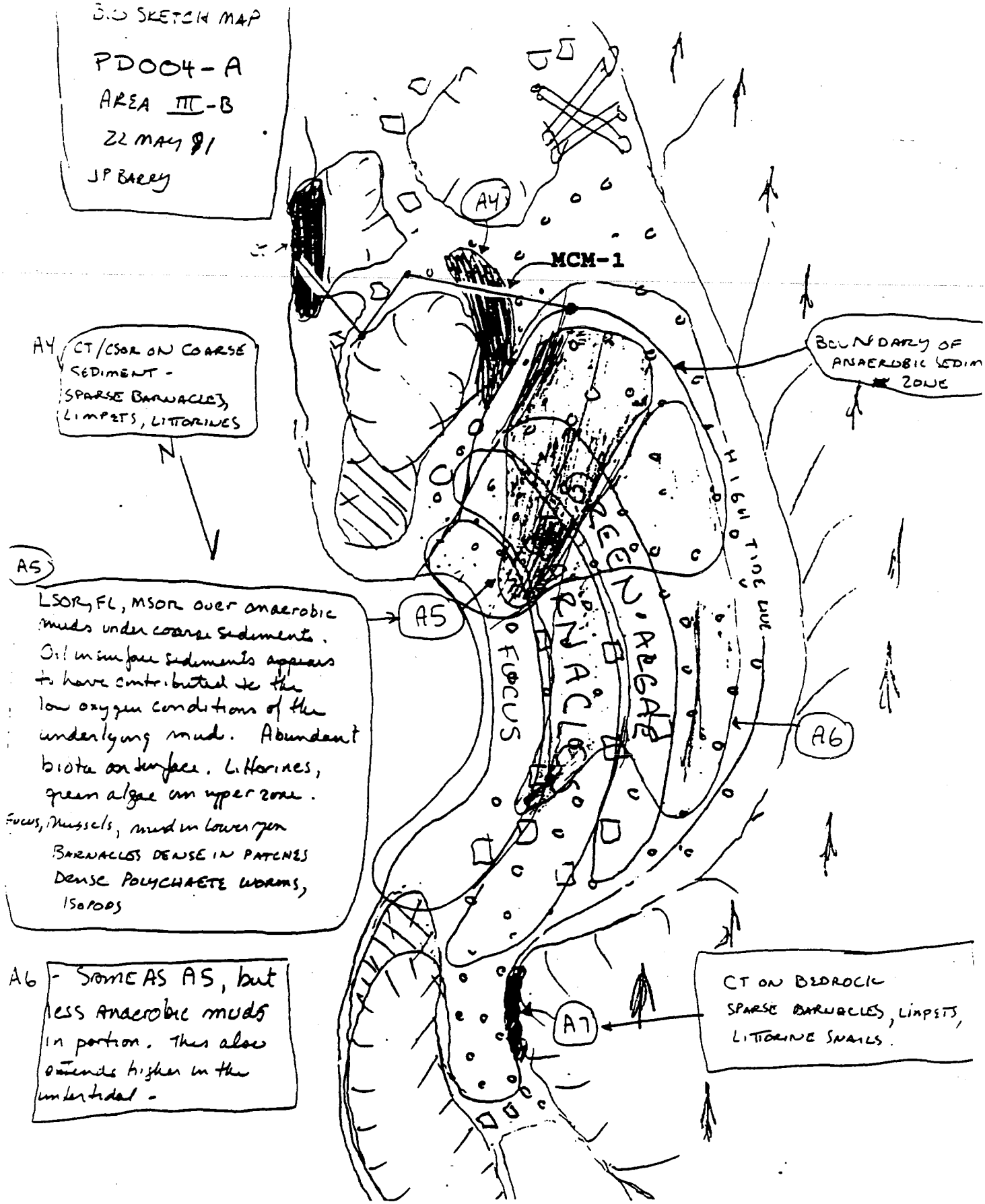


Figure T. MAYSAP sketch map showing location of oiled mussel transect MCM-1 Mars Cove, West Arm of Port Dick, Gulf of Alaska. EVOS segment PD-004A.

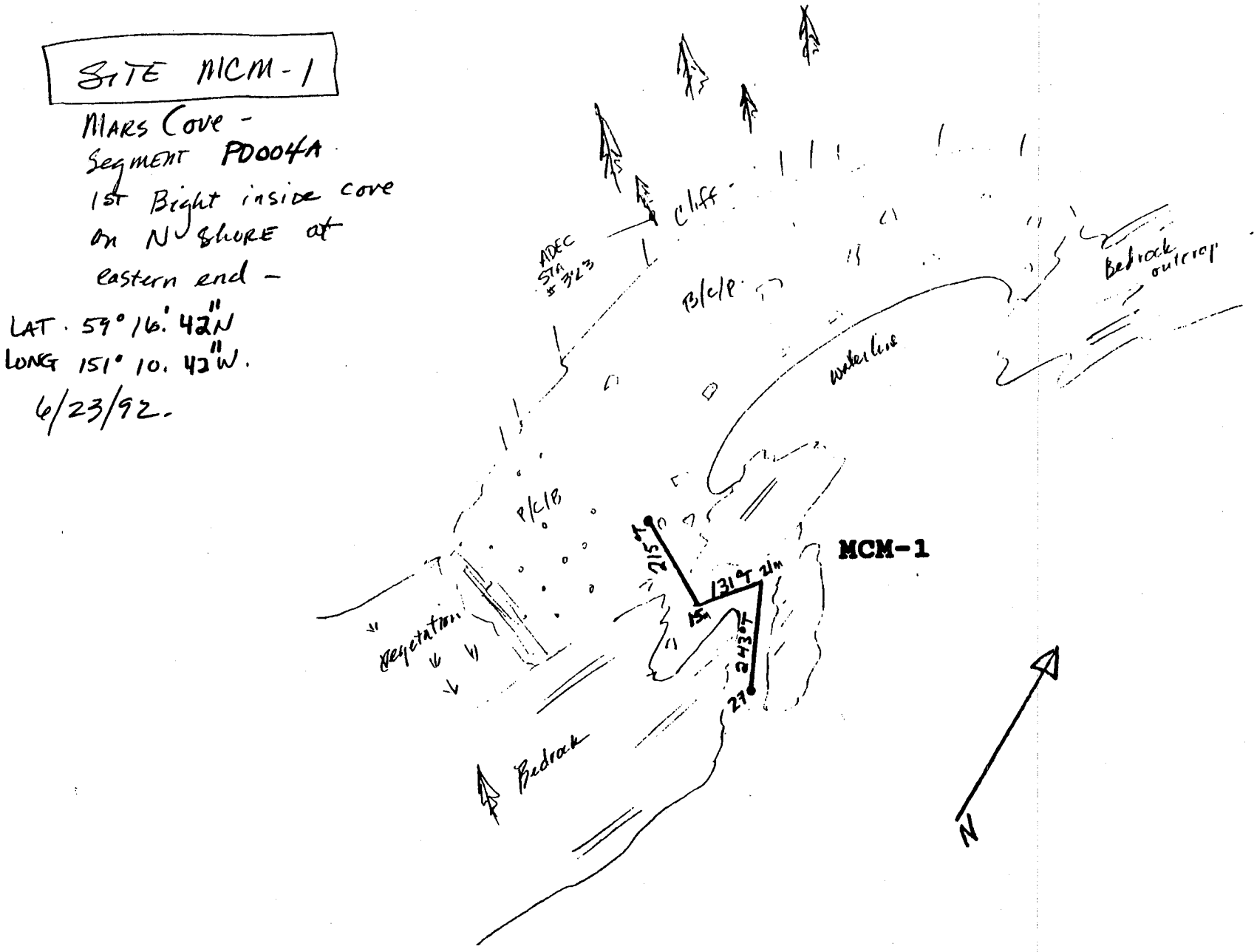


Figure U. Sketch map showing location of oiled mussel transect MCM-1, Mars Cove, West Arm of Port Dick, Gulf of Alaska. EVOS segment PD-004A.

SEGMENT: PD-010A **TRANSECT:** PM-1 **DATE:** 06/22/92		
OBSERVERS: Cusick, Crosby, Schoch		
LOCATION: West Arm Port Dick, Pikes Point, W. side Isthmus		
REFERENCES:ADEC Post Treatment Survey(09/27/89), SSAT, ADEC Daily Beach Survey Report(4/26/90).		
TREATMENT HISTORY: 1989-Manual removal, high pressure wash, some mussel removal.		
LAT/LONG: 59°15'39"N, 151°07'25"W		
TIME: 1245 - 1323	**TIDE:** +1.70ft - +1.80ft	**FILM:** Roll 3
TRANSECT LENGTH:30m	**BEARING:** 175° True	**WEATHER:**Cloudy

SITE DESCRIPTION:

Transect PM-1 is located on the west side of the isthmus beach coming from the main land to the western-most island that forms Pikes Point (Figure S). This west facing beach is moderately sloped and consists of a parent substratum of sub-angular cobble overlying angular pebbles with large intersticial spaces. Transect ran parallel to the water's edge and started at the base of a bedrock wall forming the western-most island of Pikes Point (Figure V).

MUSSEL/OILING CONDITIONS:

This beach contained the most extensive mussel bed encountered during the summer survey encompassing an area of 40m X 20m and up to 15cm thick. A sand/organic/crushed shell matrix underlies the mussel mat causing a "raised" appearance of the bed. This same matrix however, is lacking on the mussel free portions of the beach. Mousse mats (1m diameter) with subsurface thickness up to 8cm throughout mussel bed. Oiling extends from lower intertidal zone (+1.1ft and below) to upper intertidal zone. Silver and rainbow sheen present in disturbed patches throughout the mussel bed. Our skiff's landing area soon produced large sheens on the incoming tide and oil odors were prevalent.

There was no MAYSAP data on this site. SSAT and a DEC Daily Beach Survey Report dated 04/26/90 were the chief written documents referred to for this site. DEC guide Clara Crosby thought this beach should have warranted more attention in terms of clean up.

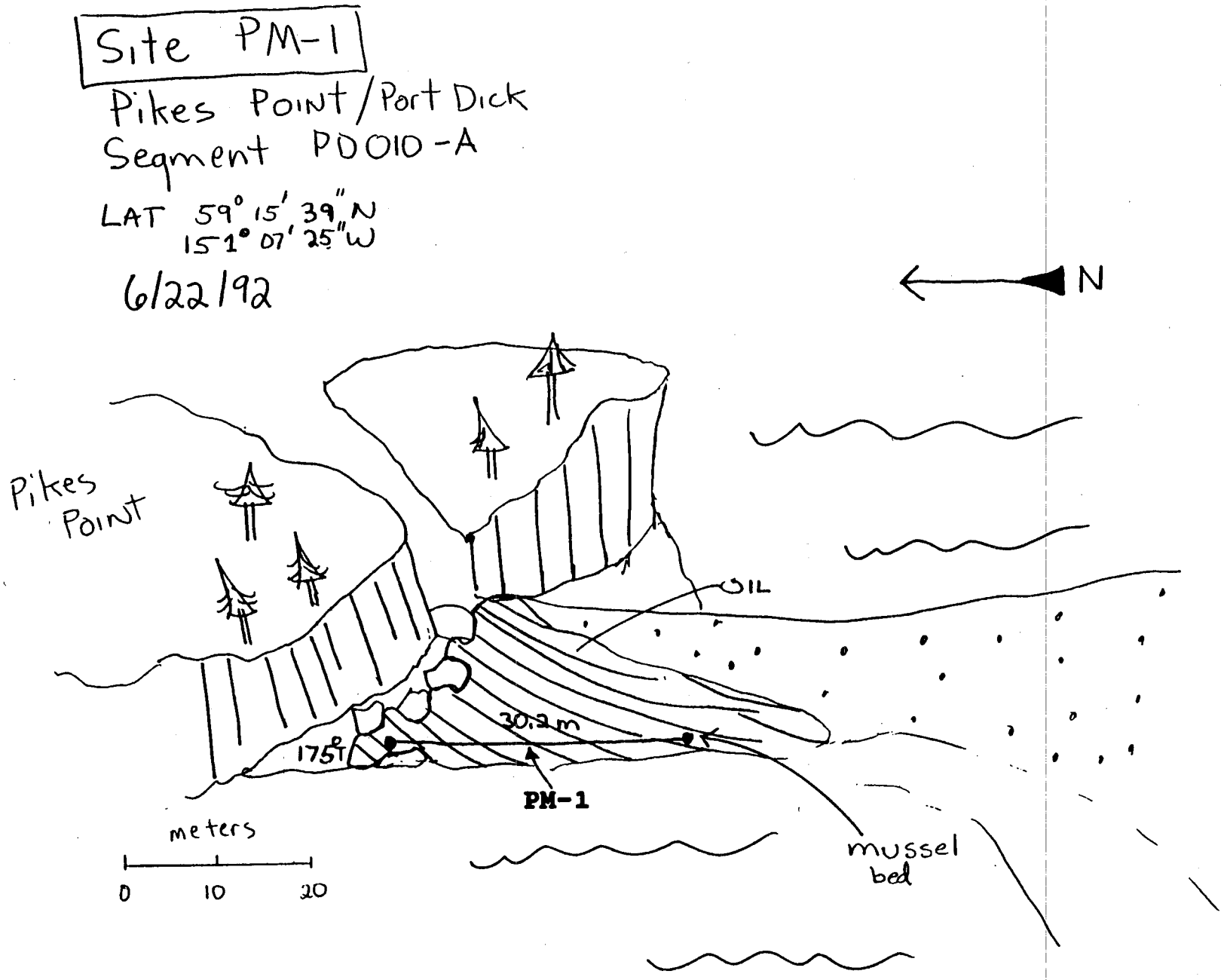


Figure V. Sketch map showing location of oiled mussel transect PM-1, Pikes Point, West Arm of Port Dick, Gulf of Alaska. EVOS segment PD-010A.

SEGMENT: K0920CN002A **TRANSECT:** CNM-1 **DATE:** 08/06/92		
OBSERVERS: Cusick, Schoch		
LOCATION: Alaska Peninsula, Cape Nukshak, 1st offshore island, Site A(MAYSAP).		
REFERENCES: SSAT, MAYSAP		
TREATMENT HISTORY: Recommended for Manual treatment - 1990.		
LAT/LONG: 58°23'30"N 153°58'51"W		
TIME: 0706 - 0754	**TIDE:** +6.67ft - +8.55ft	**FILM:** Roll 8
TRANSECT LENGTH:20m	**BEARING:** 62° True	**WEATHER:**Lt.Rain

SITE DESCRIPTION:

The area surveyed is the north facing side of a saddle between Cape Nukshak and the first offshore island located on the southern side of Hallo Bay within Katmai National Park and Preserve (Figure W). At low to mid tide the saddle is exposed, yet protected from high energy waves by a band of offshore imbricated boulders. Transect CNM-1 is located parallel to the water along a rounded boulder/cobble beach corresponding to Site A; MAYSAP sketch map (Figure X). Rounded pebble and sand filled intersticial spaces. Substrate was observed as settled and fairly well sorted.

MUSSEL/OILING CONDITIONS:

Mussels, barnacles, Littorina and limpets moderately dense. Mussels attached to pebbles and sand matrix amongst boulders and in few places in direct contact with oiled sediments. Very light to light coat, stain and surface oil residue in intersticial spaces and under boulders. Sticky, chocolate mousse observed underneath boulders and many times acting like a cement and holding substrate in place. Silver sheen observed in intersticial pools.

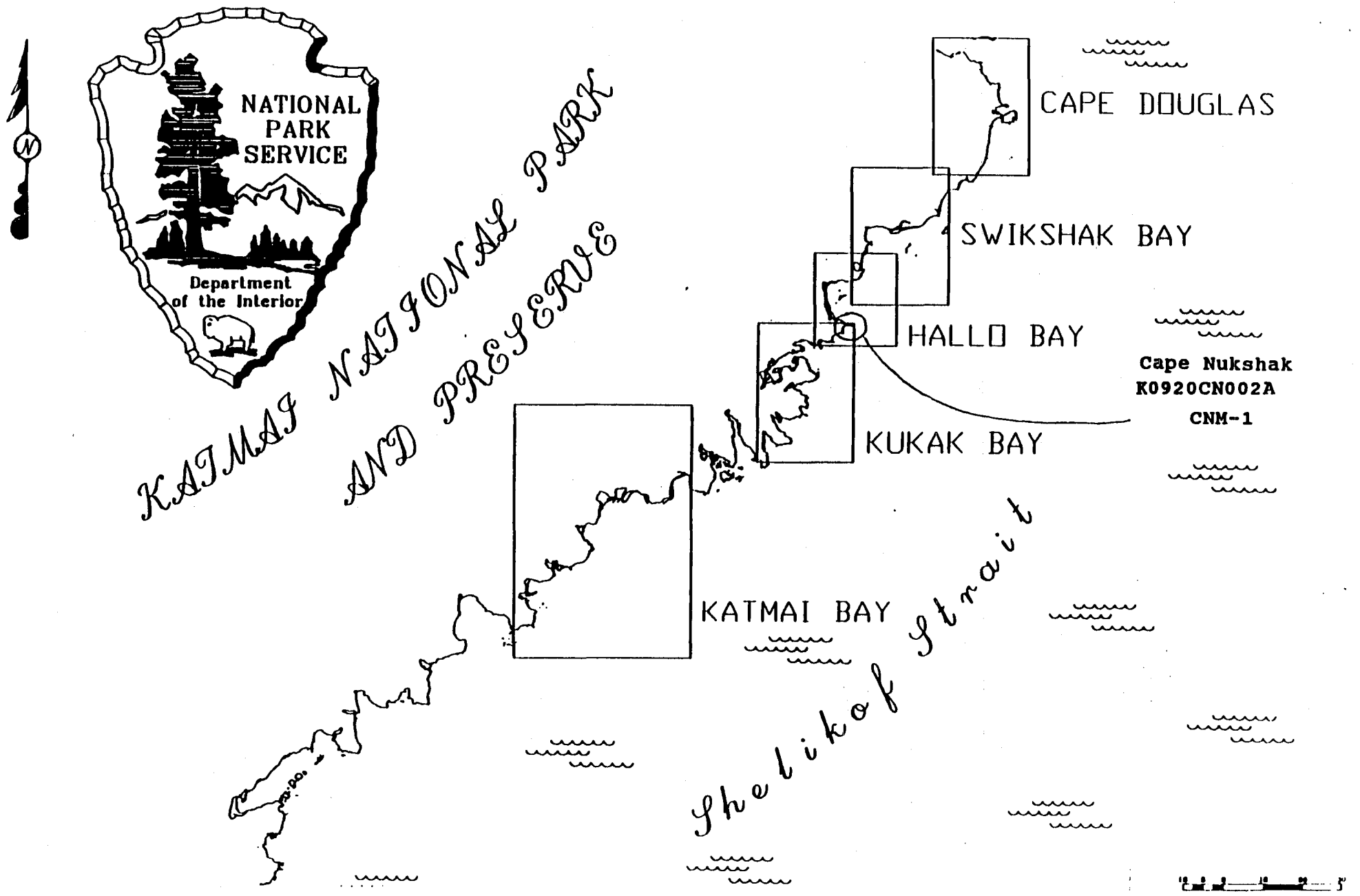


Figure W. Cape Nukshak oiled mussel transect (CNM-1) location within Katmai National Park and Preserve, Gulf of Alaska. EVOS segment K0920CN002A.

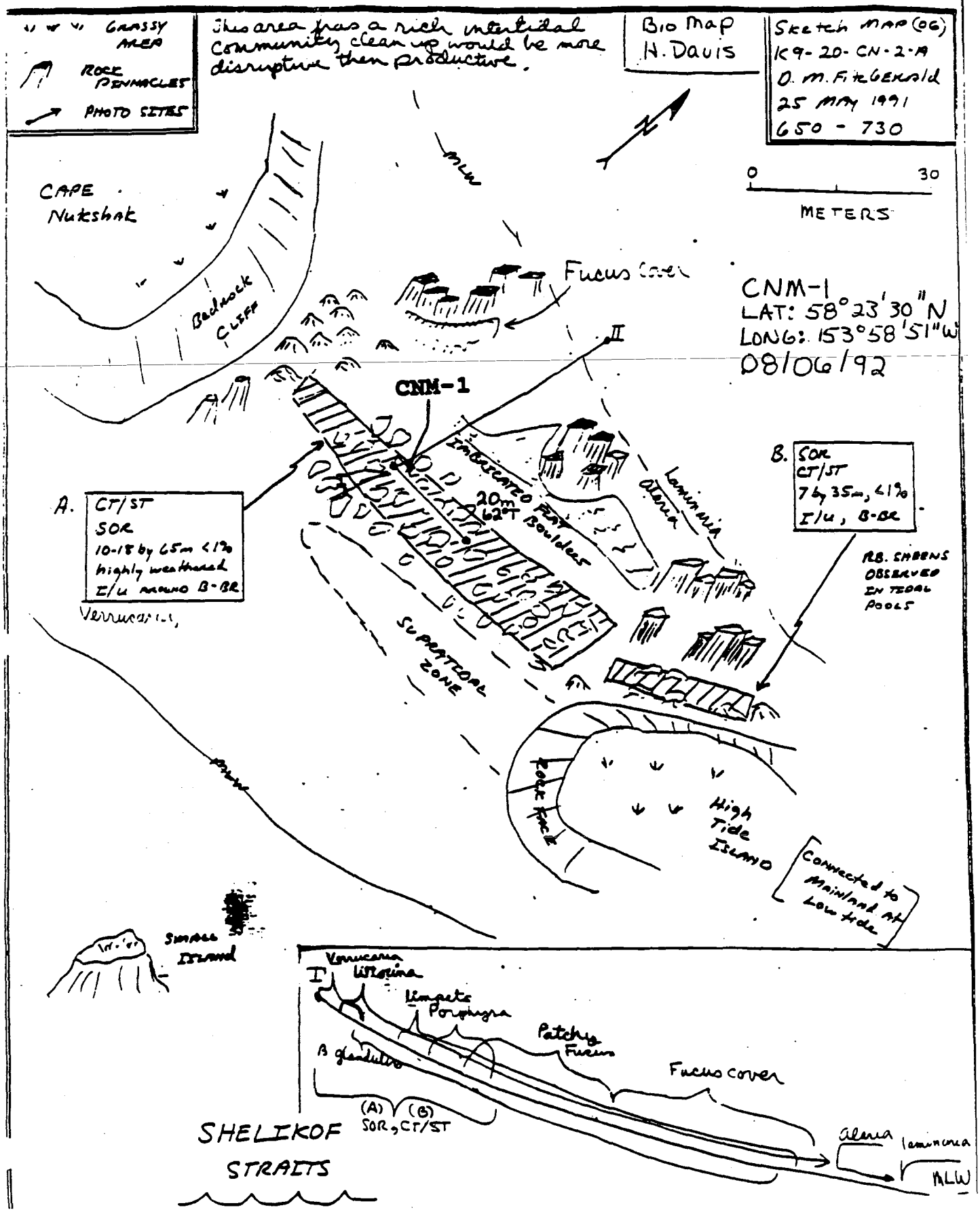


Figure X. MAYSAP sketch map showing location of oiled mussel transect CNM-1, Cape Nukshak, Gulf of Alaska. EVOS segment K0920CN002A.

Appendix E
Reconnaissance of sites visited but not sampled

APPENDIX E

West Pocket Beach, YP004A. 1 June. Priority: Low. Noted as Site B - August 7, 1989 SCAT survey. Some surface oil residue observed along with scattered asphalt patches in exact locations noted in MAYSAP map (Sites A1-A4). Slightly aromatic mousse under angular slate clasts at head of this highly protected cove. Some silver sheens observed in small area within Fucus mat when substrate disturbed. This area contained only sparse concentrations of mussels and did not meet criteria for sampling.

East Pocket Beach, YP004A. 9 June. Priority: Low. Not on original priority list, but was visited due to Fate/Persistence Study. Noted as Site A - August 1989 survey. Highly mobile substrate-angular slate pebbles- and a greater exposure than West Pocket Beach. No oil observed. Tide was too high to observe mussels, but prior oiling was in the upper intertidal.

Yalik Bay, N. cove, YB002A. 9 June. Priority: Low. Visited sites G and H (August 2, 1989 SCAT survey) by skiff at mid high tide. Found trace oiling (coat and stain) in patches on bedrock faces and no oil amongst sparse to moderate mussels.

Harris Bay, Lagoon. 2 June. This beach was not on original priority list, but was visited with Malin Babcock to demonstrate mussel/sediment sampling techniques. Mussels were sparse and no oil was observed on this sheltered tidal area at the head of Harris Bay. Former NOAA study site.

Verdant Cove, HA002A. 5 June. Priority: Low. Same as Duggins Site #54. Using SSAT map of area; of the four distinct previously oiled sites, there was only slight staining observed on a boulder within the westernmost oiled site. Mussels sparse and below oil stains. Observations of Duggins site photos taken in 1989 clearly show oiling in the upper to supra intertidal. This area did not meet criteria for sampling.

McArthur Pass, MR001A. 10 June. Priority: High. Near Duggins site #59. Extensive interstitial oil(OP) through subdivisions B and C(MAYSAP report). Carl Schoch observed area looks very similar to 1990. Oil is all in the upper intertidal zone and far above moderate concentrations of mussels.

Morning Cove, PY008C, PY008E, PY008F. 10 June. Priorities: High. Landed on site A1 (MAYSAP report) for both PY008C and PY008E and observed scattered surface oil residue in the upper intertidal region; far above sparse to moderate mussels. Skiffed along portions of PY008F during a rising tide so actual beach landings did not occur, however, observing the oil level in relation to tide height in other areas of the cove, it was determined a low probability of finding oiled mussels.

APPENDIX E (Continued): Reconnaissance of sites visited but not sampled.

Nuka Island, N.E. cove, NK001A. 9 June. Priority: High. Very little change observed in oiling within sites 1 and 2 (MAYSAP) since 1991. Site 1 contained sparse to moderate concentrations of mussels, but were not in direct contact with pooled mousse beneath pebbles. Oiling (tar and asphalt patches) was observed in site 2 within the upper to mid intertidal zones within an extensive Fucus bed along with sparse to moderate concentrations of mussels. Although no transect was conducted here, Site 1 was very close to meeting sampling criteria. With the apparent lack of weathering at the head of this cove, **I recommend further consideration.**

Nuka Island, N.E. cove, north shore, NK002A. 9 June. Priority: High. Scattered oil coat and stain with associated spruce needles observed in area A6 and A4 (MAYSAP). No oil observed in contact with moderate to dense mussels on boulder faces. Regrettably, we bypassed areas A1 and A2. MAYSAP reports some oil/mussel overlap in these areas and because of proximity to NK001A, **I also recommend further consideration.**

N. Outer shore Tonsina Bay TB001A. 7 June. Not on original priority list. Skiff survey conducted during rough weather along this highly exposed shoreline of bedrock cliffs north of Long Island. Two probable beach areas of interest (new information from Malin Babcock) were the probable native mussel beach, near a caged mussel site (NOAA mussel site map 1989) N.W. of Long Island and the confirmed native mussel site (NOAA mussel site map 1989) due N. of Long Island. Due to the high exposure of both sites, no actual landings were feasible, however, chance of finding oiled mussels here is quite low. Recommend no further examination.

Lagoon entrance, N. shore Tonsina Bay TB002A. 8 June. Priority: High. Due to lack of a proper map the only site visited within this whole segment was the dense mussel bed at lagoon entrance; no oil was observed. **However**, just to the south of the lagoon entrance there is a south facing cove (Site A3-MAYSAP) with a dense mussel bed that contained light surface oil residue. **Another** dense mussel bed to the west of the lagoon at the mouth of an anadromous stream (Site A1-MAYSAP), also was observed in 1991 to have oil coat in nearby zones. Due to the relative low exposure of these sites and the abundance of other oiled mussel sites in this region, **I recommend both of these sites for further examination.**

Tonsina Bay, Isthmus Beach, TB004A. 23 June. Priority: High. A brief survey was performed of the inner Isthmus area during a poor low tide series. No oil or mussels observed. This area corresponds to the ADEC transect #318 which was discontinued due to lack of oiling along transect line (ADEC, Daily Beach Survey Report- July 23, 1990). With the degree of prior oiling (very light-100m) recorded in ASAP report and no mention of oiled mussels, I recommend no further examination.

APPENDIX E (Continued): Reconnaissance of sites visited but not sampled.

Long Island, TB005B. 7 June, 23 June. Priority: High. Inner cove on Long Island (TB005B) was surveyed during a high tide on June 7 so we could not accurately assess for sampling criteria. This small protected cove was heavily oiled and determined to have mussels within and near oil deposits (MAYSAP). **Recommend this area to be examined further.** Rough weather on 23 June prevented landing on the east side of Long Island (included in TB005A) which also was determined to contain several pocket beaches with oiled mussels(MAYSAP). Due to the small size of this island and the moderated exposure of the coves on the south and east sides of Long Island, it is likely that oil affected mussels are still present. **Recommend this area to be examined further.**

Lagoon, N. Shore Tonsina Bay TB006A. 8 June. Priority: Low. Skiff survey conducted inside lagoon during a high tide. Observe no oil at this low priority site. According to MAYSAP of segment, mussels were sparsely distributed amongst cobble while oil was in a thin band in the middle to high tide level. Lack of sampling criteria to warrant further consideration.

West Arm Port Dick, PD003A. 22 June. Not on original priority list, however, due to an early start on the tides, we surveyed the S.W. and W. edge of the tidal flat at the extreme western end of Port Dick. Occasional surface oil residue and tar was observed S.E. of cabin and sparse mussels under Fucus cover. Tide was too high to see the NOAA subsistence site-PTD-1 in the N.E. quadrant of the tidal flat and time was limited; still had to visit two other sites this day.

Windy Bay, N. shore, WB002A. 21 June. Priority: High. This whole segment was surveyed by foot and skiff. As indicated by the MAYSAP report, there was some oiling in areas of mussel concentrations, but clearly no dense and well defined sites were observed during survey. MAYSAP sites-B3, B4, B5, B6, B7, B8 and B9 were all investigated and found to generally contain discontinuous surface oil residue(SOR) between and beneath boulder/cobble surface armor within the upper intertidal. Patchy and discontinuous concentrations of mussels when oil was found. This area did not meet criteria for sampling.

Windy Bay, N. shore, WB002E. 21 June. Priority: High. A quick survey was conducted along this large boulder strewn shoreline. SSAT reports wide and narrow oiling along the upper intertidal region and locally dense mussel beds in mini-cove regions, however, due to a poor tide series and lack of time, this area received little attention. Extent of oiling in other areas of Windy Bay indicate a slim possibility of finding extensive oiled mussels. Recommend this area not be examined further.

APPENDIX E (Continued): Reconnaissance of sites visited but not sampled.

Windy Bay, Island W. of Oystercatcher Island, WB007A. 21 June. Not on original priority list but ADEC guide Clara Crosby indicated the south facing shore of this island and a NOAA Hazmat site, might contain oiled mussels. Oil observed was asphalt and surface oil residue with some contact with mussels but not so extensive to warrant a transect. Recommend this area not be examined further.

Shaw Island, K0906CP002A. 29 June. Visited the north portion of Shaw Island in conjunction with Carl Schoch's Fate/Persistence study. This area was not on original priority list, however, we observed trace surface oil residue and intersticial oil amongst boulders and cobble in the upper to supra intertidal zones. Mussels were not observed near oiled areas.

Cape Douglas, N. of Promitory, K0908CD003A. 30 June. Not on original priority list. Visited site in conjunction with Fate/Persistence study. Offshore boulders and bedrock dissipated wave energy from this normally high energy beach. Intersticial oil(OP) and concentrations of surface oil residue found amongst and beneath boulders and cobble. Oiling far and above concentrations of mussels.

Kiukpalik Island, E side, K0914SK101A. 31 June. Not on original priority list. Visited site in conjunction with Fate/Persistence study. Located below the spruce tree grove this high energy shoreline is protected from extensive weathering by large offshore boulders and bedrock platforms. Extensive intersticial oil beneath and between sub-angular boulders and cobble. Oiling observed in mid to upper intertidal zone. No mussels observed.

Ninagiak Island, K0919HB050A. 19 July. Priority: High. Surveyed the southeastern and southwest coast of Ninagiak Island by skiff during seabird colony survey. Conducted while tides were high, however, the light oiling observed in the supra and high intertidal in the MAYSAP report, suggests poor criteria for sampling.

Ninagiak Island, Frans Arch, K0919HB050B. 1 August. Priority: High. Visited this small beach area near the confluence of segments A and B during the Fate/Persistence study. Noted as subdivision A in the MAYSAP report, weathered SOR was observed between boulders and coat on bedrock faces. All oiling was above sparse concentrations of mussels between boulders.

Cape Gull, K0922CG001A. 2 August. Priority: High. Surveyed this highly sheltered cove in the rain while installing a Fate/Persistence transect. Patches of SOR and intersticial oil between and beneath sub-angular cobble and boulders. All oiling was above patches of mussels.
On July 18 during an intertidal survey of the extreme low tidal area at the mouth of the cove, the crew observed moderate to dense concentrations of mussels but found no oil.

APPENDIX E (Continued): Reconnaissance of sites visited but not sampled.

Kashvik Bay, K0935KA002A. 4 August. Priority: Low. Located north of Cape Kubagakli, this segment was visited during the Fate/Persistence study. While oil was found in the mid to lower intertidal zone corresponding to area 1 (SSAT report), no mussels were observed in contact with oil. SSAT report indicates moderate to dense patches of mussels in areas near oil but no directly affected beds were noted.

Perevalnie Passage, N.E. Shuyak Is., K0110SI003A. 25 June. Priority: High. Visited site where ADEC installed station K011002 on a warm water wash beach area (Area E-MAYSAP). Also visited sites A, B, C, D and F. Mussels were sparse to rare all along segment. Oiling was very sporadic with patches of surface oil residue amongst large boulders and cobble. Although this north facing beach is fairly protected from high energy wave action, the oil observed was highly weathered and light. No transect was installed and recommend no further examination.

Perevalnie Passage, Bulldozer beach, K0110SI005A. 25 June. Priority: High. Very sporadic patches of surface oil residue and tar patches were found along this 500m segment. Mussel concentrations were very low and discontinuous. Greatest concentrations of mussels were found in Area B (MAYSAP report) within boulder cracks, east of bulldozer beach. Recommend no further examination.

Perevalnie Passage, Lagoon entrance, K0111SI004M. 25 June. Priority: Low. Segment included a tidally-influenced lagoon entrance and was generally characterized as rocky substrate, boulder and bedrock. Moderate Fucus coverage and sparse mussels were observed. Oiling very sporadic. Tide level, though quite poor for a low, was sufficient to carry out a good walking survey in the mid-intertidal zone of all three segments. As with the other two segments mentioned above, these areas did not meet sampling criteria. Recommend no further examination.

Chief Cove, Southern shore, K0619CK005A. 5 August. Priority: High. Surveyed area during a poor low tidal window. Observed trace amounts of oil on border of CK005A and SB006. No oil observed at State of Alaska, CERCLA study site at rock outcroppings on west side of small cove. The extensive mussel bed noted in the SSAT report at the head of the cove could not be surveyed due to tides. Other small baylets were also surveyed which contained moderate densities of mussels, but no oil was seen. Due to the light oiling noted in the SSAT reports for this segment and our current observations, I recommend no further examination.

Chief Cove, K0620SB001A. 25 August. A quick survey conducted within this small segment but no oil was observed. SSAT report indicated 56m of narrow oiling in 1990 and patchy dense mussel beds extending around cobbles and boulders, however, local indications

at sampling time convinced field crew that chances of finding oiled mussels within this segment was low. Poor tidal window necessitated field crew to continue surveys in other portions of Chief Cove.

Chief Cove, Southern shore, K0619SB006A. 5 August. Small patch of weathered mousse in the upper intertidal zone observed on southern border of this segment. This area contained only a few, scattered mussels. Before departing area the survey crew talked with some people regarding locations of any oiled mussel sites. They said that they had not seen any concentrations of oil or oil affected mussels in area. This area did not meet sampling criteria.

Appendix F
Information and recommendations for sites not visited

Pony Cove, South cove, AI003A. Land Manager:NPS, Priority:High
Not surveyed due to a combination of poor timing and poor tide series. This area probably would offer the "best" chance to find oiled mussels within Kenai Fjords National Park. SSAT in 1990 indicated moderate densities of mussels in the mid-intertidal zone. Within Pony Cove south, strong oil smell and sheens were observed in tidal pools according to a report (6/15/90) and which also observed more pooled oil than in previous report(SSAT). Although this cove is of moderate surf energy, there is possible oil remaining near concentrations of mussels. **Recommend that this area be examined further.**

Nuka Passage, Pocket Beach, YP002A. Land Manager:ADNR, Priority:High. This small, moderately exposed pocket beach was not surveyed. SSAT report indicates moderate to dense mussels in mid-intertidal. Very light oiling consisting of coat on bedrock faces. This segment was placed as high priority originally because personal communication with Leslie Pearson(former ADEC technician) indicated this to be a good candidate for mussels on or near oil. However, with the small area of prior oiling and moderate exposure in this cove, I would not recommend further consideration.

Petroff Point, PP001A. Land Manager:ADNR, Priority:Low
Not surveyed. MAYSAP notes little oil within a 500m stretch of beach located at the mouth of a stream. Since the MAYSAP team only investigated a small portion of this segment, there was suspect as to the other portions of this segment containing oil affected mussels. After visiting nearby Yalik Glacier and observing the highly weathered state of oil there, however, I suspect this segment would not meet sampling criteria.

Hoof Point, PY006. Land Manager:USFWS, Priority:Low
Not surveyed due to time constraints and hazardous landing conditions. Personal communication with Leslie Pearson(May, 1992) indicated a likely site (east facing shore north of Hoof Point) to find oiled mussels. This highly exposed shoreline that received moderate oiling however, contains no mention of oiled mussels in 1989 shoreline reports. Recommend this area not be examined further.

Ragged Is., N.E. side, PY007A. Land Manager:USFWS, Priority:Low
Not surveyed due to time constraints. Personal communication with Leslie Pearson(May, 1992) indicated a likely site to find mussels. Oiled mussels were observed in southern portion of cove in September 3, 1989 SCAT survey. MAYSAP report (survey by skiff) observed continuous cover of mussels in subdivision A and found no oil. Lack of a thorough survey in 1991 originally prompted a low priority rating, but now I suspect this area would not meet sampling criteria.

APPENDIX F (Continued): Information and recommendations for sites not visited.

Ragged Is., N., PY015B. Land Manager:USFWS, Priority:High
No survey conducted due to summer logistics and poor tidal windows. MAYSAP report indicated a moderately dense mussel bed present 6m from sites A1/A2. Light oiling observed throughout segment. Since conducting a survey on nearby MR001 and observing the height of the oil layer in relation to the mussel layer, I would not rate this segment as a good candidate for oiled mussels.

Rocky Bay, Rocky Point, RB001A. Land Manager:ADNR, Priority:High
This segment was not visited due to a combination of poor weather (this is a "nice" weather landing site), and a tight time schedule. MAYSAP report indicated mussel beds covering medium and light surface oil residue at location B. The SOR was generally 2-3cm thick. Light SOR under mussel bed at location A. Sheens were found in tidal pools. ADEC also established a transect at this location (301-T). I suspect this area would meet sampling criteria and **recommend this area be examined further.**

Rocky Bay, Rocky Point, RB001B. Land Manager:ADNR, Priority:Low
This segment not surveyed due to poor weather and lack of time. This area received no attention in the MAYSAP walk unlike the neighboring segment RB001A. Very little oil was observed in the SSAT, however, moderate to dense mussels were noted in the mid and upper intertidal zones. Although oiling was classified as very light, this small segment should be considered due to it's proximity to RB001A. **Recommend this area to be examined further.**

Rocky Bay, Grungy Cove, RB005A. Land Manager:Pt.Graham, Priority:Low. This small, low energy cove was 400 meters to the east of our transect site in RB005B. The MAYSAP report indicates only light oiling along bedrock faces, above most biota. Recommend no further consideration.

Chugach Bay, N.W. shore, CB003B.Land Manager:Pt.Graham
Priority:Low. Not surveyed due to lack of time and poor tides. MAYSAP report indicated dense mussels in one area (sub-division F) where mousse(1%) lies in boulder crevices. Sparse mussels in other areas with mousse(1%), coat and stain. No observations of the lower intertidal were possible. The presence of heavy and moderate oiling observed along this segment indicates a fair chance of finding oil affected mussels. **Recommend that this area be examined further.**

Chugach Bay, N. shore, CB003C. Land Manager:Port Graham.
Not on original priority list due to newly acquired MAYSAP report. Moderate to dense concentrations of mussels were observed in most of the oiled sites in the upper to mid intertidal zone in Areas A and B(MAYSAP report). Due to the relative low exposure to waves caused by offshore boulders and bedrock at several of the sites, the probability of oiled mussels still remain high. **Recommend that this area be examined further.**

APPENDIX F (Continued): Information and recommendations for sites not visited.

Chugach Bay, S. shore, CB004B. Land Manager:Pt.Graham Priority:Low. Not surveyed due to lack of time and poor tides. A fairly exposed, clean sand/pebble/cobble beach with well-developed intertidal biota on adjacent bedrock outcroppings(MAYSAP report). According to MAYSAP report, moderately to dense patches of mussels were observed near intersticial mousse and coatings of oil. Biota appears healthy near oil zones with evidence of recent recruitment noted in mussels. The proximity of this segment to CB003B and the transect data compiled from ADEC transect 306-T at this site implores that this segment be surveyed in the future for oiled mussels. **Recommend that this area be examined further.**

Cape Douglas, K0910CD011A. Land Manager:NPS, Priority: Low. This area was not surveyed. After work conducted on a site to the north, it was determined that this low priority beach would most likely not meet sampling criteria.

Big River, K0916BR001B. Land Manager:NPS, Priority: Low. This area was not surveyed due to time constraints and the extremely low probability of finding oiled mussels. SSAT mentioned very light oiling and no oiling near mussels on intertidal rock benches. Recommend this area not be considered further.

Ninagiak Reef, K0919HB100A. Land Manager: NPS, Priority: Low. Not surveyed due to poor tidal window. This area needs extremely low tides to access oiled area. SSAT mentioned mussels were dense to moderate in upper and mid ITZ and patchy concentrations near oiled areas. Recommend this area not be considered further.

Kukak Bay, K0921KU003A. Land Manager: NPS, Priority: Low. Not surveyed. Mussels noted in a few dense patches on rock outcroppings and flat low areas in SSAT. No mussels were observed near oiled areas. Recommend this area not be considered further.

Cape Gull, K0923CG003A. Land Manager: NPS, Priority: High. Not surveyed. While conducting work in the local area it was determined that visiting this site would be a waste of time due to the very light oiling and patchy mussels observed in the SSAT. Recommend this area not be examined further.

Kuliak Bay, K0924KU004A. Land Manager: NPS, Priority: Low. Not surveyed. Very light oiling observed in this area in 1990 makes this bay an unlikely area to find oiled mussels. Recommend this area not be examined further.

Kashvik Bay, Bayhead, K0935KA003A. Land Manager: NPS, Priority: Low. Not surveyed due to time constraints and low probability of finding oiled mussels. MAYSAP noted mousse and surface oil residue in MITZ, but above any mussels. Recommend this area not be examined further.

APPENDIX F (Continued): Information and recommendations for sites not visited.

Kashvik Bay, South, K0936KA001A. Land Manager: NPS, Priority: Low. Not surveyed due to time constraints and low probability of finding oiled mussels. SSAT noted very light oiling, all of which was in the upper intertidal. Recommend this area not be examined further.

Alinchak Bay, K1002AS007A. Land Manager:USFWS, Priority: High. This area was not surveyed due to time and tide constraints. SSAT indicated dense to moderate patches of mussels along the western and northern edge of an extensive mud flat. Narrow oiling was observed. MAYSAP assessment focused on the heaviest oiling along the base of a rock cliff, east of anadromous stream #262-65-10040 and observed SOR amongst boulders in the upper intertidal. Some sheens were observed as well. Mussels were not observed in oiling area, however due to conversations with USFWS personnel (Donna Dewhurst, 1992) this area still remains a likely site for oiled mussels. **Recommend this area be examined further.**

Alinchak Bay, K1005AS004B. Land Manager:USFWS, Priority: Low. This segment lies on the southern side of Alinchak Bay. Due to time and tide constraints this was not surveyed. SSAT assessments observed medium to narrow oiling in the forms of splattered cover and patches of mousse pavement. No specific mention of oiled mussels. MAYSAP recorded two oiled sites along segment. Mussels were observed in proximity to SOR(1m X 1m). Sheen was seen in tidal pools. Opportunity to locate oiled mussels here is probably low and I recommend this area not be examined further.

Shuyak Harbor, K0103SS002B. Land Manager:ADNR, Priority: Low. This segment was not surveyed. MAYSAP report recorded very light oiling along this low energy, highly indented embayment within Shuyak Harbor on the S.W. side of Shuyak Island. Oiling (SOR, coat and stain) was observed below the SITZ in places where mussels were found in sporadic clusters. Mussel beds at head of bay. Early this spring interviews with persons familiar with this area indicated the S.W. corner of Shuyak Harbor would be a likely site for oiled mussels (Goodwin, 1992). However due to the difficulty of the MAYSAP crew to locate any residual oiling and the patchiness of mussel concentrations, I recommend this area not be examined further.

Malina Bay, K0210MB006A. Land Manager:USFWS, Priority: Low. This segment was not surveyed. SSAT report observed 5m of very light oiling along this N.W. embayment within Malina Bay (Afognak Island). Moderate to dense mussel densities near mousse/pavement patches but there were no observations of direct contact with oiled substrate. Originally placed on the priority list due to a personal recommendation, this segment however would most likely not meet sampling criteria. I recommend this area not be examined further.

APPENDIX F (Continued): Information and recommendations for sites not visited.

Sturgeon Lagoon, K0634SL009A. Land Manager:Koniag Inc., Priority: Low. Located south of Cape Karluk on the southwestern side of Kodiak Island this segment included the mouth of Sturgeon Lagoon but was not visited during this summer's survey. This segment received historically the most oil for this area, but during the SSAT assessment no oil was observed possibly due to burying by shifting sediments. Personal communication with the shellfish biologist for the Kodiak Area Native Association (Donahue, 1992) indicated this area was a good location for oiled mussels. Due to the relative high energy of this shoreline however, the chance of this area meeting sampling criteria is quite low.